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SET-4

Series : SR3PQ

प्रश्न-पत्र कोड
Q.P. Code **465**

रोल नं.
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book.

व्यावहारिक गणित
APPLIED MATHEMATICS

निर्धारित समय : ***3*** *घण्टे* | *अधिकतम अंक :* ***80***
Time allowed : ***3*** *hours* | *Maximum Marks :* ***80***

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **23** हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में **38** प्रश्न हैं ।
- **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में यथा स्थान पर प्रश्न का क्रमांक अवश्य लिखें ।**
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains **23** printed pages.
- Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **38** questions.
- **Please write down the Serial Number of the question in the answer-book at the given place before attempting it.**
- 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period. [ ]

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सामान्य निर्देश :

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सख़्ती से पालन कीजिए :

(i) *इस प्रश्न-पत्र में **38** प्रश्न हैं। **सभी** प्रश्न **अनिवार्य** हैं।*

(ii) *यह प्रश्न-पत्र **पाँच** खण्डों में विभाजित है – **क, ख, ग, घ** एवं **ङ**।*

(iii) ***खण्ड क** में, प्रश्न संख्या **1** से **18** तक बहुविकल्पीय (MCQ) तथा प्रश्न संख्या **19** एवं **20** अभिकथन एवं तर्क आधारित **1** अंक के प्रश्न हैं।*

(iv) ***खण्ड ख** में, प्रश्न संख्या **21** से **25** तक अति लघु-उत्तरीय (VSA) प्रकार के **2** अंकों के प्रश्न हैं।*

(v) ***खण्ड ग** में, प्रश्न संख्या **26** से **31** तक लघु-उत्तरीय (SA) प्रकार के **3** अंकों के प्रश्न हैं।*

(vi) ***खण्ड घ** में, प्रश्न संख्या **32** से **35** तक दीर्घ-उत्तरीय (LA) प्रकार के **5** अंकों के प्रश्न हैं।*

(vii) ***खण्ड ङ** में, प्रश्न संख्या **36** से **38** तक प्रकरण अध्ययन आधारित **4** अंकों के प्रश्न हैं।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड ख के 2 प्रश्नों में, खण्ड ग के 2 प्रश्नों में, खण्ड घ के 2 प्रश्नों में तथा खण्ड ङ के 3 प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।*

(ix) *कैल्कुलेटर का उपयोग **वर्जित** है।*

खण्ड क

*इस खण्ड में **20** बहुविकल्पीय प्रश्न (MCQ) हैं, जिनमें प्रत्येक प्रश्न **1** अंक का है।*

1. वास्तविक x, जिसके लिए $2(2x + 3) - 10 < 6(x - 2)$ है, है :

(A) $x > 2$ (B) $x > 3$

(C) $x > 4$ (D) $x > -4$

2. प्रत्येक प्रविष्टि 1 या 2 के साथ कोटि 3×2 के सभी संभावित आव्यूहों की संख्या है :

(A) 6 (B) 16

(C) 24 (D) 64

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General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) *This question paper contains **38** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** Sections – **A**, **B, C, D** and **E**.*

(iii) *In **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.*

(iv) *In **Section B,** Questions no. **21** to **25** are Very Short Answer (VSA) type questions, carrying **2** marks each.*

(v) *In **Section C,** Questions no. **26** to **31** are Short Answer (SA) type questions, carrying **3** marks each.*

(vi) *In **Section D,** Questions no. **32** to **35** are Long Answer (LA) type questions carrying **5** marks each.*

(vii) *In **Section E,** Questions no. **36** to **38** are case study based questions carrying **4** marks each.*

(viii) *There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and 3 questions in Section E.*

(ix) *Use of calculator is **not** allowed.*

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) $x > -4$

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

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3. यदि $AB = A$ और $BA = B$ है, तो $(B^2 + B)$ बराबर है :

(A) $2A$ (B) O

(C) $2I$ (D) $2B$

4. $\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{vmatrix}$ का मान है :

(A) 5 (B) -7

(C) 9 (D) 0

5. अवकल समीकरण $y \log y \, dx - x \, dy = 0$ का व्यापक हल है :

(A) $y = \log |cx|$ (B) $y = e^{|cx|}$

(C) $y = e^{c+x}$ (D) $\log y = |c + x|$

6. यदि $\int_0^{40} \frac{dx}{2x+1} = \log k$ है, तो k का मान है :

(A) 3 (B) 9

(C) $\frac{9}{2}$ (D) $\frac{3}{2}$

7. यदि $x = t^2$ और $y = t^3$ है, तो $\frac{d^2y}{dx^2}$ बराबर है :

(A) $\frac{3}{2}$ (B) $\frac{3}{4t}$

(C) $\frac{1}{2t^2}$ (D) $\frac{3}{2t}$

❀

3. If AB = A and BA = B, then $(B^2 + B)$ is equal to :

(A) 2A (B) O

(C) 2I (D) 2B

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

5. General solution of differential equation $y \log y \, dx - x \, dy = 0$ is :

(A) $y = \log |cx|$ (B) $y = e^{|cx|}$

(C) $y = e^{c+x}$ (D) $\log y = |c + x|$

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) $\frac{3}{2}$

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) $\frac{3}{2t}$

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8. एक वृत्त के क्षेत्रफल में परिवर्तन की दर उसकी त्रिज्या r के सापेक्ष (cm^2/s में), जब $r = 6$ cm है, है :

(A) 10π (B) 12π

(C) 8π (D) 11π

9. यदि X एक असतत यादृच्छिक चर है, तो X का प्रसरण है :

(A) $E(X^2)$ (B) $E(X^2) - [E(X)]^2$

(C) $E(X^2) + [E(X)]^2$ (D) $\sqrt{E(X^2) - [E(X)]^2}$

10. यदि 'm' एक प्वासों बंटन का माध्य है, तो इस बंटन का प्रसरण होगा :

(A) m^2 (B) $\sqrt{m}$

(C) m (D) $\frac{m}{2}$

11. एक मानक सामान्य वक्र के अंतर्गत कुल क्षेत्रफल है :

(A) 1 (B) $\sqrt{2}$

(C) 2 (D) $\frac{1}{2}$

12. महत्त्व के t-परीक्षण के उद्देश्य के लिए, यदि आकार 34 का एक यादृच्छिक नमूना एक सामान्य जनसंख्या से लिया जाता है, तब स्वतन्त्रता की डिग्री (ν) है :

(A) 32 (B) 33

(C) 34 (D) 35

13. t-वितरण के चर 't' की सीमा है :

(A) (0, 1) (B) (1, 2)

(C) (– 1, 1) (D) $(-\infty, \infty)$

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

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) $\sqrt{E(X^2) - [E(X)]^2}$

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) $\frac{m}{2}$

11. The total area under a standard normal curve is :

(A) 1 (B) $\sqrt{2}$

(C) 2 (D) $\frac{1}{2}$

12. For the purpose of t-test of significance, if a random sample of size 34 is drawn from a normal population, then the degree of freedom (ν) is :

(A) 32 (B) 33

(C) 34 (D) 35

13. The range of variable t of the t-distribution is :

(A) (0, 1) (B) (1, 2)

(C) (– 1, 1) (D) $(-\infty, \infty)$

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14. प्रत्येक अवधि के अंत में देय ₹ R की एक संततता का वर्तमान मूल्य, जबकि धनराशि पर ब्याज i प्रति अवधि मिलता है, है :

(A) Ri (B) $R + \frac{R}{i}$

(C) $\frac{R}{i}$ (D) $R - Ri$

15. फ्लैट दर विधि का उपयोग करते हुए, ₹ 20,000 का ऋण $2\frac{1}{2}$ वर्षों में, जो 8% प्रति वर्ष की ब्याज दर पर है, चुकाने के लिए EMI है :

(A) ₹ 700 (B) ₹ 800

(C) ₹ 900 (D) ₹ 100

16. यदि ₹ 10,000 का निवेश 4 वर्षों में ₹ 60,000 हो जाता है, तो चक्रवृद्धि वार्षिक वृद्धि दर (CAGR) है :

(A) $\frac{\sqrt[4]{6}-1}{100}$ (B) $\frac{\sqrt[4]{6}+1}{100}$

(C) $(\sqrt[4]{6}-1) \times 100$ (D) $(\sqrt[4]{6}+1) \times 100$

17. एक मशीन का मूल्य ₹ 45,000 है तथा इसका अनुमानित उपयोगी जीवन 5 वर्ष है और इसका अवशिष्ट मूल्य ₹ 10,000 है। मशीन का वार्षिक मूल्यह्रास है :

(A) ₹ 8,000 (B) ₹ 7,000

(C) ₹ 6,000 (D) ₹ 5,000

18. अवरोधों $x \leq 3, y \leq 2, x \geq 0, y \geq 0$ के अंतर्गत फलन $z = 7x + 5y$ का अधिकतम मान है :

(A) 10 (B) 21

(C) 31 (D) 29

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) $R - Ri$

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

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) $(\sqrt[4]{6}+1) \times 100$

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

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

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*प्रश्न संख्या **19** और **20** अभिकथन एवं तर्क आधारित प्रश्न हैं । दो कथन दिए गए हैं, जिनमें एक को अभिकथन (A) तथा दूसरे को तर्क (R) द्वारा अंकित किया गया है। इन प्रश्नों के सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए।*

(A) अभिकथन (A) और तर्क (R) दोनों सही हैं और तर्क (R), अभिकथन (A) की सही व्याख्या करता है।

(B) अभिकथन (A) और तर्क (R) दोनों सही हैं, परन्तु तर्क (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है।

(C) अभिकथन (A) सही है, परन्तु तर्क (R) ग़लत है।

(D) अभिकथन (A) ग़लत है, परन्तु तर्क (R) सही है।

19. *अभिकथन (A) :* $\int \frac{1}{\sqrt{9 - x^2}}\, dx = \sin^{-1} \frac{x}{3} + C$

तर्क (R) : $\int \frac{1}{\sqrt{a^2 - x^2}}\, dx = \sin^{-1} \frac{x}{a} + C$

20. *अभिकथन (A) :* एक ऋण शोधन निधि (सिंकिंग फंड) में, नियमित अन्तराल में एक निश्चित राशि जमा की जाती है।

तर्क (R) : बचत (सेविंग) बैंक खाते में, कोई भी राशि किसी भी समय पर जमा की जा सकती है।

खण्ड ख

*इस खण्ड में अति लघु-उत्तरीय (VSA) प्रकार के **5** प्रश्न हैं, जिनमें प्रत्येक के **2** अंक हैं।*

21. एक व्यक्ति एक नाव में 12 किमी धारा के अनुकूल जाता है और 3 घंटे में नाव में प्रारंभिक बिन्दु पर वापस आता है (बिना रुके)। यदि धारा की गति 3 किमी/घंटा है, तो नाव की वह गति ज्ञात कीजिए जिससे यह व्यक्ति शांत जल में नाव चला सकता है।

22. (क) निम्नलिखित अवकल समीकरण को हल कीजिए :

$$\frac{dy}{dx} = \frac{2 - y}{x + 1}$$

अथवा

(ख) यदि $\int_a^b x^3\, dx = 0$ तथा $\int_a^b x^2\, dx = \frac{2}{3}$ है, तो 'a' और 'b' के मान ज्ञात कीजिए।

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*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) : $\int \frac{1}{\sqrt{a^2 - x^2}}\, dx = \sin^{-1} \frac{x}{a} + C$

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.

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.

22. (a) Solve the following differential equation :

$$\frac{dy}{dx} = \frac{2 - y}{x + 1}$$

OR

(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'.

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23. (क) प्वासों बंटन के लिए यदि माध्य (m) = 1 है, तो P(r = 1) ज्ञात कीजिए।

अथवा

(ख) द्विपद बंटन $B\left(4, \frac{1}{3}\right)$ का माध्य और मानक विचलन ज्ञात कीजिए।

24. निम्नलिखित आँकड़ों के लिए 3-वर्षीय चल औसत ज्ञात कीजिए :

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

25. एक व्यक्ति 15% प्रति वर्ष की ब्याज दर (मासिक परिकलित) पर ₹ 2,00,000 का व्यक्तिगत ऋण लेता है, जिसे 4 वर्षों में समान मासिक किश्तों में चुकाना होता है। घटती शेष राशि विधि का उपयोग करके EMI की गणना कीजिए। [दिया गया है : $(1{\cdot}0125)^{-48} = 0{\cdot}55$]

खण्ड ग

*इस खण्ड में लघु-उत्तरीय (SA) प्रकार के **6** प्रश्न हैं, जिनमें प्रत्येक के **3** अंक हैं।*

26. (क) (i) धनात्मक पूर्णांकों 17 तथा 13 के लिए धनात्मक मौडुलो (modulo) 30 का प्रयोग कीजिए।

(ii) संख्या 11 तथा 3 के लिए मौडुलो (modulo) 8 घटाव ज्ञात कीजिए।

अथवा

(ख) एक टंकी को तीन पाइप A, B और C मिलकर 8 घंटे में भर सकते हैं। 2 घंटे तीनों एक साथ काम करने के बाद, पाइप B को बंद कर दिया जाता है और शेष टंकी को पाइप A और C 9 घंटे में भरते हैं। अकेले पाइप B द्वारा टंकी को पूरा भरने पर लगने वाले समय की गणना कीजिए।

❀

23. (a) For a Poisson distribution, if mean (m) = 1, then find P(r = 1).

OR

(b) Find the mean and standard deviation of the Binomial distribution $B\left(4, \frac{1}{3}\right)$.

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

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 : $(1{\cdot}0125)^{-48} = 0{\cdot}55$]

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.

OR

(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.

❋

27. क्रैमर नियम का उपयोग करके, दर्शाइए कि रैखिक समीकरणों का निम्नलिखित निकाय सुसंगत है, अत: इसे हल कीजिए।

$$2x - 3y + 5z = 11$$
$$3x + 2y - 4z = -5$$
$$x + y - 2z = -3$$

28. (क) $\mathbb{R}$ में वह अन्तराल ज्ञात कीजिए जिनमें फलन $f(x) = x^4 - 2x^2$ वर्धमान या ह्रासमान है।

अथवा

(ख) ज्ञात कीजिए : $\int \frac{2x+1}{18-4x-x^2}\, dx$

29. एक साबुन बनाने वाली कंपनी एक विशेष ब्रांड के साबुन को कई खुदरा दुकानों में बड़ी संख्या में वितरित कर रही थी। एक बड़े विज्ञापन अभियान से पहले, प्रति दुकान प्रति सप्ताह औसत बिक्री 140 दर्जन थी। अभियान के बाद 26 दुकानों का नमूना लिया गया और औसत बिक्री, मानक विचलन 16 के साथ 147 दर्जन पाई गई। क्या आप विज्ञापन अभियान को प्रभावी मान सकते हैं ?

[दिया गया है : $t_{25}\ (0{\cdot}05) = 2{\cdot}06$]

30. एक कंपनी XYZ लिमिटेड ने ₹ 10,000 के अंकित मूल्य वाला एक बॉन्ड जारी किया है जो 8·5% की दर से वार्षिक लाभांश देता है। बॉन्ड 10 वर्ष के अंत में सममूल्य पर भुनाया जाएगा। यदि निवेशक 8% की उपज दर चाहता है, तो बॉन्ड का खरीद मूल्य ज्ञात कीजिए।

[दिया गया है : $(1{\cdot}08)^{-10} = 0{\cdot}46319349$]

31. निम्नलिखित रैखिक प्रोग्रामिंग समस्या (एलपीपी) को ग्राफ द्वारा हल कीजिए :

$z = 3x + 5y$ का अधिकतमीकरण कीजिए।

अवरोधों के अंतर्गत :

$$x + 2y \leq 2000$$
$$x + y \leq 1500$$
$$y \leq 600$$
$$x \geq 0, y \geq 0$$

27. Using Cramer's rule, show that the following system of linear equations is consistent and hence solve it :

$$2x - 3y + 5z = 11$$

$$3x + 2y - 4z = -5$$

$$x + y - 2z = -3$$

28. (a) Find the intervals in $\mathbb{R}$ for which the function $f(x) = x^4 - 2x^2$ is increasing or decreasing.

OR

(b) Find : $\int \frac{2x+1}{18 - 4x - x^2}\, dx$

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 $t_{25}(0{\cdot}05) = 2{\cdot}06$]

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 : $(1{\cdot}08)^{-10} = 0{\cdot}46319349$]

31. Solve the following Linnear Programming Problem (LPP) graphically :

Maximize $z = 3x + 5y$

subject to the constraints :

$x + 2y \leq 2000$

$x + y \leq 1500$

$y \leq 600$

$x \geq 0, y \geq 0$

❋

खण्ड घ

*इस खण्ड में **4** दीर्घ-उत्तरीय (LA) प्रकार के प्रश्न हैं, जिनमें प्रत्येक के **5** अंक हैं।*

32. निम्नलिखित असमिका को हल कीजिए :

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

33. (क) मांग फलन $p = 25 - x - x^2$ के लिए उपभोक्ता अधिशेष ज्ञात कीजिए, जहाँ प्रचलित बाज़ार मूल्य $p_0 = 19$ है।

अथवा

(ख) निम्नलिखित प्रारंभिक मान अवकल समीकरण को हल कीजिए :

$(x - 1) \frac{dy}{dx} = 2xy$, जबकि $y(2) = 1$

34. (क) एक अच्छी प्रकार से फेंटी गई 52 पत्तों की ताश की गड्डी में से एक-एक करके प्रतिस्थापन सहित दो पत्ते यादृच्छया निकाले गए। इक्कों की संख्या का प्रायिकता बंटन ज्ञात कीजिए। इसका माध्य तथा विचरण भी ज्ञात कीजिए।

अथवा

(ख) यह दिया गया है कि किसी कंपनी द्वारा निर्मित 2% स्क्रू दोषपूर्ण हैं। प्वासों बंटन का उपयोग करके यह प्रायिकता ज्ञात कीजिए कि 100 स्क्रू के पैकेट में (i) कोई दोषपूर्ण स्क्रू नहीं है (ii) केवल एक दोषपूर्ण स्क्रू है।

35. श्री आर्य जानना चाहते हैं कि उन्हें एक सोने की खदान के लिए कितनी राशि का भुगतान करना चाहिए, जिससे अगले 10 वर्षों तक ₹ 4 लाख का वार्षिक रिटर्न प्राप्ति की अपेक्षा है, जिसके बाद यह बेकार हो जाएगी। यदि वह अपने निवेश पर 18% वार्षिक रिटर्न प्राप्त करना चाहता है और खरीद मूल्य के बदले में एक ऋण शोधन निधि (सिंकिंग फंड) भी स्थापित करना चाहता है, तो उसे खदान के लिए कितनी राशि का भुगतान करना चाहिए, यह ज्ञात कीजिए। मान लीजिए कि ऋण शोधन निधि (सिंकिग फंड) वार्षिक 10% कमाता है। $[(1{\cdot}1)^{10} = 2{\cdot}5937$ का उपयोग कीजिए]

SECTION D

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

32. Solve the following inequation :

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

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

OR

(b) Solve the following initial value differential equation :

$(x - 1)\frac{dy}{dx} = 2xy$, when $y(2) = 1$.

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.

OR

(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.

