

Series : W1XZY

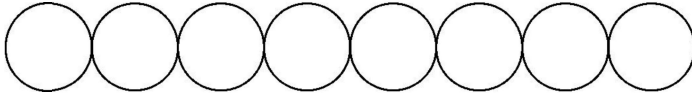


SET ~ 4



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

Time allowed : 3 hours

अधिकतम अंक : 80

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 सख्ती 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. $-41 \pmod{9}$ 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. $-41 \bmod 9$ 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) $\begin{bmatrix} \frac{1}{3} & \frac{1}{6} \\ \frac{2}{3} & -\frac{1}{6} \end{bmatrix}$
- (C) $\begin{bmatrix} \frac{1}{6} & \frac{1}{6} \\ -\frac{1}{3} & \frac{2}{3} \end{bmatrix}$ (D) $\begin{bmatrix} -\frac{2}{3} & \frac{1}{6} \\ -\frac{1}{3} & -\frac{1}{6} \end{bmatrix}$
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) $\frac{3}{2}$ (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) $\frac{3}{2}$ (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 क्रमशः $C(x) = 100 + 0.015x^2$ 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

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

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 $C(x) = 100 + 0.015x^2$, $R(x) = 3x$, 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

$$\begin{aligned} \text{(A)} \quad t &= \frac{\bar{x} - \bar{y}}{\sqrt{s}} & \text{(B)} \quad t &= \frac{\bar{x} - \bar{y}}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \\ \text{(C)} \quad t &= \frac{\bar{x} - \bar{y}}{\frac{s}{\sqrt{n-1}}} & \text{(D)} \quad t &= \frac{\bar{x} + \bar{y}}{s \sqrt{\frac{1}{n_1} - \frac{1}{n_2}}} \end{aligned}$$

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

$$\text{क्षेत्रफल} \int_a^b f(x) dx \text{ होता है।}$$

20. अभिकथन (A) : वक्र कुल $y = mx$, m एक स्वेच्छ स्थिरांक है, को निरूपित करने वाला अवकल

$$\text{समीकरण है, } x \frac{dy}{dx} - y = 0 \text{ है।}$$

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 $1\frac{1}{2}$ 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 $1\frac{1}{2}$ 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-तत्व मिल सकें ? इसके लिए रैखिक प्रोग्रामन समस्या का निर्माण कीजिए।

अथवा

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

$$\text{व्यवरोधों } 2x + y \leq 18$$

$$3x + 2y \leq 34$$

$$x, y \geq 0$$

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 । अतः 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

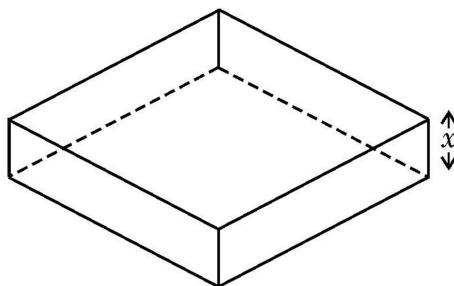
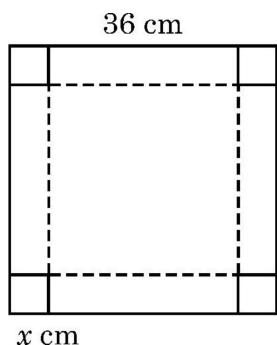
35. एक मशीन का मूल्य ₹ 1,00,000 है तथा इसका प्रभावी जीवन 12 वर्ष होने का अनुमान है। मशीन के जीवन काल के अंत में, जब इसके स्क्रेप की कीमत केवल ₹ 5,000 होती है, इसे नए मॉडल से बदलने के लिए एक सिंकिंग फंड बनाया जाता है। ज्ञात कीजिए कि प्रति वर्ष लाभ में से कितनी राशि अलग रखी जाए यदि सिंकिंग फंड 5% प्रभावी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

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

खण्ड – ड

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 महंगा 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