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 $(1{\cdot}1)^{10} = 2{\cdot}5937$]

❋

खण्ड ङ

*इस खण्ड में **3** प्रकरण-अध्ययन आधारित प्रश्न हैं, जिनमें प्रत्येक के **4** अंक हैं।*

प्रकरण अध्ययन – 1

36. तीन स्कूलों A, B और C ने बाढ़ पीड़ितों के पुनर्वास में मदद करने के लिए धन इकट्ठा करने हेतु एक मेला आयोजित किया। उन्होंने क्रमश: ₹ 25, ₹ 50 और ₹ 10 की लागत से पुनर्नवीनीकृत सामग्री से हाथ से बने पंखे, चटाई और प्लेटें बेचीं। बेचीं गई वस्तुओं की संख्या नीचे दी गई है :

स्कूल / वस्तुएँ	A	B	C
हाथ से बने पंखे	50	30	35
चटाई	60	35	40
प्लेटें	40	50	25

उपर्युक्त सूचना के आधार पर, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) मूल्य आव्यूह क्या है ? *1*

(ii) बिक्री आव्यूह क्या है ? *1*

(iii) (क) स्कूल B द्वारा एकत्रित धन का आव्यूह क्या है ? *2*

अथवा

(iii) (ख) स्कूलों A और C द्वारा एकत्रित कुल धन कितना है ? *2*

SECTION E

*This section comprises **3** Case-Study Based questions of **4** marks each.*

Case Study – 1

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*

❋

प्रकरण अध्ययन – 2

37. जब लंबे समय तक देखा जाता है, तो एक समय श्रृंखला डेटा, प्रवृत्ति की भविष्यवाणी कर सकता है जो विचाराधीन चर की वृद्धि या कमी या ठहराव का पूर्वानुमान लगा सकता है । इस तरह के विश्लेषणात्मक अध्ययन उत्पादन या भविष्य की अनुमानित बिक्री के पूर्वानुमान या भविष्यवाणी के लिए एक व्यवसाय को लाभ पहुँचा सकते हैं।

गणितीय रूप से, किसी प्रवृत्ति का प्रतिनिधित्व करने के लिए सबसे उपयुक्त रेखा खोजने हेतु कई तरीके उपलब्ध हैं। मूविंग-एवरेज और कम-से-कम वर्ग जैसी विधियाँ ऐसी प्रवृत्तियों की भविष्यवाणी करने की कुछ तकनीकें हैं।

श्री नितिन एक साबुन बनाने की फैक्ट्री चलाते हैं और 2018 – 2024 की अवधि के लिए उनके साबुन की बिक्री का रिकॉर्ड इस प्रकार है :

वर्ष	2018	2019	2020	2021	2022	2023	2024
बिक्री (₹ हजारों में)	80	90	92	83	94	99	92

उपर्युक्त सूचना के आधार पर, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) दिए गए आँकड़ों के लिए प्रवृत्ति रेखा प्राप्त कीजिए। *1*

(ii) बिक्री में औसत परिवर्तन ज्ञात कीजिए। *1*

(iii) (क) वास्तविक बिक्री और प्रवृत्ति मूल्यों में अन्तर का योग ज्ञात कीजिए (2018 – 2024 के लिए)। *2*

अथवा

(iii) (ख) वर्ष 2025 में अपेक्षित बिक्री क्या है ? *2*

Case Study – 2

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*

❋

प्रकरण अध्ययन – 3

38. एक व्यक्ति के पास चावल और गेहूँ खरीदने के लिए ₹ 15,000 हैं। चावल की एक बोरी और गेहूँ की एक बोरी की लागत क्रमश: ₹ 1,800 और ₹ 1,200 है। उसके पास 10 बोरियों की भंडारण क्षमता है। वह चावल की प्रति बोरी पर ₹ 100 और गेहूँ की प्रति बोरी पर ₹ 90 का लाभ कमाता है। यह मानते हुए कि वह खरीदी गई सभी वस्तुओं को बेच सकता है, वह चावल की x बोरियाँ और गेहूँ की y बोरियाँ खरीदता है।

उपर्युक्त सूचना के आधार पर और रैखिक प्रोग्रामिंग समस्या (एलपीपी) सूत्रीकरण द्वारा, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) उद्देश्य फलन को लिखिए जो दोनों प्रकार की कुल बोरियों की बिक्री से कुल लाभ का प्रतिनिधित्व करता है। *1*

(ii) दोनों प्रकार की बोरियों की कुल लागत से संबंधित व्यवरोधों को लिखिए। *1*

(iii) (क) अधिकतम लाभ प्राप्त करने के लिए व्यक्ति को प्रत्येक प्रकार की कितनी बोरियाँ खरीदनी चाहिए ? *2*

अथवा

(iii) (ख) वह व्यक्ति सभी बोरियों को बेचकर कितना लाभ अर्जित कर सकता है ? ज्ञात कीजिए। *2*

Case Study – 3

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*

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
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	-	-

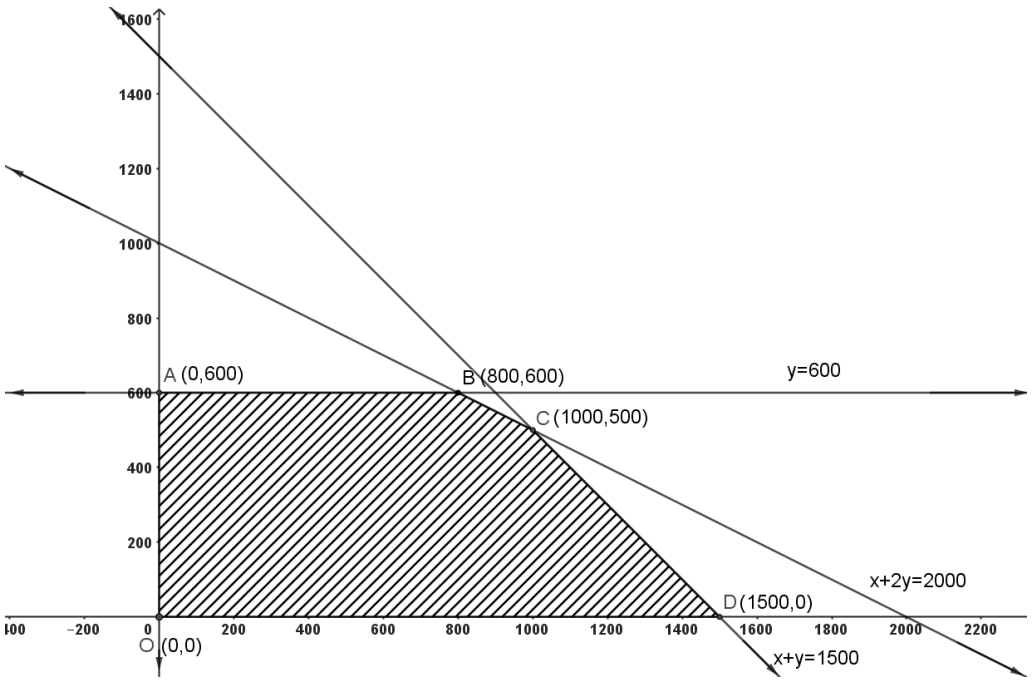
Correct Table — **I** — **2**

(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*

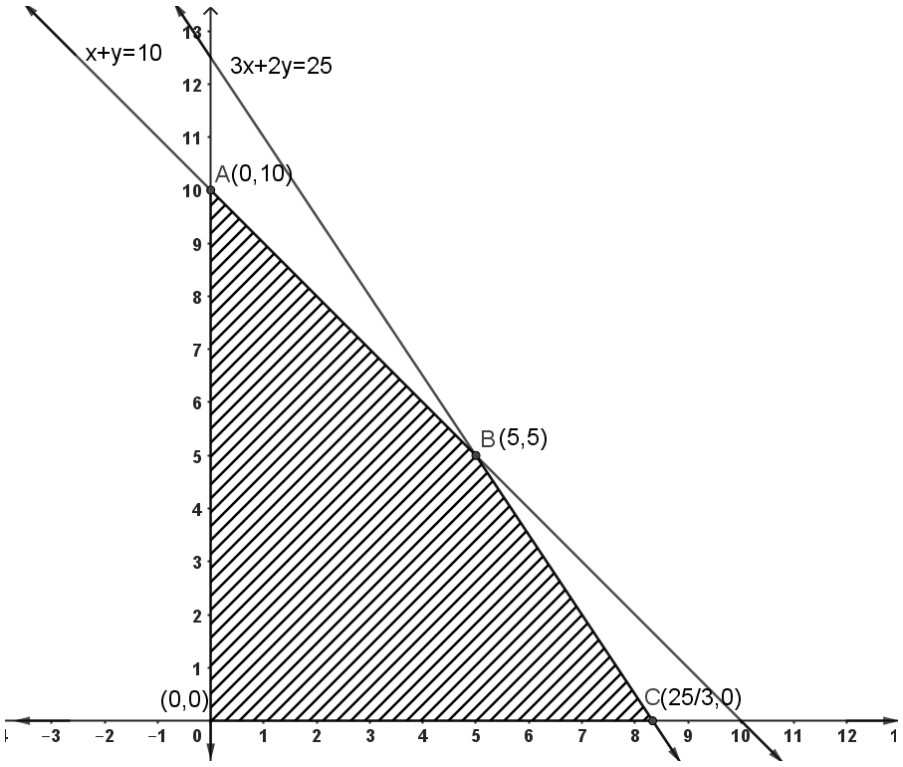
Sol.

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**

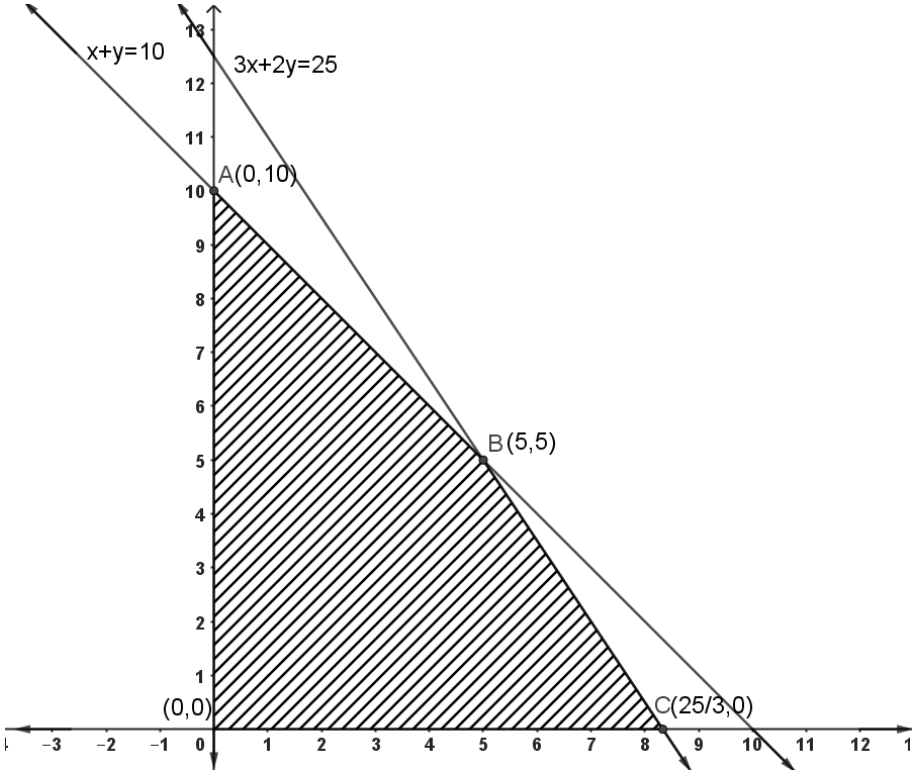
Corner Points	$Z = 100x + 90y$
O (0, 0)	0
A (0, 10)	900
B (5,5)	950 → Maximum Value
$C\left(\frac{25}{3}, 0\right)$	$\frac{2500}{3}$

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)

Series : W1XZY

SET ~ 4

रोल नं.

Roll No.

प्रश्न-पत्र कोड **Q.P. Code 465**

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।

Candidates must write the Q.P. Code on the title page of the answer-book.

व्यावहारिक गणित

APPLIED MATHEMATICS

निर्धारित समय : 3 घण्टे *अधिकतम अंक : 80*

Time allowed : 3 hours *Maximum Marks : 80*

नोट

(I) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **23** हैं ।

(II) कृपया जाँच कर लें कि इस प्रश्न-पत्र में **38** प्रश्न हैं ।

(III) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।

(IV) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में यथा स्थान पर प्रश्न का क्रमांक अवश्य लिखें ।**

(V) इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।

NOTE

(I) Please check that this question paper contains **23** printed pages.

(II) Please check that this question paper contains **38** questions.

(III) Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.

(IV) **Please write down the serial number of the question in the answer-book at the given place before attempting it.**

(V) 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period. ~

✡ ✡

सामान्य निर्देश :

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सख़्ती से पालन कीजिए :

(i) *इस प्रश्न-पत्र में **38** प्रश्न हैं । **सभी** प्रश्न **अनिवार्य** हैं ।*

(ii) *यह प्रश्न-पत्र **पाँच** खण्डों में विभाजित है – **क, ख, ग, घ** एवं **ङ** ।*

(iii) *खण्ड – **क** में प्रश्न संख्या **1** से **18** तक बहुविकल्पीय तथा प्रश्न संख्या **19** एवं **20** अभिकथन एवं तर्क आधारित **1** अंक के प्रश्न हैं ।*

(iv) *खण्ड – **ख** में प्रश्न संख्या **21** से **25** तक अति लघु-उत्तरीय (VSA) प्रकार के **2** अंकों के प्रश्न हैं ।*

(v) *खण्ड – **ग** में प्रश्न संख्या **26** से **31** तक लघु-उत्तरीय (SA) प्रकार के **3** अंकों के प्रश्न हैं ।*

(vi) *खण्ड – **घ** में प्रश्न संख्या **32** से **35** तक दीर्घ-उत्तरीय (LA) प्रकार के **5** अंकों के प्रश्न हैं ।*

(vii) *खण्ड – **ङ** में प्रश्न संख्या **36** से **38** प्रकरण अध्ययन आधारित **4** अंकों के प्रश्न हैं ।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है । यद्यपि, खण्ड – **ख** के **2** प्रश्नों में, खण्ड – **ग** के **2** प्रश्नों में, खण्ड – **घ** के **2** प्रश्नों में तथा खण्ड-**ङ** के **3** प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है ।*

(ix) *कैल्कुलेटर का उपयोग **वर्जित** है ।*

खण्ड – क

इस खण्ड में बहुविकल्पीय प्रश्न हैं जिनमें प्रत्येक **1** अंक का है ।
(प्रश्न सं. **1** से **18** में सही विकल्प चुनिए ।)

1. – 41 mod 9 बराबर है :

(A) 5 (B) 4
(C) 3 (D) 0

2. यदि $a > b$ तथा $c < 0$ है, तो निम्न में से कौनसा सही है ?

(A) $a + c < b + c$ (B) $a - c < b - c$
(C) $a\,c > b\,c$ (D) $a - c > b + c$

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) *This question paper contains **38** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** Sections – Section **A**, **B**, **C**, **D** and **E**.*

(iii) *In Section – **A**, Questions Number **1** to **18** are Multiple Choice Questions (MCQs) and questions Number **19** & **20** are Assertion-Reason based questions of **1** mark each.*

(iv) *In Section – **B**, Questions Number **21** to **25** are Very Short Answer (VSA) type questions, carrying **2** marks each.*

(v) *In Section – **C**, Questions Number **26** to **31** are Short Answer (SA) type questions, carrying **3** marks each.*

(vi) *In Section – **D**, Questions Number **32** to **35** are Long Answer (LA) type questions, carrying **5** marks each.*

(vii) *In Section – **E**, Questions Number **36** to **38** are case study based questions, carrying **4** marks each.*

(viii) *There is no overall choice. However, an internal choice has been provided in **2** questions in Section – **B**, **2** questions in Section – **C**, 2 questions in Section – **D** and **3** questions in Section – **E**.*

(ix) *Use of calculators is **NOT** allowed.*

SECTION – A

This section comprises of Multiple Choice Questions (MCQs) of **1** mark each. Select the correct option (Question 1 to Question 18) :

1. – 41 mod 9 is

(A) 5 (B) 4

(C) 3 (D) 0

2. If $a > b$ and $c < 0$, then which of the following is true ?

(A) $a + c < b + c$ (B) $a - c < b - c$

(C) $a c > b c$ (D) $a - c > b + c$

3. यदि A तथा B समान कोटि के सममित आव्यूह हैं, तो $(AB' - BA')$ एक

(A) सममित आव्यूह है
(B) शून्य आव्यूह है
(C) विकर्ण आव्यूह है
(D) विषम-सममित आव्यूह है

4. आव्यूह $A = \begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$ का व्युत्क्रम है :

(A) $\frac{1}{6}\begin{bmatrix} -4 & 2 \\ -1 & -1 \end{bmatrix}$
(B) $\begin{bmatrix} 1/3 & 1/6 \\ 2/3 & -1/6 \end{bmatrix}$
(C) $\begin{bmatrix} 1/6 & 1/6 \\ -1/3 & 2/3 \end{bmatrix}$
(D) $\begin{bmatrix} -2/3 & 1/6 \\ -1/3 & -1/6 \end{bmatrix}$

5. यदि $\begin{vmatrix} 2x & 5 \\ 4 & x \end{vmatrix} = \begin{vmatrix} 3 & 5 \\ 4 & 6 \end{vmatrix}$ है, तो x का मान है :

(A) $3/2$
(B) 6
(C) 3
(D) ± 3

6. $x = 6$ पर वक्र $y = \frac{x-3}{x-4}$ के अभिलंब की प्रवणता है :

(A) 4
(B) $-\frac{1}{4}$
(C) -4
(D) $\frac{1}{4}$

7. समय (t) के सापेक्ष जनसंख्या P(t) में परिवर्तन की दर, जहाँ α तथा β क्रमशः स्थिर जन्म और मृत्यु दर हैं, है :

(A) $\frac{dP}{dt} = (\alpha + \beta)P$
(B) $\frac{dP}{dt} = (\alpha - \beta)P$
(C) $\frac{dP}{dt} = \frac{\alpha + \beta}{P}$
(D) $\frac{dP}{dt} = \frac{\alpha - \beta}{P}$

3. If A and B are symmetric matrices of the same order, then $(AB' - BA')$ is a

(A) symmetric matrix
(B) null matrix
(C) diagonal matrix
(D) skew symmetric matrix

4. The inverse of matrix $A = \begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$ is

(A) $\frac{1}{6}\begin{bmatrix} -4 & 2 \\ -1 & -1 \end{bmatrix}$
(B) $\begin{bmatrix} 1/3 & 1/6 \\ 2/3 & -1/6 \end{bmatrix}$
(C) $\begin{bmatrix} 1/6 & 1/6 \\ -1/3 & 2/3 \end{bmatrix}$
(D) $\begin{bmatrix} -2/3 & 1/6 \\ -1/3 & -1/6 \end{bmatrix}$

5. If $\begin{vmatrix} 2x & 5 \\ 4 & x \end{vmatrix} = \begin{vmatrix} 3 & 5 \\ 4 & 6 \end{vmatrix}$, then the value of x is

(A) $3/2$
(B) 6
(C) 3
(D) ± 3

6. The slope of the normal to the curve $y = \frac{x-3}{x-4}$ at $x = 6$ is

(A) 4
(B) $-\frac{1}{4}$
(C) -4
(D) $\frac{1}{4}$

7. The rate of change of population P(t) with respect to time (t), where α, β are the constant birth and death rates, respectively, is

(A) $\frac{dP}{dt} = (\alpha + \beta)P$
(B) $\frac{dP}{dt} = (\alpha - \beta)P$
(C) $\frac{dP}{dt} = \frac{\alpha + \beta}{P}$
(D) $\frac{dP}{dt} = \frac{\alpha - \beta}{P}$

8. पासों के एक जोड़े को दो बार उछाला गया । यदि प्राप्त हुए द्विकों की संख्या X से दर्शाती है, तो X की प्रत्याशा है :

(A) $\frac{1}{6}$ (B) 1

(C) $\frac{1}{3}$ (D) $\frac{11}{36}$

9. t-बंटन का माध्य है :

(A) 0 (B) 1

(C) 2 (D) अपरिभाषित

10. जलवायु, त्योहारों अथवा मौसम में परिवर्तन के कारण होने वाले बदलावों को कहा जाता है :

(A) धर्म-निरपेक्ष बदलाव (B) चक्रीय बदलाव

(C) मौसमी परिवर्तन (D) अनियमित बदलाव

11. एक LPP में, अवरोधों $x + y \leq 40$, $x + 2y \leq 60$, $x, y \geq 0$ के अंतर्गत $z = 3x + 4y$ का अधिकतम मान है :

(A) 120 (B) 140

(C) 150 (D) 130

12. प्रत्येक वर्ष के अंत में किए जाने वाले तथा हमेशा के लिए जारी रहने वाले ₹ 100 के भुगतानों के अनुक्रम का वर्तमान मूल्य, यदि धन का मूल्य 5% वार्षिक, चक्रवृद्धि ब्याज से संयोजित होता है, है :

(A) ₹ 2,000 (B) ₹ 20,000

(C) ₹ 5,000 (D) ₹ 12,000

13. एक एकाधिकारवादी का माँग फलन $p = 30 + 5x - 3x^2$ द्वारा प्रदत्त है, जहाँ x, माँग किए गए नगों की संख्या दर्शाता है तथा p एक नग का मूल्य है । 2 नगों की बिक्री पर सीमांत राजस्व है :

(A) ₹ 28 (B) ₹ 23

(C) ₹ 1 (D) ₹ 14

8. A pair of dice is thrown two times. If X represents the number of doublets obtained, then the expectation of X is

(A) $\frac{1}{6}$ (B) 1

(C) $\frac{1}{3}$ (D) $\frac{11}{36}$

9. The mean of t-distribution is

(A) 0 (B) 1

(C) 2 (D) not defined

10. The variations which occur due to change in climate, festivals or weather conditions are known as

(A) secular variations (B) cyclic variations

(C) seasonal variations (D) irregular variations

11. In a LPP, the maximum value of $z = 3x + 4y$ subject to the constraints $x + y \leq 40$, $x + 2y \leq 60$, $x, y \geq 0$ is

(A) 120 (B) 140

(C) 150 (D) 130

12. The present value of a sequence of payments of ₹ 100 made at the end of every year and continuing forever, if the money is worth 5% compounded annually, is

(A) ₹ 2,000 (B) ₹ 20,000

(C) ₹ 5,000 (D) ₹ 12,000

13. The demand function of a monopolist is given by $p = 30 + 5x - 3x^2$, where x is the number of units demanded and p is the price per unit. The marginal revenue when 2 units are sold, is

(A) ₹ 28 (B) ₹ 23

(C) ₹ 1 (D) ₹ 14

14. यदि x वस्तुओं का लागत फलन तथा राजस्व फलन क्रमश: $C(x) = 100 + 0.015\ x^2$ तथा $R(x) = 3x$ हैं, तो अधिकतम लाभ के लिए, x का मान है :

(A) 50 (B) 100

(C) 150 (D) 200

15. यदि यादृच्छिक चर X का प्रायिकता बंटन है

$$P(X = x) = \begin{cases} k, & \text{यदि} \quad x = 0 \\ 2k, & \text{यदि} \quad x = 1 \text{ या } 2 \\ 0, & \text{अन्यथा} \end{cases},$$

तो k का मान है :

(A) $\frac{1}{3}$ (B) $\frac{1}{5}$

(C) $\frac{1}{6}$ (D) $\frac{1}{4}$

16. दो स्वतंत्र नमूनों के बीच अंतर के महत्त्व का परीक्षण करने के लिए, परीक्षण आँकड़ा t द्वारा दिया जाता है :

(A) $t = \frac{\bar{x} - \bar{y}}{\sqrt{s}}$ (B) $t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

(C) $t = \frac{\bar{x} - \bar{y}}{\frac{s}{\sqrt{n-1}}}$ (D) $t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{n_1} - \frac{1}{n_2}}}$

17. अर्धवार्षिक रूप से संयोजित 4% की नाममात्र दर के समतुल्य प्रभावी ब्याज दर है :

(A) 4.12% (B) 4.04%

(C) 4.08% (D) 4.14%

14. If the cost function and revenue function of x items are respectively given as $C(x) = 100 + 0.015\,x^2$, $R(x) = 3x$, then the value of x for maximum profit is

(A) 50 (B) 100

(C) 150 (D) 200

15. If a random variable X has the probability distribution

$$P(X = x) = \begin{cases} k, & \text{if } x = 0 \\ 2k, & \text{if } x = 1 \text{ or } 2 \\ 0, & \text{otherwise,} \end{cases}$$

then the value of k is

(A) $\frac{1}{3}$ (B) $\frac{1}{5}$

(C) $\frac{1}{6}$ (D) $\frac{1}{4}$

16. The test statistic t for testing the significance of differences between the means of two independent samples is given by

(A) $t = \frac{\bar{x} - \bar{y}}{\sqrt{s}}$ (B) $t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

(C) $t = \frac{\bar{x} - \bar{y}}{\frac{s}{\sqrt{n-1}}}$ (D) $t = \frac{\bar{x} + \bar{y}}{s\sqrt{\frac{1}{n_1} - \frac{1}{n_2}}}$

17. The effective rate of interest equivalent to a nominal rate of 4% compounded semi-annually, is

(A) 4.12% (B) 4.04%

(C) 4.08% (D) 4.14%

18. एक निवेश, जिसका प्रारंभिक मूल्य ₹ 5,000 है और यह 4 वर्षों में ₹ 25,000 तक बढ़ जाता है, का CAGR है : [दिया है $(5)^{0.25} = 1.4953$]

(A) 49.53% (B) 14.95%

(C) 495.3% (D) 1.49%

प्रश्न संख्या **19** और **20** अभिकथन एवं तर्क आधारित प्रश्न हैं और प्रत्येक प्रश्न का **1** अंक है । दो कथन दिए गए हैं जिनमें एक को अभिकथन (A) तथा दूसरे को तर्क (R) द्वारा अंकित किया गया है । इन प्रश्नों के सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए ।

(A) अभिकथन (A) और तर्क (R) दोनों सही हैं और तर्क (R), अभिकथन (A) की सही व्याख्या करता है ।

(B) अभिकथन (A) और तर्क (R) दोनों सही हैं, परन्तु तर्क (R), अभिकथन (A) की सही व्याख्या नहीं करता है ।

(C) अभिकथन (A) सही है, परन्तु तर्क (R) गलत है ।

(D) अभिकथन (A) गलत है, परन्तु तर्क (R) सही है ।

19. **अभिकथन (A) :** रेखा $y - 1 = x$, x-अक्ष तथा रेखाओं $x = -1$ और $x = 1$ के बीच घिरे क्षेत्र का क्षेत्रफल 2 वर्ग इकाई है ।

तर्क (R) : वक्र $y = f(x)$, x-अक्ष तथा रेखाओं $x = a$ तथा $x = b$ के बीच घिरे क्षेत्र का क्षेत्रफल $\int_a^b f(x)\,dx$ होता है ।

20. **अभिकथन (A) :** वक्र कुल $y = mx$, m एक स्वेच्छ स्थिरांक है, को निरूपित करने वाला अवकल समीकरण है, $x\frac{dy}{dx} - y = 0$ है ।

तर्क (R) : किन्हीं वक्रों के कुल के लिए अवकल समीकरण प्राप्त करने के लिए वक्र कुल के समीकरण को x के सापेक्ष अवकलित करने के बाद, उसमें स्थित स्वेच्छ स्थिरांक का विलोपन किया जाता है ।

18. The CAGR of an investment, whose starting value is ₹ 5,000 and it grows to ₹ 25,000 in 4 years, is : [Given $(5)^{0.25} = 1.4953$]

(A) 49.53% (B) 14.95%

(C) 495.3% (D) 1.49%

Questions number **19** and **20** are Assertion – Reason based questions of **1** mark each. Two statements are given – one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not correct explanation for 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) :** The area of the region bounded by the line $y - 1 = x$, the x-axis and the ordinates $x = -1$ and $x = 1$ is 2 square units.

Reason (R) : The area of the region bounded by the curve $y = f(x)$, the x-axis and the ordinates $x = a$ and $x = b$ is given by $\int_a^b f(x)\,dx$.

20. **Assertion (A) :** The differential equation representing the family of curves $y = mx$, m being an arbitrary constant, is $x\frac{dy}{dx} - y = 0$.

Reason (R) : For a family of curves, the differential equation is obtained by differentiating the equation of family of curves with respect to x and then eliminating the arbitrary constant, if any.

खण्ड – ख

प्रश्न संख्या **21** से **25** तक अति लघु-उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक के **2** अंक हैं ।

21. (a) टाइप I चीनी का मूल्य ₹ 25 प्रति किलो तथा टाइप II चीनी का मूल्य ₹ 35 प्रति किलो है । यदि टाइप I चीनी तथा टाइप II चीनी को 3:2 में मिलाया जाए, तो मिश्रण का प्रति किलो मूल्य ज्ञात कीजिए ।

अथवा

(b) पाइप A एक टैंक को 1 घंटे में भर सकता है जबकि पाइप B इसी टैंक को 1½ घंटों में भर सकता है । यदि खाली टैंक में दोनों पाइपों को एक साथ खोल दिया जाए, तो टैंक को भरने में कितना समय लगेगा ?

22. एक बोट 3.5 km धारा की प्रतिकूल दिशा में जाकर वापिस उसी स्थान पर आती है तथा इसमें कुल 1 घंटा 12 मिनट का समय लगता है । यदि धारा की चाल 1 km/h है, तो शांत जल में बोट की चाल ज्ञात कीजिए ।

23. खिलाड़ी A, खिलाड़ी B से $\frac{3}{2}$ गुना तेज भाग सकता है । यदि खिलाड़ी A, खिलाड़ी B को 40 m की बढ़त देता है, तो शुरुआती बिंदु से विजयी पोस्ट कितना दूर होना चाहिए ताकि A और B एक ही समय पर वहाँ पहुँचे ?

24. दिया है $A = \begin{bmatrix} 2 & 0 & 1 \\ 3 & 4 & 5 \\ 0 & 2 & 3 \end{bmatrix}$ तथा $B = \begin{bmatrix} 1 & 1 & -5 \\ -5 & 1 & -5 \\ 1 & -2 & 4 \end{bmatrix}$, तो BA ज्ञात कीजिए ।

25. (a) एक निष्पक्ष सिक्का 6 बार उछाला गया । कम से कम 4 बार चित आने की प्रायिकता ज्ञात कीजिए ।

अथवा

(b) दिया है कि एक नॉर्मल चर X का माध्य 9 है तथा मानक विचलन 3 है, तो ज्ञात कीजिए :

(i) आँकड़ों के बिंदु 15 का z-स्कोर

(ii) z-स्कोर 4 वाले आँकड़ों का बिंदु

SECTION – B

Questions Number **21** to **25** are Very Short Answer (VSA) type questions of **2** marks each.

21. (a) The cost of Type I sugar is ₹ 25 per kg and Type II sugar is ₹ 35 per kg. If both Type I sugar and Type II sugar are mixed in the ratio 3:2, find the price per kg of the mixture.

OR

(b) Pipe A can fill a tank in 1 hour and Pipe B can fill it in 1½ hours. If both the pipes are opened in the empty tank, how much time will they take to fill the tank ?

22. A boat goes 3.5 km upstream and then returns. Total time taken is 1 hour and 12 minutes. If the speed of the current is 1 km/h, then find the speed of the boat in still water.

23. A runs $\frac{3}{2}$ times as fast as B. If A gives B a start of 40 m, how far must the winning post from the starting point be, so that A and B reach at the same time ?

24. Given $A = \begin{bmatrix} 2 & 0 & 1 \\ 3 & 4 & 5 \\ 0 & 2 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 & -5 \\ -5 & 1 & -5 \\ 1 & -2 & 4 \end{bmatrix}$, find BA.

25. (a) If a fair coin is tossed 6 times, find the probability of getting atleast 4 heads.

OR

(b) Given that mean of a normal variate X is 9 and standard deviation is 3, then find :

(i) the z-score of the data point 15

(ii) the data point if its z-score is 4.

खण्ड – ग

प्रश्न संख्या **26** से **31** तक लघु-उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न के **3** अंक हैं ।

26. 7^{295} का इकाई का अंक ज्ञात कीजिए ।

27. प्रथम छः धन पूर्णांकों में से दो संख्याएँ यादृच्छया (बिना प्रतिस्थापन) चुनी गईं । मान लें X प्राप्त दोनों संख्याओं में से छोटी संख्या को व्यक्त करता है । E(X) ज्ञात कीजिए ।

28. (a) यदि एक द्विघात बंटन का माध्य तथा प्रसरण क्रमशः $\frac{4}{3}$ तथा $\frac{8}{9}$ हैं, तो $P(x = 1)$ ज्ञात कीजिए ।

अथवा

(b) किसी बीमारी की मृत्यु दर 0.007 है । प्वासों बंटन के प्रयोग से, 400 लोगों के समूह में 2 मृत्यु होने की प्रायिकता ज्ञात कीजिए । $[e^{-2.8} = 0.0608$ का प्रयोग कीजिए]

29. (a) दो प्रकार के उर्वरक F_1 तथा F_2 हैं । F_1 में 10% नाइट्रोजन और 6% फॉस्फोरिक अम्ल है तथा F_2 में 5% नाइट्रोजन तथा 10% फॉस्फोरिक अम्ल है । मिट्टी का परीक्षण करने के पश्चात् एक किसान पाता है कि उसे अपनी फसल के लिए 14 kg नाइट्रोजन तथा 14 kg फॉस्फोरिक अम्ल की आवश्यकता है । यदि F_1 का मूल्य ₹ 6 प्रति किलो और F_2 का मूल्य ₹ 5 प्रति किलो है, तो प्रत्येक प्रकार का कितना उर्वरक उपयोग करना चाहिए ताकि न्यूनतम मूल्य पर वांछित पोषक-तत्त्व मिल सकें ? इसके लिए रैखिक प्रोग्रामन समस्या का निर्माण कीजिए ।

अथवा

(b) निम्न रैखिक प्रोग्रामन समस्या का ग्राफ द्वारा हल ज्ञात कीजिए :

व्यवरोधों $2x + y \leq 18$

$3x + 2y \leq 34$

$x, y \geq 0$

के अंतर्गत $z = 50x + 30y$ का अधिकतमीकरण करना ।

SECTION – C

Questions Number **26** to **31** are Short Answer (SA) type questions of **3** marks each.

26. Find the units digit in 7^{295}.

27. Two numbers are selected at random (without replacement) from first six positive integers. Let X denotes the smaller of the two numbers obtained. Calculate the mathematical expectation of X.

28. (a) If the mean and variance of a binomial distribution are $\frac{4}{3}$ and $\frac{8}{9}$ respectively, then find P(x = 1).

OR

(b) The mortality rate for a certain disease is 0.007. Using Poisson distribution, calculate the probability for 2 deaths in a group of 400 people. [Use $e^{-2.8} = 0.0608$]

29. (a) There are two types of fertilizers F_1 and F_2. F_1 consists of 10% nitrogen and 6% phosphoric acid. F_2 consists of 5% nitrogen and 10% phosphoric acid. After testing the soil conditions, a farmer finds that he needs atleast 14 kg of nitrogen and 14 kg of phosphoric acid for his crop. If F_1 costs ₹ 6 per kg and F_2 costs ₹ 5 per kg, how much of each type of fertilizer should be used so that the cost is minimum. Formulate a linear programming problem.

OR

(b) Solve the following linear programming problem graphically :

Maximise z = $50x + 30y$

subject to $2x + y \leq 18$

$3x + 2y \leq 34$

$x, y \geq 0$.

30. एक मशीन बनाने वाला इंजन के पुर्जे बना रहा है जिसमें वह 0.7 cm व्यास का एक्सल बनाता है । 10 पुर्जों के एक यादृच्छय नमूने का माध्य व्यास 0.742 cm तथा मानक विचलन 0.04 cm पाया जाता है । इस नमूने के आधार पर ज्ञात कीजिए कि क्या यह कार्य घटिया प्रकार का है ।

(दिया है t_9 (0.05) = 2.262)

31. ₹ 5,00,000 के एक ऋण के लिए 7.5% वार्षिक ब्याज दर पर 5 वर्षों के लिए, फ्लैट रेट प्रणाली से EMI ज्ञात कीजिए ।

खण्ड – घ

प्रश्न संख्या **32** से **35** तक दीर्घ उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न के **5** अंक हैं ।

32. (a) यदि $A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$ है, तो A^{-1} ज्ञात कीजिए । अत: निम्न रैखिक समीकरण निकाय का हल ज्ञात कीजिए ।

$2x - 3y + 5z = 11,\ 3x + 2y - 4z = -5,\ x + y - 2z = -3$

अथवा

(b) सारणिकों के गुणधर्मों के प्रयोग से सिद्ध कीजिए कि

$$\Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix} = 2abc\,(a+b+c)^3$$

33. यदि आपूर्ति फलन $p = 4 - 5x + x^2$ है, तो उत्पादक-अधिशेष ज्ञात कीजिए जब कीमत 18 है ।

30. A machinist is making engine parts with axle diameter of 0.7 cm. A random sample of 10 parts shows mean diameter 0.742 cm with a standard deviation of 0.04 cm. On the basis of this sample, find if you would say that the work is inferior. (Given t_9 (0.05) = 2.262)

31. Calculate EMI under Flat-Rate System for a loan of ₹ 5,00,000 with 7.5% annual interest rate for 5 years.

SECTION – D

Questions number **32** to **35** are Long Answer (LA) type questions of **5** marks each.

32. (a) If $A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$, find A^{-1} and hence solve the following system of linear equations :

$2x - 3y + 5z = 11$, $3x + 2y - 4z = -5$, $x + y - 2z = -3$

OR

(b) Using properties of determinants, prove that

$$\Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix} = 2abc\,(a+b+c)^3$$

33. If the supply function is $p = 4 - 5x + x^2$, then find the producer's surplus when price is 18.

34. (a) कागज के उत्पादन के दिए गए आँकड़ों (हजार टन में) से 4-वर्षीय चल औसत द्वारा मौसमी सूचकांकों की गणना कीजिए :

वर्ष :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
सूचकांक :	2450	1470	2150	1800	1210	1950	2300	2500	2480	2680

अथवा

(b) निम्नलिखित आँकड़ों के लिए न्यूनतम वर्ग विधि द्वारा एक सीधी रेखा प्रवृत्ति फिट कीजिए :

वर्ष :	2011	2012	2013	2014	2015	2016
उत्पादन (टनों में) :	210	225	275	220	240	235

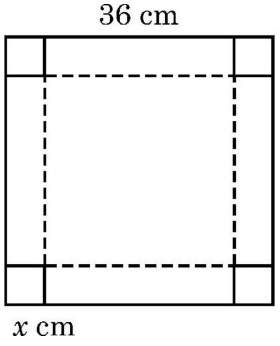
35. एक मशीन का मूल्य ₹ 1,00,000 है तथा इसका प्रभावी जीवन 12 वर्ष होने का अनुमान है । मशीन के जीवन काल के अंत में, जब इसके स्क्रैप की कीमत केवल ₹ 5,000 होती है, इसे नए मॉडल से बदलने के लिए एक सिंकिंग फंड बनाया जाता है । ज्ञात कीजिए कि प्रति वर्ष लाभ में से कितनी राशि अलग रखी जाए यदि सिंकिंग फंड 5% प्रभावी स्तर पर संचित होता है ।

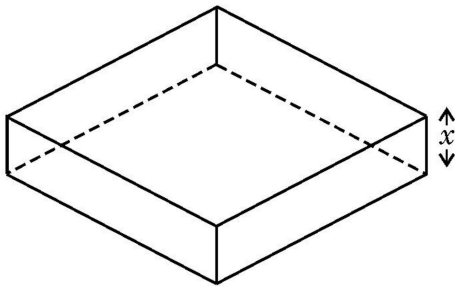
$[(1.05)^{12} = 1.7958$ का प्रयोग कीजिए ।]

खण्ड – ङ

प्रश्न संख्या **36** से **38** तक प्रकरण अध्ययन आधारित प्रश्न हैं तथा प्रत्येक प्रश्न **4** अंकों का है ।

36. एक व्यक्ति के पास एक 36 cm भुजा का वर्गाकार सोने का महँगा बोर्ड है । वह इससे चारों कोनों से एक-एक वर्ग काट कर तथा किनारों को मोड़कर एक ऊपर से खुले बक्से में बदलना चाहता है । माना किनारों से काटे गए प्रत्येक वर्ग की भुजा x cm है ।





34. (a) Compute the seasonal indices by 4-year moving averages from the given data of production of paper (in thousand tons) :

Year :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Index number :	2450	1470	2150	1800	1210	1950	2300	2500	2480	2680

OR

(b) Fit a straight-line trend by method of least squares for the following data :

Year :	2011	2012	2013	2014	2015	2016
Production (in tons) :	210	225	275	220	240	235

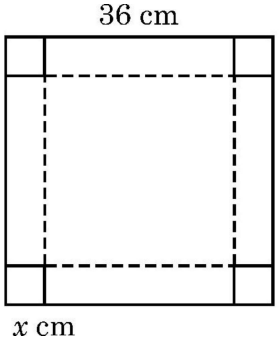
35. A machine costs ₹ 1,00,000 and its effective life is estimated to be 12 years. A sinking fund is created for replacing the machine by a new model at the end of its life time when its scrap realizes a sum of ₹ 5,000 only. Find what amount should be set aside at the end of each year, out of the profits for the sinking fund if it accumulates at 5% effective.

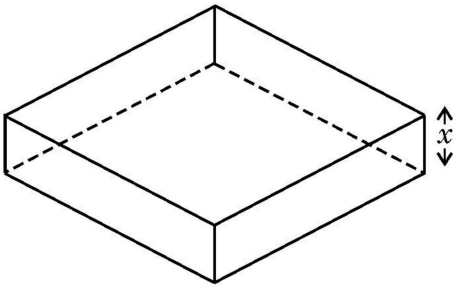
[Use $(1.05)^{12} = 1.7958$]

SECTION – E

Questions number **36** to **38** are case-study based questions of **4** marks each.

36. A man has an expensive square-shaped piece of golden board of side 36 cm. He wants to turn it into a box without top by cutting a square from each corner and folding the flaps. Let x cm be the side of square, which is cut from each corner.





उपरोक्त जानकारी के आधार पर, निम्न प्रश्नों के उत्तर दीजिए :

(i) x के पदों में खुले बक्से के आयतन (V) के लिए व्यंजक ज्ञात कीजिए ।

(ii) $\frac{dV}{dx}$ ज्ञात कीजिए ।

(iii) x का वह मान ज्ञात कीजिए जिसके लिए आयतन (V) अधिकतम हो ।

अथवा

(iii) खुले बॉक्स का अधिकतम आयतन ज्ञात कीजिए ।

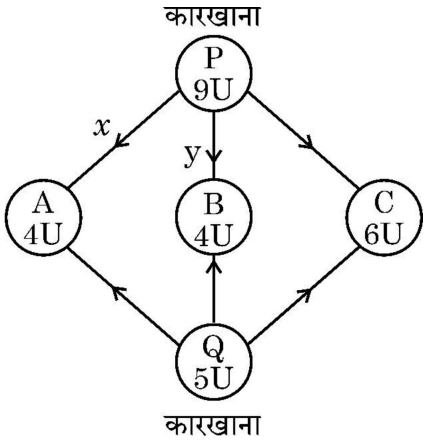
37. दो कारखाने P और Q पर स्थित हैं । इन स्थानों से सामान A, B और C पर स्थित तीन डिपों में भेजे जाने हैं जिनकी साप्ताहिक आवश्यकता क्रमश: 4, 4, 6 नग की है, जबकि P और Q कारखानों की उत्पादन क्षमता क्रमशः 9 और 5 नग हैं ।

प्रति नग परिवहन व्यय निम्न प्रकार है :

से / को	मूल्य (₹ में)		
	A	B	C
P	160	100	150
Q	100	120	100

उपरोक्त जानकारी के आधार पर, निम्न प्रश्नों के उत्तर दीजिए :

माना कि माल के x नग और y नग कारखाना P से क्रमश: डिपों A तथा B को भेजे गए, तो



Based on the above information, answer the following questions :

(i) Find the expression for the volume (V) of open box in terms of x.

(ii) Find $\frac{dV}{dx}$.

(iii) Find the value of x for which the volume (V) is maximum.

OR

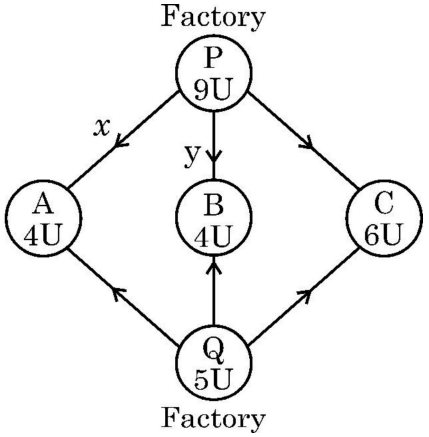
(iii) Find the maximum volume of the open box.

37. There are two factories located one at P and the other at Q. From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirements of the depots are respectively 4, 4 and 6 units of the commodity while the production capacity of the factories at P and Q are 9 and 5 units respectively. The cost of transportation per unit is given as :

From / To	**Cost (in ₹)**		
	A	B	C
P	160	100	150
Q	100	120	100

Based on the above information, answer the following questions :

Let x units and y units of the commodity be transported from factory P to the depots at A and B respectively, then



(i) ज्ञात कीजिए कि P से C को (x तथा y के पदों में) कितने नग भेजे गए ।

(ii) ज्ञात कीजिए कि Q से क्रमश: A, B तथा C को कितने नग भेजे गए ।

(iii) भाग (i) तथा (ii) के प्रयोग से, कुल परिवहन लागत z ज्ञात कीजिए ।

अथवा

(iii) (i) तथा (ii) के प्रयोग से, न्यूनतम लागत z के लिए व्यवरोध असमिकाएँ ज्ञात कीजिए ।

38. रमेश ने एक बैंक से गृह ऋण के रूप में ₹ 7,00,000, 12% वार्षिक ब्याज दर पर 30 वर्षों के लिए प्राप्त किए जिसे मासिक किश्तों में वापिस करना है ।

उपरोक्त जानकारी के आधार पर निम्न प्रश्नों के उत्तर दीजिए :

(i) घटती शेष राशि विधि द्वारा, EMI की गणना करने का सूत्र लिखिए ।

(ii) P, i तथा n के क्रमश: मान लिखिए ।

(iii) EMI ज्ञात कीजिए । [$(1.01)^{-360} = 0.02781668$ लीजिए]

अथवा

(iii) यदि ऋण की राशि को 20 वर्षों में लौटाना हो, तो EMI ज्ञात कीजिए ।

[$(1.01)^{-240} = 0.09180584$ लीजिए]

(i) Find (in terms of x and y) how many units of commodity be transported from factory P to depot C.