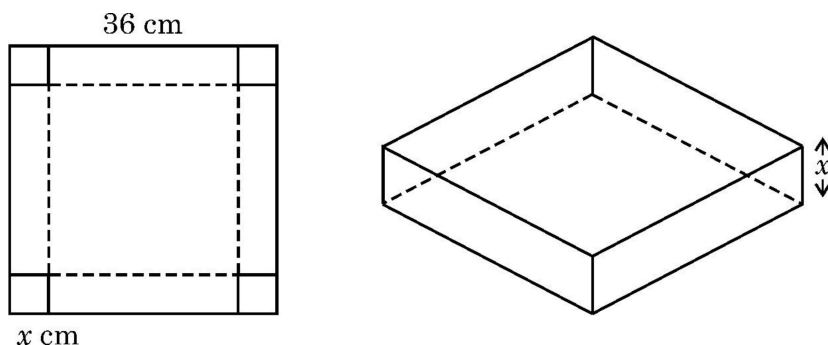
35. A machine costs ₹ 1,00,000 and its effective life is estimated to be 12 years. A sinking fund is created for replacing the machine by a new model at the end of its life time when its scrap realizes a sum of ₹ 5,000 only. Find what amount should be set aside at the end of each year, out of the profits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

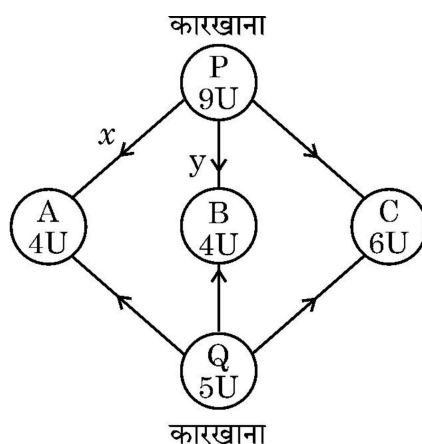
37. दो कारखाने P और Q पर स्थित हैं । इन स्थानों से सामान A, B और C पर स्थित तीन डिपों में भेजे जाने हैं जिनकी साप्ताहिक आवश्यकता क्रमशः 4, 4, 6 नग की है, जबकि P और Q कारखानों की उत्पादन क्षमता क्रमशः 9 और 5 नग हैं ।

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 क्रमशः 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

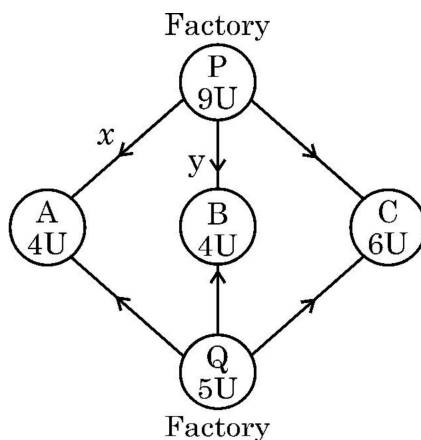
- (iii) Find the maximum volume of the open box.

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 क्रमशः 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 क्रमशः 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 ।

$$[(1.01)^{-240} = 0.09180584 \text{ लीजिए}]$$



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



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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 ($\sqrt{}$) wherever answer is correct. For wrong answer CROSS ‘X’ be marked. Evaluators will not put right ($\checkmark$) 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	<u>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”.</u>
10	<u>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”.</u>
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

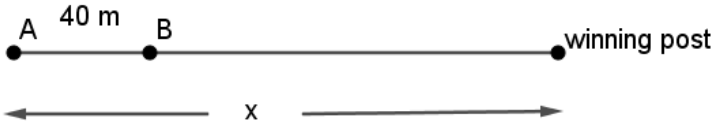
Q. No.	EXPECTED OUTCOMES/VALUE POINTS	Marks
	SECTION A Questions no. 1 to 18 are multiple choice questions (MCQs) and questions number 19 and 20 are Assertion-Reason based questions of 1 mark each .	
1.	$-41 \bmod 9$ is (A) 5 (B) 4 (C) 3 (D) 0	
Sol.	(B) 4	1
2.	If $a > b$ and $c < 0$, then which of the following is true ? (A) $a + c < b + c$ (B) $a - c < b - c$ (C) $a c > b c$ (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) $\begin{bmatrix} \frac{1}{3} & \frac{1}{6} \\ \frac{2}{3} & -\frac{1}{6} \end{bmatrix}$ (C) $\begin{bmatrix} \frac{1}{6} & \frac{1}{6} \\ -\frac{1}{3} & \frac{2}{3} \end{bmatrix}$ (D) $\begin{bmatrix} -\frac{2}{3} & \frac{1}{6} \\ -\frac{1}{3} & -\frac{1}{6} \end{bmatrix}$	
Sol.	(C) $\begin{bmatrix} \frac{1}{6} & \frac{1}{6} \\ -\frac{1}{3} & \frac{2}{3} \end{bmatrix}$	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) $\frac{3}{2}$ (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 $C(x) = 100 + 0.015x^2$, $R(x) = 3x$, 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
	<i>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.</i> (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 <pre> Type I Type II ₹ 25 ₹ 35 \ / \ / \ / \ / \ / ₹ x / \ / \ / \ / \ / \ Type I Type II ₹ 25 ₹ 35 </pre> 35 - x x - 25 $\therefore \frac{35-x}{x-25} = \frac{3}{2}$ $\Rightarrow 70 - 2x = 3x - 75$ Solving, we get $x = 29$ $\therefore$ 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 $1\frac{1}{2}$ 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 $\therefore \frac{1}{n} = \frac{1}{60} + \frac{1}{90}$ $\Rightarrow \frac{1}{n} = \frac{3+2}{180} = \frac{5}{180} = \frac{1}{36}$ $\therefore n = 36$ 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 $\therefore$ Speed of the boat upstream = $(x - 1)$ km/h and speed of the boat downstream = $(x + 1)$ km/h $\therefore \frac{3.5}{x-1} + \frac{3.5}{x+1} = 1 + \frac{12}{60} = \frac{6}{5}$ $\Rightarrow 3.5(2x)5 = 6(x^2 - 1)$ $\Rightarrow 6x^2 - 35x - 6 = 0$ Solving, we get $x = 6$ km/h (rejecting the -ve value)	1 1 1 1

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. $\therefore \frac{x}{3/2} = \frac{x-40}{1}$ $\Rightarrow \frac{x}{2} = \frac{3}{2} \times 40 = 60 \Rightarrow x = 120 \text{ metres}$	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, $n = 6, p = \frac{1}{2}, q = \frac{1}{2}$ $P(\text{at least 4 heads in 6 throws}) = P(X \geq 4)$ $= {}^6C_4 \left(\frac{1}{2}\right)^4 \left(\frac{1}{2}\right)^2 + {}^6C_5 \left(\frac{1}{2}\right)^5 \left(\frac{1}{2}\right)^1 + {}^6C_6 \left(\frac{1}{2}\right)^6 \left(\frac{1}{2}\right)^0$ $= 22 \left(\frac{1}{2}\right)^6 = \frac{22}{64} \text{ or } \frac{11}{32}$	$\frac{1}{2}$ 1 $\frac{1}{2}$
	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) $4 = \frac{X-9}{3} \Rightarrow X = 21$	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, $(7^2)^{147} \equiv (-1)^{147}(mod\ 10) \equiv -1(mod\ 10)$ $\Rightarrow 7^{295} = (7^2)^{147} \times 7 \equiv -7(mod\ 10) \equiv 3(mod\ 10)$ $\therefore$ Units digit is 3.	1 1 $\frac{1}{2}$ $\frac{1}{2}$																		
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 <table><tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>P(X)</td><td>$\frac{5}{15}$</td><td>$\frac{4}{15}$</td><td>$\frac{3}{15}$</td><td>$\frac{2}{15}$</td><td>$\frac{1}{15}$</td></tr><tr><td>X P(X)</td><td>$\frac{5}{15}$</td><td>$\frac{8}{15}$</td><td>$\frac{9}{15}$</td><td>$\frac{8}{15}$</td><td>$\frac{5}{15}$</td></tr></table> $E(X) = \sum X P(X) = \frac{35}{15} = \frac{7}{3}$	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)	$\frac{5}{15}$	$\frac{8}{15}$	$\frac{9}{15}$	$\frac{8}{15}$	$\frac{5}{15}$	$\frac{1}{2}$ 1 1 $\frac{1}{2}$
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)	$\frac{5}{15}$	$\frac{8}{15}$	$\frac{9}{15}$	$\frac{8}{15}$	$\frac{5}{15}$															
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 $= npq = \frac{8}{9}$ $\Rightarrow q = \frac{8}{9} \times \frac{3}{4} = \frac{2}{3}$ $\therefore p = 1 - \frac{2}{3} = \frac{1}{3}$ $n \times \frac{1}{3} = \frac{4}{3} \Rightarrow n = 4$ $P(x = 1) = {}^4C_1 \left(\frac{1}{3}\right)^1 \left(\frac{2}{3}\right)^3 = 4 \times \frac{1}{3} \times \frac{8}{27}$ $= \frac{32}{81}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$																		
	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, $P(X = 2) = \frac{(2.8)^2 e^{-2.8}}{2!}$ $= \frac{7.84}{2} \times 0.0608 = 0.2383$	$\frac{1}{2}$ 1 1 $\frac{1}{2}$
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.	$\frac{1}{2}$ 1 1 $\frac{1}{2}$
	OR	
29 (b).	Solve the following linear programming problem graphically : Maximise $z = 50x + 30y$ subject to $2x + y \leq 18$ $3x + 2y \leq 34$ $x, y \geq 0$.	