(ii) Find how many units of commodity be transported from factory Q to A, B and C respectively.

(iii) Using (i) and (ii), find the total transportation cost z.

OR

(iii) Using (i) and (ii), find the constraint inequalities for minimum cost z.

38. Ramesh borrowed a home loan amount of ₹ 7,00,000 from a bank at an interest of 12% per annum for 30 years, to be paid in monthly installments.

Based on the above information, answer the following questions :

(i) Write the formula for calculating EMI by reducing balance method.

(ii) Write the values of P, i and n respectively.

(iii) Find the EMI. [Use $(1.01)^{-360} = 0.02781668$]

OR

(iii) If the loan is to be returned in 20 years, find EMI.

[Use $(1.01)^{-240} = 0.09180584$]



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

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 un assessed 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)

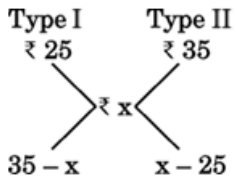
Section A

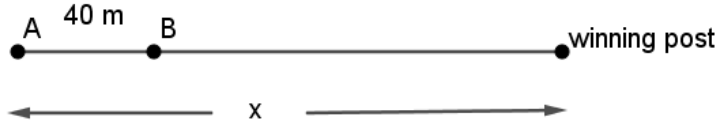
Q. No.	EXPECTED OUTCOMES/VALUE POINTS	Marks
	SECTION A Questions no. 1 to 18 are multiple choice questions (MCQs) and questions number 19 and 20 are Assertion-Reason based questions of **1 mark each.**	
1.	$-41 \bmod 9$ is (A) 5 (B) 4 (C) 3 (D) 0	
Sol.	(B) 4	**1**
2.	If $a > b$ and $c < 0$, then which of the following is true ? (A) $a + c < b + c$ (B) $a - c < b - c$ (C) $ac > bc$ (D) $a - c > b + c$	
Sol.	(D) $a - c > b + c$	**1**
3.	If A and B are symmetric matrices of the same order, then $(AB' - BA')$ is a (A) symmetric matrix (B) null matrix (C) diagonal matrix (D) skew symmetric matrix	
Sol.	(D) skew symmetric matrix	**1**
4.	The inverse of matrix $A = \begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$ is (A) $\frac{1}{6}\begin{bmatrix} -4 & 2 \\ -1 & -1 \end{bmatrix}$ (B) $\begin{bmatrix} 1/3 & 1/6 \\ 2/3 & -1/6 \end{bmatrix}$ (C) $\begin{bmatrix} 1/6 & 1/6 \\ -1/3 & 2/3 \end{bmatrix}$ (D) $\begin{bmatrix} -2/3 & 1/6 \\ -1/3 & -1/6 \end{bmatrix}$	
Sol.	(C) $\begin{bmatrix} 1/6 & 1/6 \\ -1/3 & 2/3 \end{bmatrix}$	**1**
5.	If $\begin{vmatrix} 2x & 5 \\ 4 & x \end{vmatrix} = \begin{vmatrix} 3 & 5 \\ 4 & 6 \end{vmatrix}$, then the value of x is (A) $3/2$ (B) 6 (C) 3 (D) ± 3	
Sol.	(D) ± 3	**1**

6.	The slope of the normal to the curve $y = \frac{x-3}{x-4}$ at $x = 6$ is (A) 4 (B) $-\frac{1}{4}$ (C) -4 (D) $\frac{1}{4}$	
Sol.	(A) 4	**1**
7.	The rate of change of population P(t) with respect to time (t), where α, β are the constant birth and death rates, respectively, is (A) $\frac{dP}{dt} = (\alpha + \beta)P$ (B) $\frac{dP}{dt} = (\alpha - \beta)P$ (C) $\frac{dP}{dt} = \frac{\alpha + \beta}{P}$ (D) $\frac{dP}{dt} = \frac{\alpha - \beta}{P}$	
Sol.	(B) $\frac{dP}{dt} = (\alpha - \beta)P$	**1**
8.	A pair of dice is thrown two times. If X represents the number of doublets obtained, then the expectation of X is (A) $\frac{1}{6}$ (B) 1 (C) $\frac{1}{3}$ (D) $\frac{11}{36}$	
Sol.	(C) $\frac{1}{3}$	**1**
9.	The mean of t-distribution is (A) 0 (B) 1 (C) 2 (D) not defined	
Sol.	(A) 0	**1**
10.	The variations which occur due to change in climate, festivals or weather conditions are known as (A) secular variations (B) cyclic variations (C) seasonal variations (D) irregular variations	
Sol.	(C) seasonal variations	**1**
11.	In a LPP, the maximum value of $z = 3x + 4y$ subject to the constraints $x + y \leq 40$, $x + 2y \leq 60$, $x, y \geq 0$ is (A) 120 (B) 140 (C) 150 (D) 130	
Sol.	(B) 140	**1**

12.	The present value of a sequence of payments of ₹ 100 made at the end of every year and continuing forever, if the money is worth 5% compounded annually, is (A) ₹ 2,000 (B) ₹ 20,000 (C) ₹ 5,000 (D) ₹ 12,000	
Sol.	(A) ₹ 2,000	**1**
13.	The demand function of a monopolist is given by $p = 30 + 5x - 3x^2$, where x is the number of units demanded and p is the price per unit. The marginal revenue when 2 units are sold, is (A) ₹ 28 (B) ₹ 23 (C) ₹ 1 (D) ₹ 14	
Sol.	(D) ₹ 14	**1**
14.	If the cost function and revenue function of x items are respectively given as $C(x) = 100 + 0.015\,x^2$, $R(x) = 3x$, then the value of x for maximum profit is (A) 50 (B) 100 (C) 150 (D) 200	
Sol.	(B) 100	**1**
15.	If a random variable X has the probability distribution $P(X = x) = \begin{cases} k, & \text{if } x = 0 \\ 2k, & \text{if } x = 1 \text{ or } 2 \\ 0, & \text{otherwise,} \end{cases}$ then the value of k is (A) $\frac{1}{3}$ (B) $\frac{1}{5}$ (C) $\frac{1}{6}$ (D) $\frac{1}{4}$	
Sol.	(B) $\frac{1}{5}$	**1**
16.	The test statistic t for testing the significance of differences between the means of two independent samples is given by (A) $t = \frac{\bar{x} - \bar{y}}{\sqrt{s}}$ (B) $t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$ (C) $t = \frac{\bar{x} - \bar{y}}{\frac{s}{\sqrt{n-1}}}$ (D) $t = \frac{\bar{x} + \bar{y}}{s\sqrt{\frac{1}{n_1} - \frac{1}{n_2}}}$	
Sol.	(B) $t = \frac{\bar{x} - \bar{y}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$	**1**

17.	The effective rate of interest equivalent to a nominal rate of 4% compounded semi-annually, is (A) 4.12% (B) 4.04% (C) 4.08% (D) 4.14%	
Sol.	(B) 4.04 %	**1**
18.	The CAGR of an investment, whose starting value is ₹ 5,000 and it grows to ₹ 25,000 in 4 years, is : [Given $(5)^{0.25} = 1.4953$] (A) 49.53% (B) 14.95% (C) 495.3% (D) 1.49%	
Sol.	(A) 49.53 %	**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) :** The area of the region bounded by the line $y - 1 = x$, the x-axis and the ordinates $x = -1$ and $x = 1$ is 2 square units. **Reason (R) :** The area of the region bounded by the curve $y = f(x)$, the x-axis and the ordinates $x = a$ and $x = b$ is given by $\int_a^b f(x)\,dx$.	
Sol.	**(A)** Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).	**1**
20.	**Assertion (A) :** The differential equation representing the family of curves $y = mx$, m being an arbitrary constant, is $x\frac{dy}{dx} - y = 0$. **Reason (R) :** For a family of curves, the differential equation is obtained by differentiating the equation of family of curves with respect to x and then eliminating the arbitrary constant, if any.	
Sol.	**(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 very short answer (VSA) type questions of 2 marks each.	
21(a).	The cost of Type I sugar is ₹ 25 per kg and Type II sugar is ₹ 35 per kg. If both Type I sugar and Type II sugar are mixed in the ratio 3:2, find the price per kg of the mixture.	
Sol.	Let the price per kg of mixture be ₹ **x**  $\therefore \frac{35-x}{x-25} = \frac{3}{2}$ $\Longrightarrow 70 - 2x = 3x - 75$ Solving, we get $x = 29$ ∴ Price per kg of the mixture is ₹ 29	**1** **1**
	OR	
21(b).	Pipe A can fill a tank in 1 hour and Pipe B can fill it in 1½ hours. If both the pipes are opened in the empty tank, how much time will they take to fill the tank ?	
Sol.	Let the required time taken be n minutes $\therefore \frac{1}{n} = \frac{1}{60} + \frac{1}{90}$ $\Longrightarrow \frac{1}{n} = \frac{3+2}{180} = \frac{5}{180} = \frac{1}{36}$ $\therefore n = 36$ minutes or $\frac{3}{5}$ hours	**1** **1**
22.	A boat goes 3.5 km upstream and then returns. Total time taken is 1 hour and 12 minutes. If the speed of the current is 1 km/h, then find the speed of the boat in still water.	
Sol.	Let the speed of the boat be x km/h ∴ Speed of the boat upstream $= (x - 1)$ km/h and speed of the boat downstream $= (x + 1)$ km/h $\therefore \frac{3.5}{x-1} + \frac{3.5}{x+1} = 1 + \frac{12}{60} = \frac{6}{5}$ $\Longrightarrow 3.5\ (2x)5 = 6\ (x^2 - 1)$ $\Longrightarrow 6x^2 - 35x - 6 = 0$ Solving, we get $x = 6$ km/h (rejecting the -ve value)	½ ½ ½ ½

23.	A runs $\frac{3}{2}$ times as fast as B. If A gives B a start of 40 m, how far must the winning post from the starting point be, so that A and B reach at the same time ?	
Sol.	 Let the winning post be x metres away from the starting point. $\therefore \frac{x}{3/2} = \frac{x-40}{1}$ $\Longrightarrow \frac{x}{2} = \frac{3}{2} \times 40 = 60 \Longrightarrow x = 120$ metres	**1** **1**
24.	Given $A = \begin{bmatrix} 2 & 0 & 1 \\ 3 & 4 & 5 \\ 0 & 2 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 & -5 \\ -5 & 1 & -5 \\ 1 & -2 & 4 \end{bmatrix}$, find BA.	
Sol.	$BA = \begin{bmatrix} 1 & 1 & -5 \\ -5 & 1 & -5 \\ 1 & -2 & 4 \end{bmatrix} \begin{bmatrix} 2 & 0 & 1 \\ 3 & 4 & 5 \\ 0 & 2 & 3 \end{bmatrix}$ Obtaining at least 4 correct entries $= \begin{bmatrix} 5 & -6 & -9 \\ -7 & -6 & -15 \\ -4 & 0 & 3 \end{bmatrix}$	**1** **1**
25 (a).	If a fair coin is tossed 6 times, find the probability of getting atleast 4 heads.	
Sol.	Here, $n = 6, p = \frac{1}{2}, q = \frac{1}{2}$ P (at least 4 heads in 6 throws) $= P(X \geq 4)$ $= 6_{C_4} \left(\frac{1}{2}\right)^4 \left(\frac{1}{2}\right)^2 + 6_{C_5} \left(\frac{1}{2}\right)^5 \left(\frac{1}{2}\right)^1 + 6_{C_6} \left(\frac{1}{2}\right)^6 \left(\frac{1}{2}\right)^0$ $= 22 \left(\frac{1}{2}\right)^6 = \frac{22}{64}$ *or* $\frac{11}{32}$	½ **1** ½
	OR	
25 (b).	Given that mean of a normal variate X is 9 and standard deviation is 3, then find : (i) the z-score of the data point 15 (ii) the data point if its z-score is 4.	
Sol.	(i) $Z = \frac{X-\mu}{\sigma} = \frac{15-9}{3} = 2$ (ii) $4 = \frac{X-9}{3} \Longrightarrow X = 21$	**1** **1**

	SECTION C This section comprises short answer (SA) type questions of 3 marks each.	
26.	Find the units digit in 7^{295}.	
Sol.	$7^2 = 49 \equiv -1(mod\ 10)$ $7^{295} = (7^2)^{147} \times 7$ Now, $(7^2)^{147} \equiv (-1)^{147}(mod\ 10) \equiv -1(mod\ 10)$ $\Longrightarrow\ 7^{295} = (7^2)^{147} \times 7 \equiv -7(mod\ 10) \equiv 3(mod\ 10)$ $\therefore$ Units digit is 3.	**1** **1** ½ ½
27.	Two numbers are selected at random (without replacement) from first six positive integers. Let X denotes the smaller of the two numbers obtained. Calculate the mathematical expectation of X.	
Sol.	Numbers on the dice are 1, 2, 3, 4, 5, 6 $\therefore$ X can take the values 1, 2, 3, 4, 5	½

X	1	2	3	4	5
P(X)	$\frac{5}{15}$	$\frac{4}{15}$	$\frac{3}{15}$	$\frac{2}{15}$	$\frac{1}{15}$
X P(X)	$\frac{5}{15}$	$\frac{8}{15}$	$\frac{9}{15}$	$\frac{8}{15}$	$\frac{5}{15}$

1

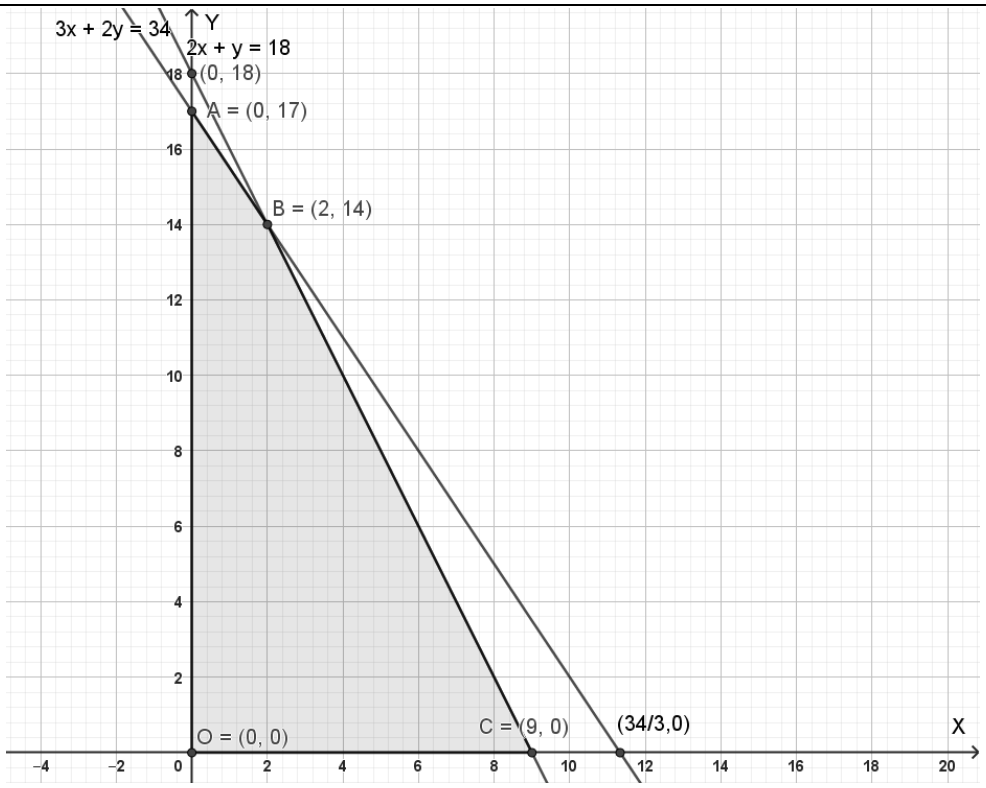
1

$E(X) = \sum X\ P(X) = \frac{35}{15} = \frac{7}{3}$ ½

28 (a).	If the mean and variance of a binomial distribution are $\frac{4}{3}$ and $\frac{8}{9}$ respectively, then find P($x = 1$).	
Sol.	Mean $= np = \frac{4}{3}$, variance $= npq = \frac{8}{9}$ $\Longrightarrow q = \frac{8}{9} \times \frac{3}{4} = \frac{2}{3}$ $\therefore p = 1 - \frac{2}{3} = \frac{1}{3}$ $n \times \frac{1}{3} = \frac{4}{3} \Longrightarrow n = 4$ $P(x = 1) = 4_{C_1} \left(\frac{1}{3}\right)^1 \left(\frac{2}{3}\right)^3 = 4 \times \frac{1}{3} \times \frac{8}{27}$ $= \frac{32}{81}$	½ ½ ½ ½ ½ ½
	OR	

28 (b).	The mortality rate for a certain disease is 0.007. Using Poisson distribution, calculate the probability for 2 deaths in a group of 400 people. [Use $e^{-2.8} = 0.0608$]	
Sol.	Given, $p = 0.007, n = 400$ $\therefore\ \lambda = np = 400 \times 0.007 = 2.8$ Now, $P(X = 2) = \frac{(2.8)^2 e^{-2.8}}{2!}$ $= \frac{7.84}{2} \times 0.0608 = 0.2383$	½ **1** **1** ½
29 (a).	There are two types of fertilizers F_1 and F_2. F_1 consists of 10% nitrogen and 6% phosphoric acid. F_2 consists of 5% nitrogen and 10% phosphoric acid. After testing the soil conditions, a farmer finds that he needs atleast 14 kg of nitrogen and 14 kg of phosphoric acid for his crop. If F_1 costs ₹ 6 per kg and F_2 costs ₹ 5 per kg, how much of each type of fertilizer should be used so that the cost is minimum. Formulate a linear programming problem.	
Sol.	Let x kg of nitrogen and y kg of phosphoric acid is used for minimum cost. $\therefore$ the objective function is Minimize $Z = 6x + 5y$ Subject to the constraints $10\% \times x + 5\% \times y \geq 14$ or $2x + y \geq 280$ and $6\% \times x + 10\% \times y \geq 14$ or $3x + 5y \geq 700$ $x, y \geq 0$ **Note: *** Marks should be awarded for the formation of equations $2x + y = 280$ and $3x + 5y = 700$ instead of inequations in Hindi medium only.	½ **1** **1** ½
	OR	
29 (b).	Solve the following linear programming problem graphically : Maximise z = $50x + 30y$ subject to $2x + y \leq 18$ $3x + 2y \leq 34$ $x, y \geq 0$.	

Sol.



1½ for correct graph

Corner Points	Value of Z
O (0,0)	0
A (0, 17)	510
B (2,14)	520
C (9, 0)	450

1 for correct table

∴ Maximum Z = 520 at B (2, 14) **½**

30. A machinist is making engine parts with axle diameter of 0.7 cm. A random sample of 10 parts shows mean diameter 0.742 cm with a standard deviation of 0.04 cm. On the basis of this sample, find if you would say that the work is inferior. (Given $t_9\,(0.05) = 2.262$)

Sol.

$\bar{x} = 0.742,\ \mu = 0.7$

$n = 10, s = 0.04$ **½**

H_0: Null hypothesis : If there is no significant difference between $\bar{x}$ and μ

H_1: Alternate hypothesis : If there is a significant difference between $\bar{x}$ and μ

$t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n-1}}} = \frac{0.742-0.7}{\frac{0.04}{\sqrt{9}}} = 3.15$ **1½**

Df $= 9$ and $t_9(0.05) = 2.262$

Since $|t| = 3.15 > 2.262$ **½**

∴ Null hypothesis is rejected

	Hence the work is inferior **Note:*** $t = \frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}}$ should also be accepted.	½
31.	Calculate EMI under Flat-Rate System for a loan of ₹ 5,00,000 with 7.5% annual interest rate for 5 years.	
Sol.	$P = ₹\,5,00,000$ Interest $= \frac{PRT}{100}$ $= \frac{500000\times7.5\times5}{100} = ₹\,1,87,500$ $n = 5$ years $= 60$ months $\therefore$ EMI $= \frac{P+I}{n}$ $= \frac{500000+187500}{60}$ $= ₹\,11,458.33$	**1** ½ **1** ½
	SECTION D This section comprises of Long Answer (LA) type questions of 5 marks each.	
32 (a).	If $A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$, find A^{-1} and hence solve the following system of linear equations : $2x - 3y + 5z = 11,\ 3x + 2y - 4z = -5,\ x + y - 2z = -3$	
Sol.	$\lvert A\rvert = 2(-4+4) + 3(-6+4) + 5(3-2) = -1 \neq 0$ $\therefore A^{-1}$ exists Now, $\begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix}$ or $AX = B \Longrightarrow X = A^{-1}B$ $\text{adj}(A) = \begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix}$ $A^{-1} = \frac{1}{\lvert A\rvert}\,\text{adj}(A) = \frac{1}{-1}\begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix}$ $\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix}\begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ So, $x = 1, y = 2, z = 3$	½ **1** **1½** ½ **1** ½

	OR	
32 (b).	Using properties of determinants, prove that $\Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix} = 2\,abc\,(a+b+c)^3$	
Sol.	LHS $= \Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix}$ Applying, $C_1 \to C_1 - C_3$ $C_2 \to C_2 - C_3$ $\Delta = \begin{vmatrix} (b+c)^2 - a^2 & 0 & a^2 \\ 0 & (c+a)^2 - b^2 & b^2 \\ c^2 - (a+b)^2 & c^2 - (a+b)^2 & (a+b)^2 \end{vmatrix}$ $= (a+b+c)^2 \begin{vmatrix} b+c-a & 0 & a^2 \\ 0 & c+a-b & b^2 \\ c-a-b & c-a-b & (a+b)^2 \end{vmatrix}$ Applying, $R_1 \to R_3 - R_1 - R_2$ $= 2(a+b+c)^2 \begin{vmatrix} b+c-a & 0 & a^2 \\ 0 & c+a-b & b^2 \\ -b & -a & ab \end{vmatrix}$ Expanding, we get $\Delta = 2abc(a+b+c)^3$	**1+1** **1** **2**
33.	If the supply function is $p = 4 - 5x + x^2$, then find the producer's surplus when price is 18.	
Sol.	$p = 4 - 5x + x^2$ $p_0 = 18$, we have $18 = 4 - 5x + x^2$ or $x^2 - 5x - 14 = 0$ $\Rightarrow (x-7)(x+2) = 0$ $\therefore x = 7, x = -2$ is rejected $p_0 x_0 = 18 \times 7 = 126$ PS $= p_0 x_0 - \int_0^7 (x^2 - 5x + 4)\,dx$ $= 126 - \left[\frac{x^3}{3} - \frac{5x^2}{2} + 4x\right]_0^7$ $= 126 - \frac{119}{6}$ $= \frac{637}{6}$ or 106.17 approx.	**1½** **½** **1** **1** **1**

34(a). Compute the seasonal indices by 4-year moving averages from the given data of production of paper (in thousand tons) :

Year :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Index number :	2450	1470	2150	1800	1210	1950	2300	2500	2480	2680

Sol.

Year	Index Number	4 yearly moving total	4 yearly moving Average	Centered Total	Centered moving average
2001	2450				
2002	1470				
		7870	1967.5		
2003	2150			3625	1812.5
		6630	1657.5		
2004	1800			3435	1717.5
		7110	1777.5		
2005	1210			3592.5	1796.25
		7260	1815		
2006	1950			3805	1902.5
		7960	1990		
2007	2300			4297.5	2148.75
		9230	2307.5		
2008	2500			4797.5	2398.75
		9960	2490		
2009	2480				
2010	2680				

4 yearly moving total – 1 mark

4 yearly moving average – 1½ marks

centered total - 1 mark

centered moving average - 1½ marks

OR

34(b). Fit a straight-line trend by method of least squares for the following data :

Year :	2011	2012	2013	2014	2015	2016
Production (in tons) :	210	225	275	220	240	235

Sol.

Year (x_i)	Index Number (Y)	$X = \frac{x_i - A}{0.5} = \frac{x_i - 2013.5}{0.5}$	X^2	XY	$Y_t = a + bx$
2011	210	-5	25	-1050	$234.17 + (-5)1.64 = 225.97$
2012	225	-3	9	-675	229.25
2013	275	-1	1	-275	232.53
2014	220	1	1	220	235.81
2015	240	3	9	720	239.09
2016	235	5	25	1175	242.37
$n = 6$	1405	$\sum X = 0$	$\sum X^2 = 70$	$\sum XY = 115$	

2½ for the correct table

$a = \frac{\sum Y}{n} = \frac{1405}{6} = 234.17$ (approx.) **1**

$b = \frac{\sum XY}{\sum X^2} = \frac{115}{70} = 1.64$ (approx.) **1**

Required line is $Y = a + bx = 234.17 + 1.64\,x$ **½**

35. A machine costs ₹ 1,00,000 and its effective life is estimated to be 12 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 ₹ 5,000 only. 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 5% effective.

[Use $(1.05)^{12} = 1.7958$]

Sol.

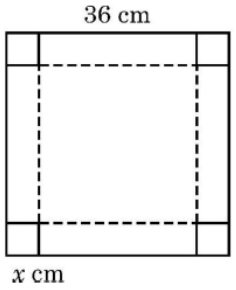
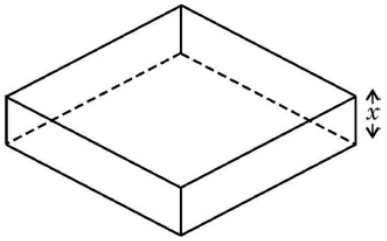
Amount needed after 12 years $= ₹\,1{,}00{,}000 - ₹\,5{,}000 = ₹\,95{,}000$ **1**

The payments into sinking fund consist of 12 annual payments at the rate of 5% per year.

$A = R\left[\frac{(1+i)^n - 1}{i}\right]$

$95000 = R\left[\frac{(1.05)^{12} - 1}{0.05}\right]$ **2**

$\Rightarrow R = \frac{95000 \times 0.05}{0.7958} = ₹\,5968.84$ (or $\frac{4750}{0.8} = ₹\,5937.50$ using approximations) **2**

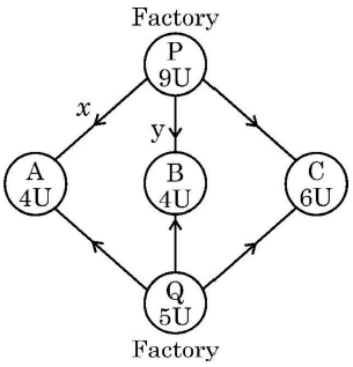
	SECTION E This section comprises of 3 case-study based questions of 4 marks each.	
36.	A man has an expensive square-shaped piece of golden board of side 36 cm. He wants to turn it into a box without top by cutting a square from each corner and folding the flaps. Let x cm be the side of square, which is cut from each corner.   Based on the above information, answer the following questions : (i) Find the expression for the volume (V) of open box in terms of x. (ii) Find $\frac{dV}{dx}$. (iii) Find the value of x for which the volume (V) is maximum. **OR** (iii) Find the maximum volume of the open box.	
Sol.	(i) $V = x\,(36-2x)^2$	**1**
	(ii) $\frac{dV}{dx} = (36-2x)^2 + 2x(36-2x)(-2)$ $= (36-2x)(36-2x-4x)$ $= (36-2x)(36-6x)$ $= 12\,(18-x)(6-x)$	**1**
	(iii) $\frac{dV}{dx} = 0 \implies x = 18$ or $x = 6$ Rejecting $x = 18$, we have $x = 6$ and $\frac{d^2V}{dx^2} = 12(18-x)(-1) + 12\,(-1)(6-x)$ $\implies \frac{d^2V}{dx^2} < 0$ at $x = 6$ $\therefore$ volume is maximum for $x = 6$ **OR**	**1** **½** **½**
	(iii) $\frac{dV}{dx} = 0 \implies x = 18$ or $x = 6$ Rejecting $x = 18$, we have $x = 6$ and $\frac{d^2V}{dx^2} = 12(18-x)(-1) + 12\,(-1)(6-x)$ $\implies \frac{d^2V}{dx^2} < 0$ at $x = 6$ $\therefore$ Max V $= 6\,(36-12)^2 = 6\,(24)^2 = 3456\ cm^3$	**1** **1**

37. There are two factories located one at P and the other at Q. From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirements of the depots are respectively 4, 4 and 6 units of the commodity while the production capacity of the factories at P and Q are 9 and 5 units respectively. The cost of transportation per unit is given as :

From / To	Cost (in ₹)		
	A	B	C
P	160	100	150
Q	100	120	100

Based on the above information, answer the following questions :

Let x units and y units of the commodity be transported from factory P to the depots at A and B respectively, then



(i) Find (in terms of x and y) how many units of commodity be transported from factory P to depot C.

(ii) Find how many units of commodity be transported from factory Q to A, B and C respectively.

(iii) Using (i) and (ii), find the total transportation cost z.

OR

(iii) Using (i) and (ii), find the constraint inequalities for minimum cost z.

Sol.

(i) P to C $= 9 - (x + y)$ **1**

(ii) Q to A $= (4 - x)$
Q to B $= (4 - y)$ } ½

Q to C $= 6 - [9 - x - y] = (x + y - 3)$ ½

(iii) $Z = 160\,x + 100\,y + 150\,(9 - x - y) + 100\,(4 - x) + 120(4 - y) + 100(x + y - 3)$ **1**

$= 10x - 70y + 1930$ **1**

OR

	(iii) $x + y \leq 9$ $x + y \geq 3$ $x \leq 4, y \leq 4$ $x, y \geq 0$	½ ½ 1
38.	Ramesh borrowed a home loan amount of ₹ 7,00,000 from a bank at an interest of 12% per annum for 30 years, to be paid in monthly installments. Based on the above information, answer the following questions : (i) Write the formula for calculating EMI by reducing balance method. (ii) Write the values of P, i and n respectively. (iii) Find the EMI. [Use $(1.01)^{-360} = 0.02781668$] **OR** (iii) If the loan is to be returned in 20 years, find EMI. [Use $(1.01)^{-240} = 0.09180584$]	
Sol.	(i) $E = \frac{P\,i}{1-(1+i)^{-n}}$ or $\frac{P\,i\,(1+i)^n}{(1+i)^n-1}$ (ii) $P = ₹\,7,00,0000, i = \frac{12}{1200} = 0.01, n = 12 \times 30 = 360$ months (iii) $E = ₹\,\frac{7,00,000\times0.01}{1-(1.01)^{-360}}$ $= \frac{7000}{0.97218332} = ₹\,7200.29$ (or $\frac{7000}{0.97} = ₹\,7216.49$ using approximations) **OR** (iii) $E = ₹\,\frac{7,00,000\times0.01}{1-(1.01)^{-240}}$ $= \frac{7000}{0.90819416} = ₹\,7707.60$ (or $\frac{7000}{0.91} = ₹\,7692.31$ using approximations)	1 1 1 1 1 1

Series &RQPS

Set – 4

प्रश्न-पत्र कोड
Q.P. Code **465**

अनुक्रमांक
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book.

- *कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ* ***27*** *हैं ।*
- *कृपया जाँच कर लें कि इस प्रश्न-पत्र में* ***38*** *प्रश्न हैं ।*
- *प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।*
- ***कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।***
- *इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।*
- *Please check that this question paper contains* ***27*** *printed pages.*
- *Please check that this question paper contains* ***38*** *questions.*
- *Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.*
- ***Please write down the serial number of the question in the answer-book before attempting it.***
- *15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.*

व्यावहारिक गणित
APPLIED MATHEMATICS

निर्धारित समय : 3 घण्टे *अधिकतम अंक : 80*

Time allowed : 3 hours *Maximum Marks : 80*

सामान्य निर्देश :

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सख़्ती से पालन कीजिए :

(i) *इस प्रश्न-पत्र में **38** प्रश्न हैं । **सभी** प्रश्न **अनिवार्य** हैं ।*

(ii) *यह प्रश्न-पत्र **पाँच** खण्डों में विभाजित है – **क, ख, ग, घ** एवं **ङ** ।*

(iii) ***खण्ड क** में प्रश्न संख्या **1** से **18** तक बहुविकल्पीय तथा प्रश्न संख्या **19** एवं **20** अभिकथन एवं तर्क आधारित **1** अंक के प्रश्न हैं ।*

(iv) ***खण्ड ख** में प्रश्न संख्या **21** से **25** तक अति लघु-उत्तरीय (VSA) प्रकार के **2** अंकों के प्रश्न हैं ।*

(v) ***खण्ड ग** में प्रश्न संख्या **26** से **31** तक लघु-उत्तरीय (SA) प्रकार के **3** अंकों के प्रश्न हैं ।*

(vi) ***खण्ड घ** में प्रश्न संख्या **32** से **35** तक दीर्घ-उत्तरीय (LA) प्रकार के **5** अंकों के प्रश्न हैं ।*

(vii) ***खण्ड ङ** में प्रश्न संख्या **36** से **38** प्रकरण अध्ययन आधारित **4** अंकों के प्रश्न हैं ।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है । यद्यपि, खण्ड ख के 2 प्रश्नों में, खण्ड ग के 2 प्रश्नों में, खण्ड घ के 2 प्रश्नों में तथा खण्ड ङ के 3 प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है ।*

(ix) *कैल्कुलेटर का उपयोग **वर्जित** है ।*

खण्ड क

इस खण्ड में बहुविकल्पीय प्रश्न हैं, जिनमें प्रत्येक प्रश्न 1 अंक का है ।

1. 1 km की दौड़ में, खिलाड़ी P, खिलाड़ी Q को 18 मीटर या 9 सेकंड से हरा देता है । दौड़ पूरी करने के लिए P का समय क्या है ?

(A) 512 सेकंड (B) 502 सेकंड

(C) 491 सेकंड (D) 481 सेकंड

2. यदि $x > y$ तथा $z < 0$ हो, तो :

(A) $xz > yz$ (B) $xz \geq yz$

(C) $\frac{x}{z} > \frac{y}{z}$ (D) $\frac{x}{z} < \frac{y}{z}$

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) *This question paper contains **38** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** Sections – **A**, **B**, **C**, **D** and **E**.*

(iii) *In **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.*

(iv) *In **Section B,** Questions no. **21** to **25** are very short answer (VSA) type questions, carrying **2** marks each.*

(v) *In **Section C,** Questions no. **26** to **31** are short answer (SA) type questions, carrying **3** marks each.*

(vi) *In **Section D,** Questions no. **32** to **35** are long answer (LA) type questions carrying **5** marks each.*

(vii) *In **Section E,** Questions no. **36** to **38** are case study based questions carrying **4** marks each.*

(viii) *There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and 3 questions in Section E.*

(ix) *Use of calculators is **not** allowed.*

SECTION A

This section comprises multiple choice questions of 1 mark each.

1. In a 1 km race, player P beats player Q by 18 metres or 9 seconds. What is P's time to complete the race ?

(A) 512 seconds (B) 502 seconds

(C) 491 seconds (D) 481 seconds

2. If $x > y$ and $z < 0$, then :

(A) $xz > yz$ (B) $xz \geq yz$

(C) $\frac{x}{z} > \frac{y}{z}$ (D) $\frac{x}{z} < \frac{y}{z}$

3. यदि $AB = A$ और $BA = B$ हो, तो $(B^2 + B)$ बराबर है :

(A) $2A$ (B) O

(C) $2I$ (D) $2B$

4. $\Delta = \begin{vmatrix} 42 & 2 & 5 \\ 79 & 7 & 9 \\ 29 & 5 & 3 \end{vmatrix}$ का मान है :

(A) 0 (B) 1

(C) -3 (D) -15

5. यदि $y = e^{-2x}$ है, तो $\frac{d^3y}{dx^3}$ बराबर है :

(A) $2e^{-2x}$ (B) e^{-4x}

(C) $4e^{-4x}$ (D) $-8e^{-2x}$

6. फलन $f(x) = x^2 - x + 1$ है :

(A) $(0, 1)$ में वर्धमान

(B) $(0, 1)$ में ह्रासमान

(C) $(0, \frac{1}{2})$ में वर्धमान और $(\frac{1}{2}, 1)$ में ह्रासमान

(D) $(\frac{1}{2}, 1)$ में वर्धमान और $(0, \frac{1}{2})$ में ह्रासमान

7. अवकल समीकरण

$$y\,dx + x\log\left(\frac{y}{x}\right)dy - 2x\,dy = 0$$

की **कोटि** एवं **घात** क्रमश: हैं :

(A) 1, 1 (B) 1, 2

(C) 2, 1 (D) 1, परिभाषित नहीं

3. If $AB = A$ and $BA = B$, then $(B^2 + B)$ equals :

(A) 2A (B) O

(C) 2I (D) 2B

4. The value of $\Delta = \begin{vmatrix} 42 & 2 & 5 \\ 79 & 7 & 9 \\ 29 & 5 & 3 \end{vmatrix}$ is :

(A) 0 (B) 1

(C) – 3 (D) –15

5. If $y = e^{-2x}$, then $\frac{d^3y}{dx^3}$ is equal to :

(A) $2e^{-2x}$ (B) e^{-4x}

(C) $4e^{-4x}$ (D) $-8e^{-2x}$

6. The function $f(x) = x^2 - x + 1$ is :

(A) increasing in (0, 1)

(B) decreasing in (0, 1)

(C) increasing in $(0, \frac{1}{2})$ and decreasing in $(\frac{1}{2}, 1)$

(D) increasing in $(\frac{1}{2}, 1)$ and decreasing in $(0, \frac{1}{2})$

7. The **order** and the **degree** of the differential equation

$$y\,dx + x\log\left(\frac{y}{x}\right)dy - 2x\,dy = 0$$

are respectively :

(A) 1, 1 (B) 1, 2

(C) 2, 1 (D) 1, not defined

8. एक न्याय सिक्का दो बार उछाला जाता है और परिणाम नोट कर लिया जाता है । यदि इस परीक्षण में चितों की संख्या को दर्शाने वाला यादृच्छिक चर X हो, तो X की गणितीय प्रत्याशा (expectation) होगी :

(A) 1 (B) $\frac{1}{2}$

(C) $\frac{1}{4}$ (D) $1\frac{1}{2}$

9. यदि वर्तमान समय, रात्रि 9:00 बजे हैं, तो 1275 घंटों के बाद कौन-सा समय होगा ?

(A) रात्रि 11 बजे (B) रात्रि 12 बजे

(C) रात्रि 9 बजे (D) सुबह 9 बजे

10. यदि एक प्वासों चर X के लिए,

$P(X = k) = P(X = k + 1)$ है,

तो X का प्रसरण होगा :

(A) $k - 1$ (B) k

(C) $k + 1$ (D) $k + 2$

11. यदि $|t|$ का परिकलित मान $t_v(\alpha)$ (t का क्रांतिक मान) से कम हो, तो निराकरणीय परिकल्पना :

(A) अस्वीकार की जाती है ।

(B) स्वीकार की जाती है ।

(C) न तो स्वीकार की जाती है और न ही अस्वीकार ।

(D) निर्धारित नहीं की जा सकती है ।

12. दो स्वतंत्र नमूनों के माध्यों के बीच के अंतर की सार्थकता की जाँच करने के लिए, स्वातंत्र्य कोटि (v) _____ ली जाती है ।

(A) $n_1 - n_2 + 2$ (B) $n_1 - n_2 - 2$

(C) $n_1 + n_2 - 2$ (D) $n_1 + n_2 + 2$

8. A fair coin is tossed twice and outcomes are noted. If the random variable X represents the number of heads that appeared in the experiment, then the mathematical expectation of X is :

(A) 1 (B) $\frac{1}{2}$

(C) $\frac{1}{4}$ (D) $1\frac{1}{2}$

9. What time will it be after 1275 hours, if the present time is 9:00 p.m. ?

(A) 11 p.m. (B) 12 p.m.

(C) 9 p.m. (D) 9 a.m.

10. If for a Poisson variate X,

$$P(X = k) = P(X = k + 1),$$

then the variance of X is :

(A) $k - 1$ (B) k

(C) $k + 1$ (D) $k + 2$

11. If the calculated value of $|t| < t_v(\alpha)$ (critical value of t), then the null hypothesis :

(A) is rejected.

(B) is accepted.

(C) is neither accepted nor rejected.

(D) cannot be determined.

12. For testing the significance of difference between the means of two independent samples, the degree of freedom (v) is taken as :

(A) $n_1 - n_2 + 2$ (B) $n_1 - n_2 - 2$

(C) $n_1 + n_2 - 2$ (D) $n_1 + n_2 + 2$

13. दिए गए मानों 23, 32, 40, 47, 58, 33, 42 के लिए, 5-वर्षीय गतिमान औसत हैं :

(A) 38, 40, 42 (B) 40, 42, 44

(C) 40, 42, 46 (D) 42, 44, 46

14. फ्लैट रेट पद्धति का उपयोग करते हुए, 8% वार्षिक ब्याज दर पर $2\frac{1}{2}$ वर्षों में ₹ 20,000 का ऋण चुकाने के लिए EMI होगा :

(A) ₹ 700 (B) ₹ 800

(C) ₹ 900 (D) ₹ 100

15. एक मोबाइल फोन का मूल्य ₹ 12,000 है और 3 वर्ष के उपयोगी जीवन के बाद, उसका स्क्रैप मूल्य ₹ 3,000 है । तो 2 वर्ष के अंत में मोबाइल फोन का बुक मूल्य होगा :

(A) ₹ 3,000 (B) ₹ 6,000

(C) ₹ 5,000 (D) ₹ 7,000

16. 8 वर्षों में ₹ 50,000 जमा करने के लिए प्रत्येक 6 महीने के अंत में कितनी धनराशि जमा की जानी चाहिए, यदि धनराशि पर ब्याज 6% वार्षिक है और ब्याज अर्ध-वार्षिक संयोजित होता है ? [दिया गया है : $(1{\cdot}03)^{16} = 1{\cdot}6047$]

(A) ₹ 3,432·53 (B) ₹ 2,783·08

(C) ₹ 2,480·57 (D) ₹ 2,149·93

17. असमीकरण $2x + 3y > 6$ का आलेख है :

(A) पूर्ण XOY-तल

(B) अर्ध-तल जिसमें मूल-बिंदु स्थित हैं

(C) अर्ध-तल जिसमें न तो मूल-बिंदु और न ही रेखा $2x + 3y = 6$ के बिंदु स्थित हैं

(D) पूर्ण XOY-तल जिसमें रेखा $2x + 3y = 6$ के बिंदु शामिल नहीं हैं

13. For the given values 23, 32, 40, 47, 58, 33, 42; the 5-yearly moving averages are :

(A) 38, 40, 42 (B) 40, 42, 44

(C) 40, 42, 46 (D) 42, 44, 46

14. 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% p.a. is :

(A) ₹ 700 (B) ₹ 800

(C) ₹ 900 (D) ₹ 100

15. A mobile phone costs ₹ 12,000 and its scrap value after a useful life of 3 years is ₹ 3,000. Then, the book value of the mobile phone at the end of 2 years is :

(A) ₹ 3,000 (B) ₹ 6,000

(C) ₹ 5,000 (D) ₹ 7,000

16. What sum of money should be deposited at the end of every 6 months to accumulate ₹ 50,000 in 8 years, if money is worth 6% p.a. compounded semi-annually ? [Given : $(1{\cdot}03)^{16} = 1{\cdot}6047$]

(A) ₹ 3,432·53 (B) ₹ 2,783·08

(C) ₹ 2,480·57 (D) ₹ 2,149·93

17. The graph of the inequation $2x + 3y > 6$ is the :

(A) entire XOY-plane

(B) half-plane that contains the origin

(C) half-plane that neither contains the origin nor the points on the line $2x + 3y = 6$

(D) whole XOY-plane excluding the points on the line $2x + 3y = 6$

18. एक रैखिक प्रोग्रामन समस्या में, यदि उद्देश्य फलन $Z = ax + by$ का अधिकतम मान सुसंगत क्षेत्र के दो कोनीय बिंदुओं पर एकसमान है, तो बिंदुओं की संख्या जिन पर Z का अधिकतम मान है, है :

(A) 0 (B) 2

(C) सीमित (D) अनंत

*प्रश्न संख्या **19** और **20** अभिकथन एवं तर्क आधारित प्रश्न हैं । दो कथन दिए गए हैं जिनमें एक को अभिकथन (A) तथा दूसरे को तर्क (R) द्वारा अंकित किया गया है । इन प्रश्नों के सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए ।*

(A) अभिकथन (A) और तर्क (R) दोनों सही हैं और तर्क (R), अभिकथन (A) की सही व्याख्या करता है ।

(B) अभिकथन (A) और तर्क (R) दोनों सही हैं, परन्तु तर्क (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है ।

(C) अभिकथन (A) सही है, परन्तु तर्क (R) ग़लत है ।

(D) अभिकथन (A) ग़लत है, परन्तु तर्क (R) सही है ।

19. *अभिकथन (A) :* फलन $f(x) = x^2 - x + 1$, अंतराल $(-1, 1)$ पर निरंतर वर्धमान है ।

तर्क (R) : यदि $f(x)$ अंतराल $[a, b]$ पर संतत और अंतराल (a, b) पर अवकलनीय है, तो अंतराल $[a, b]$ में $f(x)$ निरंतर वर्धमान है, यदि सभी $x \in (a, b)$ के लिए $f'(x) > 0$ है ।

20. एक द्विपद बंटन में, $n = 200$ और $p = 0{\cdot}04$ है । प्वासों बंटन को द्विपद बंटन के सन्निकटन के रूप में लेते हुए :

अभिकथन (A) : प्वासों बंटन का माध्य 8 है ।

तर्क (R) : $P(X = 4) = \frac{512}{3e^8}$.

18. In an LPP, if the objective function Z = ax + by has same maximum value on two corner points of the feasible region, then the number of points at which maximum value of Z occurs is :

(A) 0 (B) 2

(C) finite (D) infinite

*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) :* The function $f(x) = x^2 - x + 1$ is strictly increasing on $(-1, 1)$.

Reason (R) : If f(x) is continuous on [a, b] and derivable on (a, b), then f(x) is strictly increasing on [a, b] if $f'(x) > 0$ for all $x \in (a, b)$.

20. In a binomial distribution, n = 200 and p = 0·04. Taking Poisson distribution as an approximation to the binomial distribution :

Assertion (A) : Mean of Poisson distribution = 8.

Reason (R) : $P(X = 4) = \frac{512}{3e^8}$.

खण्ड ख

इस खण्ड में अति लघु-उत्तरीय (VSA) प्रकार के प्रश्न हैं, जिनमें प्रत्येक के 2 अंक हैं ।

21. (क) यदि $A = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$ है, तो k का वह मान ज्ञात कीजिए जिसके लिए $A^2 - 8A + kI = 0$ है ।

अथवा

(ख) यदि $\begin{bmatrix} x-y & 2x+z \\ 2x-y & 3z+w \end{bmatrix} = \begin{bmatrix} -1 & 5 \\ 0 & 13 \end{bmatrix}$ है, तो x, y, z और w के मान ज्ञात कीजिए ।

22. क्रैमर नियम का उपयोग करके, निम्नलिखित समीकरण निकाय को हल कीजिए :

$$2x_1 + 3x_2 = 5$$

$$11x_1 - 5x_2 = 6$$

23. निम्नलिखित रैखिक प्रोग्रामन समस्या का आलेखीय विधि से हल ज्ञात कीजिए (यदि कोई हल है तो) :

व्यवरोधों

$$x - y \leq -1$$
$$-x + y \leq 0$$
$$x, y \geq 0$$

के अंतर्गत

$Z = x + y$ का अधिकतमीकरण कीजिए ।

24. 6% वार्षिक, जिसे त्रैमासिक संयोजित किया गया है पर, प्रत्येक तिमाही के अंत में देय ₹ 600 की शाश्वतता का वर्तमान मूल्य ज्ञात कीजिए ।

SECTION B

This section comprises very short answer (VSA) type questions of 2 marks each.

21. (a) If $A = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$, find the value of k such that $A^2 - 8A + kI = 0$.

OR

(b) If $\begin{bmatrix} x-y & 2x+z \\ 2x-y & 3z+w \end{bmatrix} = \begin{bmatrix} -1 & 5 \\ 0 & 13 \end{bmatrix}$, find the values of x, y, z and w.

22. Using Cramer's rule, solve the following system of equations :

$$2x_1 + 3x_2 = 5$$

$$11x_1 - 5x_2 = 6$$

23. Find the solution to the following linear programming problem (if it exists) graphically :

Maximize $Z = x + y$

subject to the constraints

$$x - y \leq -1$$

$$-x + y \leq 0$$

$$x, y \geq 0.$$

24. At 6% p.a., compounded quarterly, find the present value of a perpetuity of ₹ 600 payable at the end of each quarter.

25. (क) मान लीजिए कि किसी निवेश का शुरुआती मूल्य ₹ 20,000 है और यह 3 वर्ष में बढ़कर ₹ 50,000 हो जाता है । CAGR (चक्रवृद्धित वार्षिक वृद्धि दर) की गणना कीजिए । [लीजिए $(2{\cdot}5)^{1/3} = 1{\cdot}355$]

अथवा

(ख) एक व्यक्ति एक वस्तु ₹ 12,000 में खरीदता है । वर्ष के अंत में, वह इस वस्तु को ₹ 15,000 में बेच देता है । यदि मुद्रास्फीति की दर 6% थी, तो रिटर्न की नाममात्र और वास्तविक दरें ज्ञात कीजिए ।

खण्ड ग

इस खण्ड में लघु-उत्तरीय (SA) प्रकार के प्रश्न हैं, जिनमें प्रत्येक के 3 अंक हैं ।

26. एक कंटेनर में 50 लीटर जूस है । इसमें से 5 लीटर जूस निकाल लिया जाता है और कंटेनर में 5 लीटर पानी डाल दिया जाता है । इस क्रिया को 4 बार और दोहराया जाता है । इस क्रिया के अन्त में कंटेनर में जूस की मात्रा ज्ञात कीजिए । [लीजिए $(0{\cdot}9)^5 = 0{\cdot}59049$]

27. (क) $\int_0^2 x^2\,dx$ का मान ज्ञात कीजिए, अत: ग्राफ पर वह क्षेत्र दर्शाइए जिसको यह क्षेत्रफल निरूपित करता है ।

अथवा

(ख) मान ज्ञात कीजिए : $\int_0^1 \frac{e^{-x}}{1+e^x}\,dx$

28. प्रथम चतुर्थांश में बने ऐसे वृत्तों के कुल का अवकल समीकरण ज्ञात कीजिए जो दोनों निर्देशांक अक्षों को स्पर्श करते हैं ।

29. यह दिया गया है कि एक IQ परीक्षण में उम्मीदवारों के एक समूह के अंक सामान्य बंटित होते हैं । यदि IQ परीक्षण का माध्य 100 और मानक विचलन 10 है, तो प्रायिकता ज्ञात कीजिए कि परीक्षा देने वाला उम्मीदवार 90 और 110 के बीच स्कोर करेगा ।

[दिया गया है : $P(Z < 1) = 0{\cdot}8413$ और $P(Z < -1) = 0{\cdot}1587$]

25. (a) Assume an investment's starting value is ₹ 20,000 and it grows to ₹ 50,000 in 3 years. Calculate CAGR (Compounded Annual Growth Rate) [Use : $(2{\cdot}5)^{1/3} = 1{\cdot}355$]

OR

(b) A man bought an item for ₹ 12,000. At the end of the year, he decided to sell it for ₹ 15,000. If the inflation rate was 6%, find the nominal and real rate of return.

SECTION C

This section comprises short answer (SA) type questions of 3 marks each.

26. A container has 50 litres of juice in it. 5 litres of juice is taken out and is replaced by 5 litres of water. This process is repeated 4 more times. Determine the quantity of juice in the container after final replacement.

[Use $(0{\cdot}9)^5 = 0{\cdot}59049$]

27. (a) Evaluate : $\int_0^2 x^2 \, dx$ and hence show the region on the graph whose area it represents.

OR

(b) Evaluate : $\int_0^1 \frac{e^{-x}}{1+e^x} \, dx$

28. Find the differential equation of all circles in the first quadrant which touches both the coordinate axes.

29. Given that the scores of a set of candidates on an IQ test are normally distributed. If the IQ test has a mean of 100 and a standard deviation of 10, determine the probability that a candidate who takes the test will score between 90 and 110.

[Given $P(Z < 1) = 0{\cdot}8413$ and $P(Z < -1) = 0{\cdot}1587$]

30. 20 एजेंसियों में 4-पहिया वाहन की औसत साप्ताहिक बिक्री 50 यूनिट प्रति एजेंसी थी । एक विज्ञापन अभियान के बाद, औसत साप्ताहिक ब्रिकी बढ़कर 55 यूनिट प्रति एजेंसी 10 यूनिट मानक विचलन सहित हो गई थी । जाँच कीजिए कि क्या यह विज्ञापन अभियान सफल रहा था । [दिया गया है : $\sqrt{5} = 2 \cdot 24, t_{19}(0 \cdot 05) = 1 \cdot 729$]

31. (क) हाल ही में एक लेखांकन स्नातक ने एक नया व्यवसाय खोला और एक कंप्यूटर सिस्टम स्थापित किया जिसकी लागत ₹ 45,200 थी । कंप्यूटर सिस्टम का मूल्यह्रास रैखिक रूप से 3 वर्षों के लिए होगा और इसका स्क्रैप मूल्य ₹ 0 होगा ।

(i) मूल्यह्रास की दर क्या है ?

(ii) एक रैखिक समीकरण ज्ञात कीजिए जो t वर्ष के अंत में कंप्यूटर सिस्टम के बुक वैल्यू का वर्णन करता है, जहाँ $0 \leq t \leq 3$ है ।

(iii) डेढ़ वर्ष के अंत में कंप्यूटर सिस्टम की बुक वैल्यू क्या होगी ?

अथवा

(ख) प्रभावी दर ज्ञात कीजिए जो 10% प्रति वर्ष की सामान्य दर के बराबर है, जो :

(i) अर्ध-वार्षिक संयोजित होती है ।

(ii) तिमाही संयोजित होती है ।

[दिया गया है : $(1 \cdot 05)^2 = 1 \cdot 1025, (1 \cdot 025)^4 = 1 \cdot 1038$]

खण्ड घ

इस खण्ड में दीर्घ-उत्तरीय (LA) प्रकार के प्रश्न हैं, जिनमें प्रत्येक के 5 अंक हैं ।

32. एक टंकी में तीन पाइप A, B और C लगे हैं । पाइप A और B इनलेट पाइप हैं जबकि पाइप C एक आउटलेट पाइप है । पाइप A और B टंकी को क्रमश: 3 घंटे और 4 घंटे में भर देते हैं जबकि पाइप C पूरी भरी टंकी को 1 घंटे में पूरी तरह से खाली कर देता है । यदि ये तीनों पाइप A, B और C क्रम से सुबह 5, 6 तथा 7 बजे खोले जाते हैं, तो पूरी टंकी कितने समय में खाली हो जाएगी ?

30. The mean weekly sales of a 4-wheeler was 50 units per agency in 20 agencies. After an advertising campaign, the mean weekly sales increased to 55 units per agency with standard deviation of 10 units. Test whether the advertising campaign was successful.

[Given $\sqrt{5} = 2 \cdot 24$, $t_{19}(0 \cdot 05) = 1 \cdot 729$]

31. (a) A recent accounting graduate opened a new business and installed a computer system that costs ₹ 45,200. The computer system will be depreciated linearly over 3 years and will have a scrap value of ₹ 0.

(i) What is the rate of depreciation ?

(ii) Give a linear equation that describes the computer system's book value at the end of tth year, where $0 \leq t \leq 3$.

(iii) What will be the computer system's book value at the end of the first year and a half ?

OR

(b) Find the effective rate which is equivalent to normal rate of 10% p.a. compounded :

(i) semi-annually.

(ii) quarterly.

[Given $(1 \cdot 05)^2 = 1 \cdot 1025$, $(1 \cdot 025)^4 = 1 \cdot 1038$]

SECTION D

This section comprises long answer (LA) type questions of 5 marks each.

32. A cistern has three pipes A, B and C. Pipes A and B are inlet pipes whereas C is an outlet pipe. Pipes A and B can fill the cistern separately in 3 hours and 4 hours respectively; while pipe C can empty the completely filled cistern in 1 hour. If the pipes A, B and C are opened in order at 5, 6 and 7 a.m. respectively, at what time will the cistern be empty ?

33. (क) $f(x) = -\frac{3}{4}x^4 - 8x^3 - \frac{45}{2}x^2 + 105$ द्वारा प्रदत्त फलन के लिए स्थानीय उच्चतम और स्थानीय निम्नतम के सभी बिंदुओं को ज्ञात कीजिए ।

अथवा

(ख) अंतराल ज्ञात कीजिए जिनमें $f(x) = 20 - 9x + 6x^2 - x^3$ द्वारा प्रदत्त फलन f निरंतर वर्धमान या निरंतर ह्रासमान है ।

34. (क) मान लीजिए X एक यादृच्छिक रूप से चयनित स्कूल दिवस के दौरान बारहवीं कक्षा के छात्र द्वारा अध्ययन किए गए घंटों की संख्या दर्शाता है । प्रायिकता यह है कि अज्ञात स्थिरांक 'k' के लिए X के मान x_i हो सकते हैं :

$$P(X = k) = \begin{cases} 0{\cdot}1 & \text{यदि} \quad x_i = 0 \\ kx_i & \text{यदि} \quad x_i = 1 \text{ या } 2 \\ k(5 - x_i) & \text{यदि} \quad x_i = 3 \text{ या } 4 \end{cases}$$

(i) k का मान ज्ञात कीजिए ।

(ii) छात्र के कम-से-कम 2 घंटे अध्ययन करने की प्रायिकता ज्ञात कीजिए ।

(iii) छात्र के अधिक-से-अधिक 2 घंटे अध्ययन करने की प्रायिकता ज्ञात कीजिए ।

अथवा

(ख) एक छोटे शहर के पास एक नदी में हर 10 साल में दो बार बाढ़ आती है और वह ओवरफ्लो हो जाती है । यह मानते हुए कि प्वासों बंटन उचित है, माध्य अपेक्षा क्या है ? साथ ही 10 वर्ष के अंतराल में 3 या उससे कम ओवरफ्लो तथा बाढ़ की प्रायिकता ज्ञात कीजिए ।

[दिया गया है : $e^{-2} = 0{\cdot}13534$]

35. अमृता एक कार खरीदती है जिसके लिए वह ₹ 2,50,000 का अग्रिम भुगतान करती है और शेष राशि का भुगतान 2 वर्षों में ₹ 25,448 प्रत्येक की मासिक किश्त द्वारा किया जाना है । यदि फाइनेंसर 20% प्रति वर्ष की दर से ब्याज लेता है, तो कार की वास्तविक कीमत ज्ञात कीजिए । [दिया गया है : $\left(\frac{61}{60}\right)^{-24} = 0{\cdot}67253$]

33. (a) Find all the points of local maxima and local minima of the function :

$$f(x) = -\frac{3}{4}x^4 - 8x^3 - \frac{45}{2}x^2 + 105.$$

OR

(b) Find the intervals in which the following function f is strictly increasing or strictly decreasing :

$$f(x) = 20 - 9x + 6x^2 - x^3.$$

34. (a) Let X denote the number of hours a Class 12 student studies during a randomly selected school day. The probability that X can take the values x_i, for an unknown constant 'k' :

$$P(X = k) = \begin{cases} 0{\cdot}1 & \text{if} \quad x_i = 0 \\ kx_i & \text{if} \quad x_i = 1 \text{ or } 2 \\ k(5 - x_i) & \text{if} \quad x_i = 3 \text{ or } 4 \end{cases}$$

(i) Find the value of k.

(ii) Determine the probability that the student studied for at least 2 hours.

(iii) Determine the probability that the student studied for at most 2 hours.

OR

(b) A river near a small town floods and overflows twice in every 10 years on an average. Assuming that the Poisson distribution is appropriate, what is the mean expectation ? Also, calculate the probability of 3 or less overflows and floods in a 10-year interval. [Given $e^{-2} = 0{\cdot}13534$]

35. Amrita buys a car for which she makes a down payment of ₹ 2,50,000 and the balance is to be paid in 2 years by monthly instalments of ₹ 25,448 each. If the financer charges interest at the rate of 20% p.a, find the actual price of the car. [Given $\left(\frac{61}{60}\right)^{-24} = 0{\cdot}67253$]

खण्ड ङ

इस खण्ड में 3 प्रकरण अध्ययन-आधारित प्रश्न हैं जिनमें प्रत्येक के 4 अंक हैं ।

प्रकरण अध्ययन – 1

36. अपने जन्मदिन पर, प्रेमा ने अनाथालय के बच्चों को कुछ पैसे दान करने का फैसला किया ।



यदि 8 बच्चे कम होते हैं, तो प्रत्येक बच्चे को ₹ 10 अधिक प्राप्त होते हैं । परन्तु, यदि 16 बच्चे अधिक होते हैं, तो प्रत्येक बच्चे को ₹ 10 कम प्राप्त होते हैं ।

माना अनाथालय में बच्चों की संख्या x तथा प्रत्येक बच्चे को दान से मिलने वाली राशि ₹ y है ।

उपर्युक्त सूचना के आधार पर, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) दी गई स्थिति से बने x और y में रैखिक समीकरण निकाय लिखिए । *1*

SECTION E

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

Case Study – 1

36. On her birthday, Prema decides to donate some money to children of an orphanage home.



If there are 8 children less, everyone gets ₹ 10 more. However, if there are 16 children more, everyone gets ₹ 10 less.

Let the number of children in the orphanage home be x and the amount to be donated to each child be ₹ y.

Based on the above information, answer the following questions :

(i) Write the system of linear equations in x and y formed of the given situation. *1*

(ii) ऊपर (i) में लिखे गए रैखिक समीकरण निकाय को आव्यूह समीकरण $AX = B$ के रूप में लिखिए । *1*

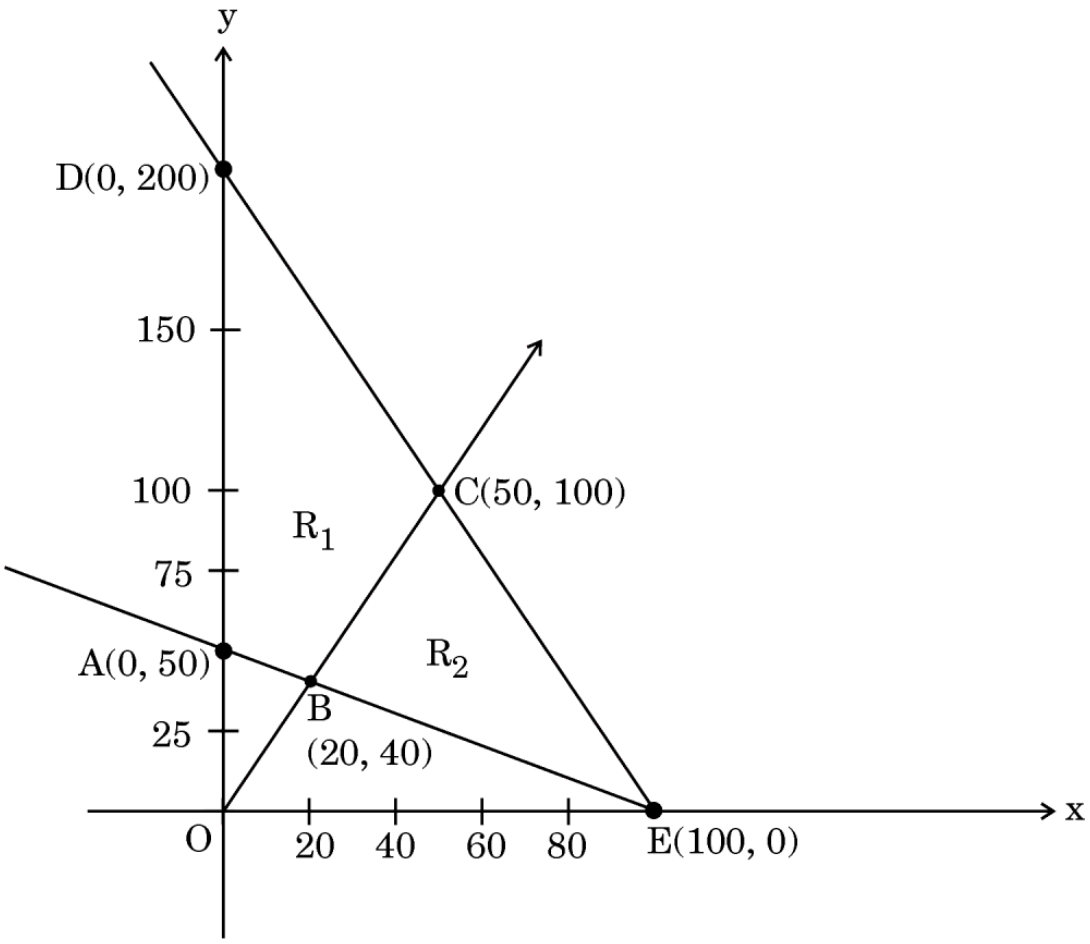
(iii) (क) आव्यूह A का प्रतिलोम ज्ञात कीजिए । *2*

अथवा

(ख) x और y के मान ज्ञात कीजिए । *2*

प्रकरण अध्ययन – 2

37. संख्या सिद्धांत में, पूर्णांक N के गुणनखंड खोजना अकसर महत्त्वपूर्ण होता है । संख्या N के दो तुच्छ गुणनखंड हैं, अर्थात 1 और N । यदि कोई अन्य गुणनखंड मौजूद है, तो उसे N का ग़ैर-तुच्छ गुणनखंड कहा जाता है । नरेश ने बिंदुओं A(0, 50), B(20, 40), C(50, 100), D(0, 200) और E(100, 0) के साथ कुछ व्यवरोधों (रैखिक असमानताओं) का एक ग्राफ तैयार किया । यह ग्राफ तीन ग़ैर-तुच्छ व्यवरोधों और दो तुच्छ व्यवरोधों से बना है । इन तीन ग़ैर-तुच्छ व्यवरोधों में एक व्यवरोध है $x + 2y \geq 100$.



(ii) Write the system of linear equations, obtained in (i) above, in matrix form AX = B. *1*

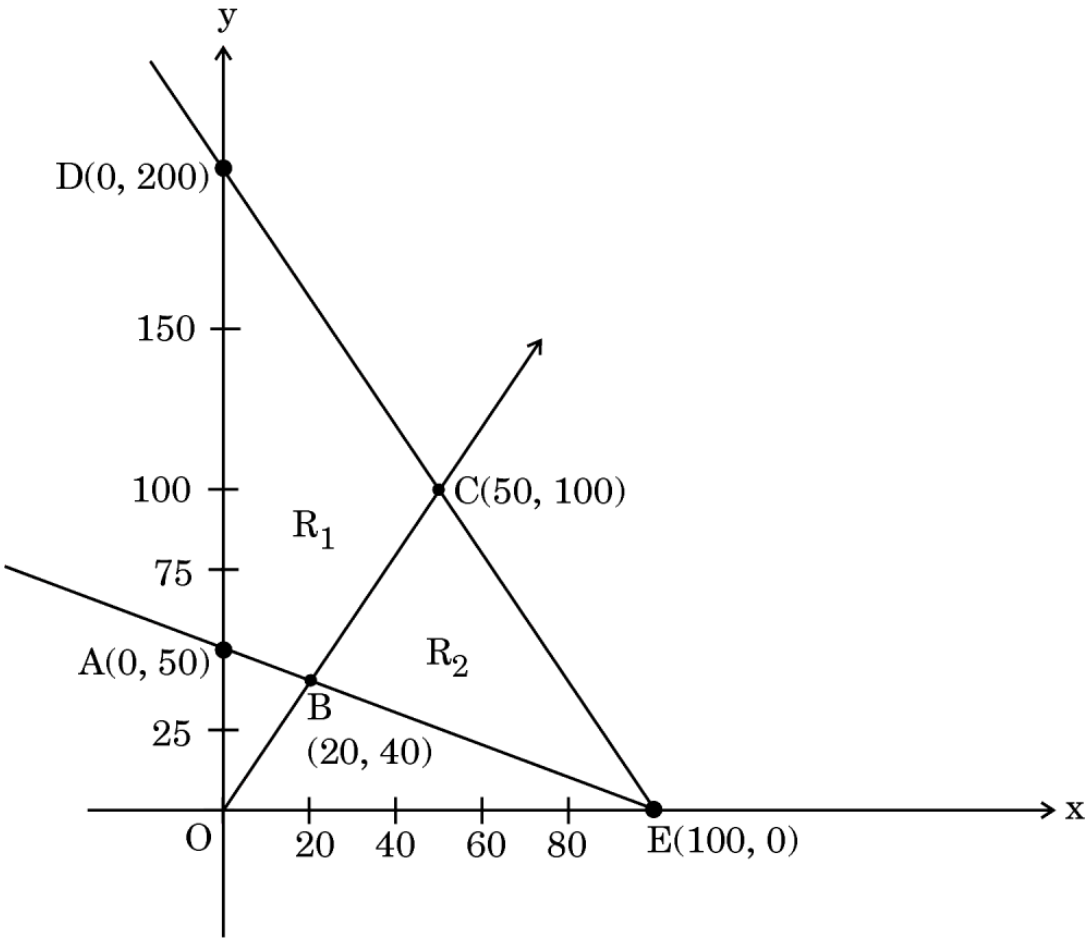
(iii) (a) Find the inverse of matrix A. *2*

OR

(b) Determine the values of x and y. *2*

Case Study – 2

37. In number theory, it is often important to find factors of an integer N. The number N has two trivial factors, namely 1 and N. Any other factor, if exists, is called non-trivial factor of N. Naresh has plotted a graph of some constraints (linear inequations) with points A (0, 50), B (20, 40), C(50, 100), D(0, 200) and E(100, 0). This graph is constructed using three non-trivial constraints and two trivial constraints. One of the non-trivial constraints is $x + 2y \geq 100$.



उपर्युक्त सूचना के आधार पर, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) दो तुच्छ व्यवरोध कौन-कौन से हैं ? *1*

(ii) (क) यदि सुसंगत क्षेत्र R_1 है, तो अन्य दो ग़ैर-तुच्छ व्यवरोध क्या हैं ? *2*

अथवा

(ख) यदि सुसंगत क्षेत्र R_2 है, तो अन्य दो ग़ैर-तुच्छ व्यवरोध क्या हैं ? *2*

(iii) यदि सुसंगत क्षेत्र R_1 है, तो उद्देश्य फलन $z = 5x + 2y$ का अधिकतम मान ज्ञात कीजिए । *1*

प्रकरण अध्ययन – 3

38. जब लंबे समय तक देखा जाता है, तो एक समय-शृंखला आँकड़े उन रुझानों की भविष्यवाणी कर सकते हैं जो विचाराधीन चर में वृद्धि या कमी या ठहराव का अनुमान लगा सकते हैं । इस तरह के विश्लेषणात्मक अध्ययन किसी व्यवसाय को भविष्य में अनुमानित बिक्री या उत्पादन की भविष्यवाणी या पूर्वानुमान के लिए लाभदायक हो सकता है ।

निम्नलिखित तालिका 1996 – 2001 के दौरान एक जिले में एक वस्तु की बिक्री को दर्शाती है :

वर्ष :	1996	1997	1998	1999	2000	2001
बिक्री (₹ लाख में) :	6·5	5·3	4·3	6·1	5·6	7·8

उपर्युक्त सूचना के आधार पर, निम्नलिखित प्रश्नों के उत्तर दीजिए :

(i) सीधी-रेखा प्रवृत्ति का समीकरण निर्धारित कीजिए । *2*

Based on the above information, answer the following questions :

(i) What are the two trivial constraints ? *1*

(ii) (a) If R_1 is the feasible region, then what are the other two non-trivial constraints ? *2*

OR

(b) If R_2 is the feasible region, then what are the other two non-trivial constraints ? *2*

(iii) If R_1 is the feasible region, then find the maximum value of the objective function $z = 5x + 2y$. *1*

Case Study – 3

38. 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.

The table below shows the sale of an item in a district during 1996 – 2001 :

Year :	1996	1997	1998	1999	2000	2001
Sales (in lakh ₹) :	6·5	5·3	4·3	6·1	5·6	7·8

Based on the above information, answer the following questions :

(i) Determine the equation of the straight-line trend. *2*

(ii) (क) वर्षों के रुझान मूल्यों को सारणीबद्ध कीजिए और वर्ष 2002 के लिए अपेक्षित बिक्री प्रवृत्ति की भी गणना कीजिए । *2*

अथवा

(ख) निम्नलिखित आँकड़ों के लिए न्यूनतम वर्ग विधि द्वारा एक सीधी-रेखा प्रवृत्ति को फिट कीजिए : *2*

वर्ष :	2004	2005	2006	2007	2008	2009	2010
लाभ (₹ '000)	114	130	126	144	138	156	164

(ii) (a) Tabulate the trend values of the years and also compute expected sales trend for the year 2002. *2*

OR

(b) Fit a straight-line trend by the method of least squares for the following data : *2*

Year :	2004	2005	2006	2007	2008	2009	2010
Profit (₹ '000)	114	130	126	144	138	156	164

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
APPLIED MATHEMATICS PAPER CODE 465

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 _____ (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 un assessed 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)

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.	In a 1 km race, player P beats player Q by 18 metres or 9 seconds. What is P's time to complete the race ? (A) 512 seconds (B) 502 seconds (C) 491 seconds (D) 481 seconds	
Sol.	(C) 491 seconds	**(1)**
2.	If $x > y$ and $z < 0$, then : (A) $xz > yz$ (B) $xz \geq yz$ (C) $\frac{x}{z} > \frac{y}{z}$ (D) $\frac{x}{z} < \frac{y}{z}$	
Sol.	(D) $\frac{x}{z} < \frac{y}{z}$	**(1)**
3.	If AB = A and BA = B, then $(B^2 + B)$ equals : (A) 2A (B) O (C) 2I (D) 2B	
Sol.	(D) 2B	**(1)**
4.	The value of $\Delta = \begin{vmatrix} 42 & 2 & 5 \\ 79 & 7 & 9 \\ 29 & 5 & 3 \end{vmatrix}$ is : (A) 0 (B) 1 (C) – 3 (D) –15	
Sol.	(A) 0	**(1)**

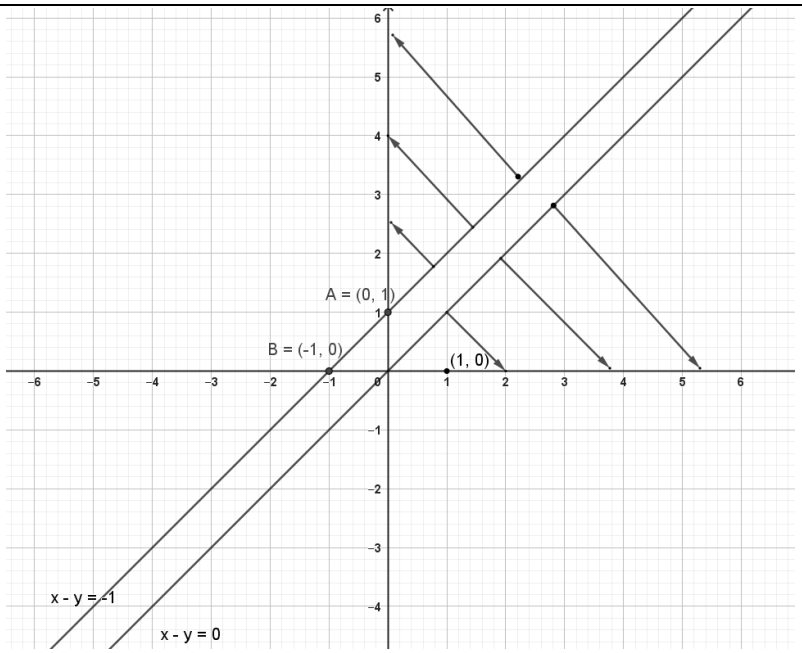
5.	If $y = e^{-2x}$, then $\frac{d^3y}{dx^3}$ is equal to : (A) $2e^{-2x}$ (B) e^{-4x} (C) $4e^{-4x}$ (D) $-8e^{-2x}$	
Sol.	(D) $-8e^{-2x}$	**(1)**
6.	The function $f(x) = x^2 - x + 1$ is : (A) increasing in (0, 1) (B) decreasing in (0, 1) (C) increasing in $(0, \frac{1}{2})$ and decreasing in $(\frac{1}{2}, 1)$ (D) increasing in $(\frac{1}{2}, 1)$ and decreasing in $(0, \frac{1}{2})$	
Sol.	(D) increasing in $\left(\frac{1}{2}, 1\right)$ and decreasing in $\left(0, \frac{1}{2}\right)$	**(1)**
7.	The **order** and the **degree** of the differential equation $y\,dx + x\log\left(\frac{y}{x}\right)dy - 2x\,dy = 0$ are respectively : (A) 1, 1 (B) 1, 2 (C) 2, 1 (D) 1, not defined	
Sol.	(A) 1,1	**(1)**
8.	A fair coin is tossed twice and outcomes are noted. If the random variable X represents the number of heads that appeared in the experiment, then the mathematical expectation of X is : (A) 1 (B) $\frac{1}{2}$ (C) $\frac{1}{4}$ (D) $1\frac{1}{2}$	
Sol.	(A) 1	**(1)**
9.	What time will it be after 1275 hours, if the present time is 9:00 p.m. ? (A) 11 p.m. (B) 12 p.m. (C) 9 p.m. (D) 9 a.m.	
Sol.	Since correct answer is not in the options given So, it is suggested that 1 mark may be given to all who attempted this question	**(1)**

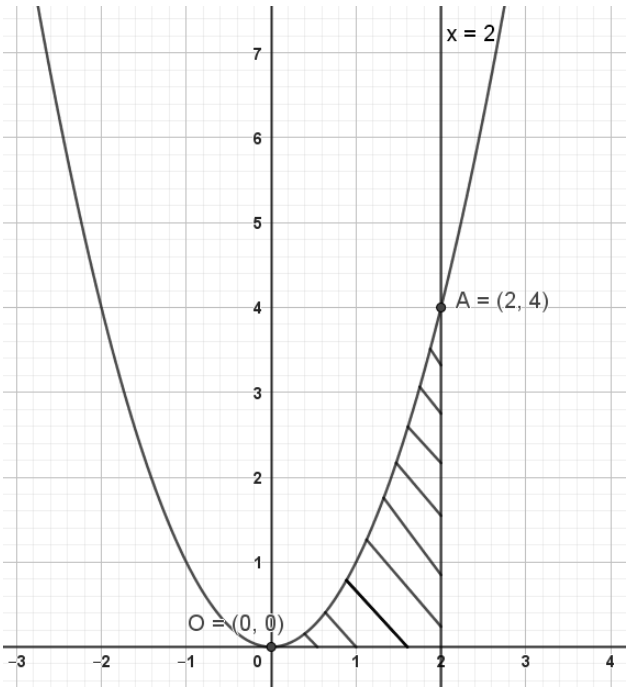
10.	If for a Poisson variate X, $P(X = k) = P(X = k + 1)$, then the variance of X is : (A) $k - 1$ (B) k (C) $k + 1$ (D) $k + 2$	
Sol.	(C) $\mathbf{k + 1}$	**(1)**
11.	If the calculated value of $\|t\| < t_v(\alpha)$ (critical value of t), then the null hypothesis : (A) is rejected. (B) is accepted. (C) is neither accepted nor rejected. (D) cannot be determined.	
Sol.	(B) is accepted	**(1)**
12.	For testing the significance of difference between the means of two independent samples, the degree of freedom (ν) is taken as : (A) $n_1 - n_2 + 2$ (B) $n_1 - n_2 - 2$ (C) $n_1 + n_2 - 2$ (D) $n_1 + n_2 + 2$	
Sol.	(C) $\boldsymbol{n_1 + n_2 - 2}$	**(1)**
13.	For the given values 23, 32, 40, 47, 58, 33, 42; the 5-yearly moving averages are : (A) 38, 40, 42 (B) 40, 42, 44 (C) 40, 42, 46 (D) 42, 44, 46	
Sol.	(B) 40, 42, 44	**(1)**
14.	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% p.a. is : (A) ₹ 700 (B) ₹ 800 (C) ₹ 900 (D) ₹ 100	
Sol.	(B) ₹ 800	**(1)**

15.	A mobile phone costs ₹ 12,000 and its scrap value after a useful life of 3 years is ₹ 3,000. Then, the book value of the mobile phone at the end of 2 years is : (A) ₹ 3,000 (B) ₹ 6,000 (C) ₹ 5,000 (D) ₹ 7,000	
Sol.	(B) ₹ 6,000	**(1)**
16.	What sum of money should be deposited at the end of every 6 months to accumulate ₹ 50,000 in 8 years, if money is worth 6% p.a. compounded semi-annually ? [Given : $(1{\cdot}03)^{16} = 1{\cdot}6047$] (A) ₹ 3,432·53 (B) ₹ 2,783·08 (C) ₹ 2,480·57 (D) ₹ 2,149·93	
Sol.	(C) ₹ 2480.57	**(1)**
17.	The graph of the inequation $2x + 3y > 6$ is the : (A) entire XOY-plane (B) half-plane that contains the origin (C) half-plane that neither contains the origin nor the points on the line $2x + 3y = 6$ (D) whole XOY-plane excluding the points on the line $2x + 3y = 6$	
Sol.	(C) half-plane that neither contains the origin nor the points on the line $\mathbf{2x + 3y = 6}$	**(1)**
18.	In an LPP, if the objective function $Z = ax + by$ has same maximum value on two corner points of the feasible region, then the number of points at which maximum value of Z occurs is : (A) 0 (B) 2 (C) finite (D) infinite	
Sol.	(D) infinite	**(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) :* The function $f(x) = x^2 - x + 1$ is strictly increasing on $(-1, 1)$. *Reason (R) :* If f(x) is continuous on [a, b] and derivable on (a, b), then f(x) is strictly increasing on [a, b] if $f'(x) > 0$ for all $x \in (a, b)$.	
Sol.	(D) Assertion (A) is false, but Reason (R) is true	**(1)**
20.	In a binomial distribution, $n = 200$ and $p = 0{\cdot}04$. Taking Poisson distribution as an approximation to the binomial distribution : *Assertion (A) :* Mean of Poisson distribution = 8. *Reason (R) :* $P(X = 4) = \frac{512}{3e^8}$.	
Sol.	(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is the not the correct explanation of the Assertion (A).	**(1)**
	SECTION B **This section comprises very short answer (VSA) type questions of 2 marks each.**	
21(a).	If $A = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$, find the value of k such that $A^2 - 8A + kI = 0$.	
Sol.	Given $\boldsymbol{A} = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$, $\mathbf{A^2} = \begin{bmatrix} 1 & 0 \\ -8 & 49 \end{bmatrix}$ $\mathbf{A^2 - 8A + kI = 0}$ gives $\begin{bmatrix} 1 & 0 \\ -8 & 49 \end{bmatrix} - 8\begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix} + k\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ $\Rightarrow \begin{bmatrix} 1 - 8 + k & 0 - 0 + 0 \\ -8 + 8 + 0 & 49 - 56 + k \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ $\Rightarrow k = 7$	$(\frac{1}{2})$ $(\frac{1}{2})$ $(\frac{1}{2})$ $(\frac{1}{2})$

	OR	
21(b).	If $\begin{bmatrix} x-y & 2x+z \\ 2x-y & 3z+w \end{bmatrix} = \begin{bmatrix} -1 & 5 \\ 0 & 13 \end{bmatrix}$, find the values of x, y, z and w.	
Sol.	Here, $\mathbf{x - y = -1, 2x - y = 0, 2x + z = 5, 3z + w = 13}$ Solving these equations, we get $\mathbf{x = 1, y = 2, z = 3, w = 4}$	**(1)** **(1)**
22.	Using Cramer's rule, solve the following system of equations : $2x_1 + 3x_2 = 5$ $11x_1 - 5x_2 = 6$	
Sol.	Here, $\mathbf{D} = \begin{vmatrix} 2 & 3 \\ 11 & -5 \end{vmatrix} = -43 \neq 0$ $\mathbf{D_1} = \begin{vmatrix} 5 & 3 \\ 6 & -5 \end{vmatrix} = -43$ $\mathbf{D_2} = \begin{vmatrix} 2 & 5 \\ 11 & 6 \end{vmatrix} = -43$ So, $\mathbf{x_1 = \frac{D_1}{D} = \frac{-43}{-43} = 1, x_2 = \frac{D_2}{D} = \frac{-43}{-43} = 1}$	$(\frac{1}{2})$ $(\frac{1}{2})$ $(\frac{1}{2})$ $(\frac{1}{2})$
23.	Find the solution to the following linear programming problem (if it exists) graphically : Maximize Z = x + y subject to the constraints $x - y \leq -1$ $-x + y \leq 0$ $x, y \geq 0.$	

Sol.	 Since feasible region is empty, there is no solution to the problem.	$(1\frac{1}{2})$ for correct graph $(\frac{1}{2})$
24.	At 6% p.a., compounded quarterly, find the present value of a perpetuity of ₹ 600 payable at the end of each quarter.	
Sol.	Here, $\mathbf{R = 600, i = \frac{0.06}{4} = 0.015}$ So, $\mathbf{PV = \frac{R}{i} = \frac{600}{0.015} = ₹\,40,000}$	**(1)** **(1)**
25 (a).	Assume an investment's starting value is ₹ 20,000 and it grows to ₹ 50,000 in 3 years. Calculate CAGR (Compounded Annual Growth Rate) [Use : $(2{\cdot}5)^{1/3} = 1{\cdot}355$]	
Sol.	$\text{CAGR} = \left[\left(\frac{50000}{20000}\right)^{1/3} - 1\right] \times 100$ $= \left[(2.5)^{1/3} - 1\right] \times 100 = (1.355 - 1) \times 100$ $= 0.355 \times 100 = 35.5\%$	**(1)** **(1)**
	OR	
25 (b).	A man bought an item for ₹ 12,000. At the end of the year, he decided to sell it for ₹ 15,000. If the inflation rate was 6%, find the nominal and real rate of return.	
Sol.	Nominal rate of return $= \frac{15000-12000}{12000} \times 100$ $= \frac{3000}{12000} \times 100 = 25\%$	$(\frac{1}{2})$ $(\frac{1}{2})$

	Real rate of return =Nominal rate of return – Inflation rate $= 25\% - 6\% = 19\%$	**(1)**
	SECTION C **This section comprises short answer (SA) type questions of 3 marks each.**	
26.	A container has 50 litres of juice in it. 5 litres of juice is taken out and is replaced by 5 litres of water. This process is repeated 4 more times. Determine the quantity of juice in the container after final replacement. [Use $(0{\cdot}9)^5 = 0{\cdot}59049$]	
Sol.	Juice contained in the container after final replacement $= 50\left(1 - \frac{5}{50}\right)^5 = 50\left(\frac{9}{10}\right)^5$ $= 50 \times 0.59049 = 29.5$ litres	**(2)** **(1)**
27(a).	Evaluate : $\int_0^2 x^2\,dx$ and hence show the region on the graph whose area it represents.	
Sol.	Required Area $= \int_0^2 x^2 dx = \left\|\frac{x^3}{3}\right\|_0^2 = \frac{8}{3}$  	**$(1\frac{1}{2})$** **$(1\frac{1}{2})$ for correct graph**
	OR	

27(b).	Evaluate : $\int_0^1 \frac{e^{-x}}{1+e^x}\,dx$	
Sol.	$\mathbf{I} = \int_0^1 \frac{dx}{e^x(1+e^x)}$ $= \int_1^e \frac{dt}{t^2(1+t)}$ **(Put** $e^x = t \Rightarrow e^x dx = dt$**)** $= \int_1^e \left(-\frac{1}{t} + \frac{1}{t^2} + \frac{1}{1+t}\right) dt$ $= \left[-\log(t) - \frac{1}{t} + \log(1+t)\right]_1^e$ $= \left[\log\left(\frac{1+t}{t}\right) - \frac{1}{t}\right]_1^e$ $= \left[\log\left(\frac{1+e}{e}\right) - \frac{1}{e}\right] - [\log 2 - 1]$ $= \log\left(\frac{1+e}{2e}\right) - \frac{1}{e} + 1$	$(\frac{1}{2})$ **(1)** **(1)** $(\frac{1}{2})$
28.	Find the differential equation of all circles in the first quadrant which touches both the coordinate axes.	
Sol.	Here, the equation of the circle is $(x-a)^2 + (y-a)^2 = a^2$ … (1) i.e., $x^2 + y^2 - 2ax - 2ay + a^2 = 0$ $\Rightarrow 2x + 2y\frac{dy}{dx} - 2a - 2a\frac{dy}{dx} = 0$ $\Rightarrow a = \frac{x+y\frac{dy}{dx}}{1+\frac{dy}{dx}}$ From (1), we have $\left(x - \frac{x+y\frac{dy}{dx}}{1+\frac{dy}{dx}}\right)^2 + \left(y - \frac{x+y\frac{dy}{dx}}{1+\frac{dy}{dx}}\right)^2 = \left(\frac{x+y\frac{dy}{dx}}{1+\frac{dy}{dx}}\right)^2$ or $\left(\frac{dy}{dx}\right)^2 (x^2 - 2xy) - 2xy\frac{dy}{dx} + y^2 - 2xy = 0$	**(1)** **(1)** **(1)**
29.	Given that the scores of a set of candidates on an IQ test are normally distributed. If the IQ test has a mean of 100 and a standard deviation of 10, determine the probability that a candidate who takes the test will score between 90 and 110. [Given P (Z < 1) = 0·8413 and P (Z < – 1) = 0·1587]	

Sol.	Here, $\mathbf{Z = \frac{X-100}{10}}$ $\mathbf{P(90 < X < 110) = P(X < 110) - P(X < 90)}$ $\mathbf{\Rightarrow P(90 < X < 110) = P(-1 < Z < 1) = P(Z < 1) - P(Z < -1)}$ $\mathbf{= 0.8413 - 0.1587}$ $\mathbf{= 0.6826}$	$\mathbf{(\frac{1}{2})}$ **(2)** $\mathbf{(\frac{1}{2})}$
30.	The mean weekly sales of a 4-wheeler was 50 units per agency in 20 agencies. After an advertising campaign, the mean weekly sales increased to 55 units per agency with standard deviation of 10 units. Test whether the advertising campaign was successful. [Given $\sqrt{5} = 2 \cdot 24$, $t_{19}(0 \cdot 05) = 1 \cdot 729$]	
Sol.	Here, $\mathbf{\mu_0 = 50, \bar{x} = 55, n = 20}$ and $\mathbf{S = 10}$ $\mathbf{H_0: \mu = 50}$ (The advertisement campaign was not successful) $\mathbf{H_\alpha: \mu > 50}$ (The advertisement campaign was successful) The test statistic $\boldsymbol{t}$ is given by $\mathbf{t = \frac{\bar{x}-\mu}{\frac{S}{\sqrt{n}}} = \frac{55-50}{\frac{10}{\sqrt{20}}} = \frac{2\sqrt{5}}{2} = \sqrt{5} = 2.24}$ Degree of freedom $= \mathbf{20 - 1 = 19}$ Here, $\mathbf{t > t_{19}(0.05)}$ as $\mathbf{2.24 > 1.729}$ $\Rightarrow$ null hypothesis is rejected i.e., Advertising campaign was successful	$\mathbf{(\frac{1}{2})}$ $\mathbf{(1\frac{1}{2})}$ $\mathbf{(\frac{1}{2})}$ $\mathbf{(\frac{1}{2})}$
31(a).	A recent accounting graduate opened a new business and installed a computer system that costs ₹ 45,200. The computer system will be depreciated linearly over 3 years and will have a scrap value of ₹ 0. (i) What is the rate of depreciation ? (ii) Give a linear equation that describes the computer system's book value at the end of tth year, where $0 \le t \le 3$. (iii) What will be the computer system's book value at the end of the first year and a half ?	
Sol.	(i) Annual amount of depreciation $= \mathbf{\frac{45200-0}{3}} = ₹ \mathbf{\frac{45200}{3}}$ Rate of depreciation $= \mathbf{\frac{\frac{45200}{3}}{45200} \times 100 = 33.3\%}$	**(1)**

	(ii) $\mathbf{v(t) = mt + C = -\frac{45200}{3}t + 45200}$ (iii) $\mathbf{v\left(1\frac{1}{2}\right) = -\frac{45200}{3} \times \frac{3}{2} + 45200 = ₹\ 22600}$	**(1)** **(1)**
	OR	
31(b).	Find the effective rate which is equivalent to normal rate of 10% p.a. compounded : (i) semi-annually. (ii) quarterly. [Given $(1{\cdot}05)^2 = 1{\cdot}1025$, $(1{\cdot}025)^4 = 1{\cdot}1038$]	
Sol.	(i) $\mathbf{r_e = \left(1 + \frac{r}{200}\right)^2 - 1 = \left(1 + \frac{10}{200}\right)^2 - 1}$ $\mathbf{= (1.05)^2 - 1 = 1.1025 - 1 = 10.25\%}$ (ii) $\mathbf{r_e = \left(1 + \frac{r}{400}\right)^4 - 1 = \left(1 + \frac{10}{400}\right)^4 - 1}$ $\mathbf{= (1.025)^4 - 1 = 1.1038 - 1 = 10.38\%}$	**(1)** **$(\frac{1}{2})$** **(1)** **$(\frac{1}{2})$**
	SECTION D **This section comprises of Long Answer (LA) type questions of 5 marks each.**	
32.	A cistern has three pipes A, B and C. Pipes A and B are inlet pipes whereas C is an outlet pipe. Pipes A and B can fill the cistern separately in 3 hours and 4 hours respectively; while pipe C can empty the completely filled cistern in 1 hour. If the pipes A, B and C are opened in order at 5, 6 and 7 a.m. respectively, at what time will the cistern be empty ?	
Sol.	Let the cistern be emptied in $\boldsymbol{n}$ hours after 5 a.m. Clearly pipes A and B fill the cistern for $\boldsymbol{n}$ and $\boldsymbol{n-1}$ hours respectively, while pipe C empties the tank for $\boldsymbol{n-2}$ hours $\therefore \mathbf{\frac{n}{3} + \frac{n-1}{4} - \frac{n-2}{1} = 0}$ Solving, we get $\boldsymbol{n = \frac{21}{5}}$ i.e., 4 hours 12 minutes past 5 am i.e., at 9:12 am	**$(1\frac{1}{2})$** **$(1\frac{1}{2})$** **(1)** **(1)**

33(a).	Find all the points of local maxima and local minima of the function : $f(x) = -\frac{3}{4}x^4 - 8x^3 - \frac{45}{2}x^2 + 105.$	
Sol.	$f(x) = -\frac{3}{4}x^4 - 8x^3 - \frac{45}{2}x^2 + 105$ $f'(x) = -3x^3 - 24x^2 - 45x$ and $f''(x) = -9x^2 - 48x - 45$ $f'(x) = 0 \Rightarrow x = 0$ or $x^2 + 8x + 15 = 0$ i.e., $x = 0, -3, -5$ At $x = 0, f''(0) < 0 \Rightarrow 0$ is a point of local maxima At $x = -3, f''(-3) > 0 \Rightarrow -3$ is a point of local minima At $x = -5, f''(-5) < 0 \Rightarrow -5$ is a point of local maxima	**(1)** **(1)** **(1)** **(1)** **(1)**
	OR	
33(b).	Find the intervals in which the following function f is strictly increasing or strictly decreasing : $f(x) = 20 - 9x + 6x^2 - x^3.$	
Sol.	$f(x) = 20 - 9x + 6x^2 - x^3$ $f'(x) = -9 + 12x - 3x^2 = -3(x^2 - 4x + 3)$ $= -3(x - 1)(x - 3)$ $f'(x) = 0 \Rightarrow x = 1,3$ Now intervals are $(-\infty, 1)$, $(1,3)$ and $(3, \infty)$ $\Rightarrow$ f(x) is strictly increasing in (1,3) or [1,3] And f(x) is strictly decreasing in $(-\infty, 1) \cup (3, \infty)$ or $(-\infty, 1] \cup [3, \infty)$	$(\frac{1}{2})$ **(1)** $(\frac{1}{2})$ $(\frac{1}{2})$ $(1\frac{1}{2})$ $(\frac{1}{2})$ $(\frac{1}{2})$

Intervals	Sign of $f'(x)$
$(-\infty, 1)$	$-$ve
(1,3)	+ve
$(3, \infty)$	$-$ve

34(a).	Let X denote the number of hours a Class 12 student studies during a randomly selected school day. The probability that X can take the values x_i, for an unknown constant 'k' : $P(X = k) = \begin{cases} 0{\cdot}1 & \text{if} \quad x_i = 0 \\ kx_i & \text{if} \quad x_i = 1 \text{ or } 2 \\ k(5 - x_i) & \text{if} \quad x_i = 3 \text{ or } 4 \end{cases}$ (i) Find the value of k. (ii) Determine the probability that the student studied for at least 2 hours. (iii) Determine the probability that the student studied for at most 2 hours.	
Sol.	(i) $\mathbf{0.1 + k + 2k + 2k + k = 1}$ $\Rightarrow \mathbf{0.1 + 6k = 1}$ $\Rightarrow \mathbf{k = \frac{3}{20}}$ (ii) $\mathbf{P(X \geq 2) = P(2) + P(3) + P(4)}$ $\mathbf{= 2k + 2k + k}$ $\mathbf{= 5k = \frac{3}{4}}$ (iii) $\mathbf{P(X \leq 2) = P(0) + P(1) + P(2)}$ $\mathbf{= 0.1 + k + 2k}$ $\mathbf{= \frac{1}{10} + \frac{9}{20} = \frac{11}{20}}$	**(1)** **(1)** **$(\frac{1}{2})$** **(1)** **$(\frac{1}{2})$** **(1)**
	OR	
34(b).	A river near a small town floods and overflows twice in every 10 years on an average. Assuming that the Poisson distribution is appropriate, what is the mean expectation ? Also, calculate the probability of 3 or less overflows and floods in a 10-year interval. [Given $e^{-2} = 0{\cdot}13534$]	
Sol.	Here, mean expectation $= \boldsymbol{\lambda = 2}$ $\mathbf{P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}}$ $\mathbf{P(X \leq 3) = P(0) + P(1) + P(2) + P(3)}$ $\mathbf{= e^{-2}\left(1 + 2 + 2 + \frac{4}{3}\right)}$ $\mathbf{= 0.13534 \times \frac{19}{3} = 0.8571 \text{ or } 0.86}$	**(1)** **(1)** **(2)** **(1)**

35.	Amrita buys a car for which she makes a down payment of ₹ 2,50,000 and the balance is to be paid in 2 years by monthly instalments of ₹ 25,448 each. If the financer charges interest at the rate of 20% p.a, find the actual price of the car. [Given $\left(\frac{61}{60}\right)^{-24} = 0{\cdot}67253$]	
Sol.	$\mathbf{n = 2 \times 12 = 24}$, $\mathbf{i = \frac{20}{1200} = \frac{1}{60}}$ EMI $= \frac{\mathbf{Pi}}{\mathbf{1-(1+i)^{-n}}}$ $\mathbf{25448 = \frac{P \times \frac{1}{60}}{1-(1+\frac{1}{60})^{-24}}}$ $\mathbf{P = 25448 \times 60\left[1-\left(1+\frac{1}{60}\right)^{-24}\right]}$ $\mathbf{P = 25448 \times 60(1-0.67253)}$ $= ₹\,\mathbf{5,00,000}$ approx. Hence the actual price of the car is ₹ 7,50,000 approx.	$(\frac{1}{2})$ $(\frac{1}{2})$ **(1)** **(1)** $(\frac{1}{2})$ **(1)** $(\frac{1}{2})$
	SECTION E **This section comprises of 3 case-study based questions of 4 marks each.**	

36.

On her birthday, Prema decides to donate some money to children of an orphanage home.



If there are 8 children less, everyone gets ₹ 10 more. However, if there are 16 children more, everyone gets ₹ 10 less.

Let the number of children in the orphanage home be x and the amount to be donated to each child be ₹ y.

Based on the above information, answer the following questions :

(i) Write the system of linear equations in x and y formed of the given situation. *1*

(ii) Write the system of linear equations, obtained in (i) above, in matrix form AX = B. *1*

(iii) (a) Find the inverse of matrix A. *2*

OR

(b) Determine the values of x and y. *2*

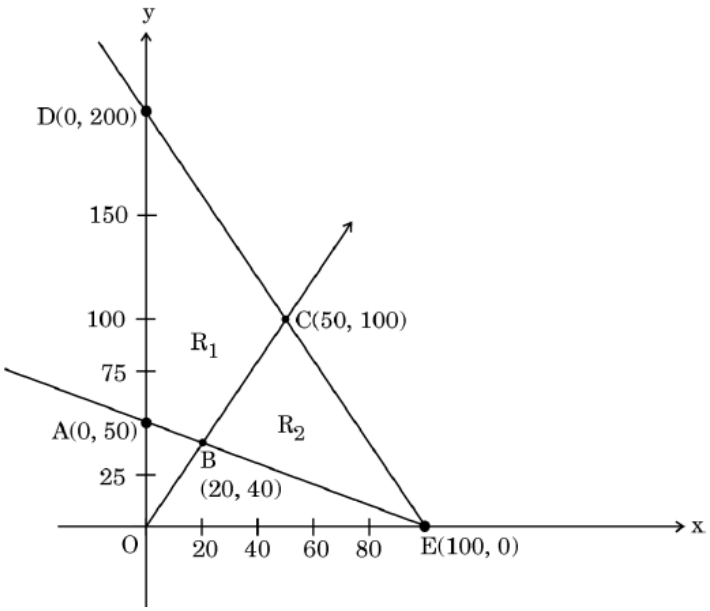
Sol.

(i) Let number of children be x and the amount donated to each child be ₹ y

$\therefore (x-8)(y+10) = xy$ and $(x+16)(y-10) = xy$ **$(\frac{1}{2})$**

i.e., $5x - 4y = 40$ and $5x - 8y = -80$ **$(\frac{1}{2})$**

(ii) $A = \begin{bmatrix} 5 & -4 \\ 5 & -8 \end{bmatrix}, X = \begin{bmatrix} x \\ y \end{bmatrix}, B = \begin{bmatrix} 40 \\ -80 \end{bmatrix}$ **(1)**

	(iii) (a) $\|A\| = -40 + 20 = -20 \neq 0$	$(\frac{1}{2})$
	adj (A) $= \begin{bmatrix} -8 & 4 \\ -5 & 5 \end{bmatrix}$	**(1)**
	$\Rightarrow A^{-1} = -\frac{1}{20}\begin{bmatrix} -8 & 4 \\ -5 & 5 \end{bmatrix} = \frac{1}{20}\begin{bmatrix} 8 & -4 \\ 5 & -5 \end{bmatrix}$	$(\frac{1}{2})$
	OR	
	(iii) (b) $X = \begin{bmatrix} x \\ y \end{bmatrix} = A^{-1}B$	
	$= \frac{1}{20}\begin{bmatrix} 8 & -4 \\ 5 & -5 \end{bmatrix}\begin{bmatrix} 40 \\ -80 \end{bmatrix}$	$(\frac{1}{2})$
	$= \frac{1}{20}\begin{bmatrix} 640 \\ 600 \end{bmatrix} = \begin{bmatrix} 32 \\ 30 \end{bmatrix}$	**(1)**
	$\Rightarrow x = 32, y = 30$	$(\frac{1}{2})$
37.	**Case Study – 2** In number theory, it is often important to find factors of an integer N. The number N has two trivial factors, namely 1 and N. Any other factor, if exists, is called non-trivial factor of N. Naresh has plotted a graph of some constraints (linear inequations) with points A (0, 50), B (20, 40), C (50, 100), D (0, 200) and E (100, 0). This graph is constructed using three non-trivial constraints and two trivial constraints. One of the non-trivial constraints is $x + 2y \geq 100$.  	

	Based on the above information, answer the following questions : (i) What are the two trivial constraints ? *1* (ii) (a) If R_1 is the feasible region, then what are the other two non-trivial constraints ? *2* **OR** (b) If R_2 is the feasible region, then what are the other two non-trivial constraints ? *2* (iii) If R_1 is the feasible region, then find the maximum value of the objective function $z = 5x + 2y$. *1*	
Sol.	(i) $x \geq 0, y \geq 0$ (ii) (a) $2x - y \leq 0$, $2x + y \leq 200$ **OR** (ii) (b) $2x + y \leq 200$, $2x - y \geq 0$ (iii) Corner points of R_1 are $A(0,50), B(20,40), C(50,100)$ and $D(0,200)$ $\mathbf{Z_A = 100;\ Z_B = 180; Z_C = 450;\ Z_D = 400}$ So, Z is maximum at C and maximum value of $Z = 450$	**(1)** **(1)** **(1)** **(1)** **(1)** $(\frac{1}{2})$ $(\frac{1}{2})$

38.

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.

The table below shows the sale of an item in a district during 1996 – 2001 :

Year :	1996	1997	1998	1999	2000	2001
Sales (in lakh ₹) :	6·5	5·3	4·3	6·1	5·6	7·8

Based on the above information, answer the following questions :

(i) Determine the equation of the straight-line trend. *2*

(a) Tabulate the trend values of the years and also compute expected sales trend for the year 2002. *2*

OR

(b) Fit a straight-line trend by the method of least squares for the following data : *2*

Year :	2004	2005	2006	2007	2008	2009	2010
Profit (₹ '000)	114	130	126	144	138	156	164

Sol.

(i)

Year (x_i)	Index Number (y)	$x = \frac{x_i - A}{0.5}$	x^2	xy
1996	6.5	-5	25	-32.5
1997	5.3	-3	9	-15.9
1998	4.3	-1	1	-4.3
1999	6.1	1	1	6.1
2000	5.6	3	9	16.8
2001	7.8	5	25	39
$n = 6$	$\sum y = 35.6$	$\sum x = 0$	$\sum x^2 = 70$	$\sum xy = 9.2$

(1) for correct table

$a = \frac{\sum y}{n} = \frac{35.6}{6}, b = \frac{\sum xy}{\sum x^2} = \frac{9.2}{70} = 0.13$ **$(\frac{1}{2})$**

∴ Equation of straight-line trend is given by

$y = a + bx = 5.9 + 0.13x$ **$(\frac{1}{2})$**

(ii) (a) Trend Values

(1) mark for correct trend values

1996 $5 \cdot 9 + (-5) \times 0 \cdot 13 = 5 \cdot 25$

1997 $5 \cdot 9 + (-3) \times 0 \cdot 13 = 5 \cdot 51$

1998 $5 \cdot 9 + (-1) \times 0 \cdot 13 = 5 \cdot 77$

1999 $5 \cdot 9 + (1) \times 0 \cdot 13 = 6.03$

2000 $5 \cdot 9 + (3) \times 0 \cdot 13 = 6.29$

2001 $5 \cdot 9 + (5) \times 0 \cdot 13 = 6.55$

Expected sales trend for 2002

$= 5.9 + 0.13\left(\frac{2002-1998.5}{0.5}\right)$ **$(\frac{1}{2})$**

$= ₹\ 6.81$ lakhs **$(\frac{1}{2})$**

OR

(ii) (b)

Year (x_i)	Profit (y)	$x = x_i - A$	x^2	xy
2004	114	-3	9	-342
2005	130	-2	4	-260
2006	126	-1	1	-126
2007	144	0	0	0
2008	138	1	1	138
2009	156	2	4	312
2010	164	3	9	492
$n = 7$	$\sum y = 972$	$\sum x = 0$	$\sum x^2 = 28$	$\sum xy = 214$

(1) for correct table

$$a = \frac{\sum y}{n} = \frac{972}{7} = 138.86, b = \frac{\sum xy}{\sum x^2} = \frac{214}{28} = 7.64$$ **$(\frac{1}{2})$**

So, required equation of straight- line trend is

$$y = a + bx = 138.86 + 7.64x$$ **$(\frac{1}{2})$**