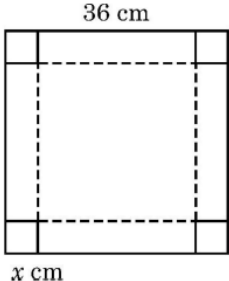
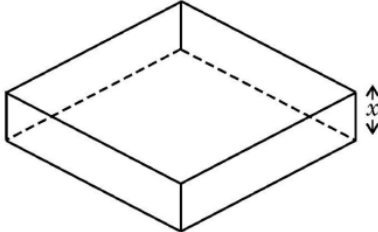
Sol.	<table><thead><tr><th>Corner Points</th><th>Value of Z</th></tr></thead><tbody><tr><td>O (0,0)</td><td>0</td></tr><tr><td>A (0, 17)</td><td>510</td></tr><tr><td>B (2,14)</td><td>520</td></tr><tr><td>C (9, 0)</td><td>450</td></tr></tbody></table> ∴ Maximum Z = 520 at B (2, 14)	Corner Points	Value of Z	O (0,0)	0	A (0, 17)	510	B (2,14)	520	C (9, 0)	450	1½ for correct graph 1 for correct table ½
Corner Points	Value of Z											
O (0,0)	0											
A (0, 17)	510											
B (2,14)	520											
C (9, 0)	450											
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.	$\bar{x} = 0.742, \mu = 0.7$ $n = 10, s = 0.04$ 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 $t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n-1}}} = \frac{0.742 - 0.7}{\frac{0.04}{\sqrt{9}}} = 3.15$ Df = 9 and $t_9(0.05) = 2.262$ Since $t = 3.15 > 2.262$ ∴ Null hypothesis is rejected	} ½ 1½ ½										

	Hence the work is inferior Note: * $t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$ should also be accepted.	$\frac{1}{2}$
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 = $\frac{PRT}{100}$ $= \frac{500000 \times 7.5 \times 5}{100} = ₹ 1,87,500$ $n = 5 \text{ years} = 60 \text{ months}$ $\therefore \text{EMI} = \frac{P+I}{n}$ $= \frac{500000 + 187500}{60}$ $= ₹ 11,458.33$	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).	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.	$ A = 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 $AX = B \Rightarrow X = A^{-1}B$ $\text{adj}(A) = \begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix}$ $A^{-1} = \frac{1}{ A } \text{adj}(A) = \frac{1}{-1} \begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix}$ $\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix} \begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ So, $x = 1, y = 2, z = 3$	$\frac{1}{2}$ 1 1½ $\frac{1}{2}$ 1 $\frac{1}{2}$

	OR	
32 (b).	Using properties of determinants, prove that $\Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix} = 2abc(a+b+c)^3$	
Sol.	$\text{LHS} = \Delta = \begin{vmatrix} (b+c)^2 & a^2 & a^2 \\ b^2 & (c+a)^2 & b^2 \\ c^2 & c^2 & (a+b)^2 \end{vmatrix}$ Applying, $C_1 \rightarrow C_1 - C_3$ $C_2 \rightarrow C_2 - C_3$ $\Delta = \begin{vmatrix} (b+c)^2 - a^2 & 0 & a^2 \\ 0 & (c+a)^2 - b^2 & b^2 \\ c^2 - (a+b)^2 & c^2 - (a+b)^2 & (a+b)^2 \end{vmatrix}$ $= (a+b+c)^2 \begin{vmatrix} b+c-a & 0 & a^2 \\ 0 & c+a-b & b^2 \\ c-a-b & c-a-b & (a+b)^2 \end{vmatrix}$ Applying, $R_1 \rightarrow R_3 - R_1 - R_2$ $= 2(a+b+c)^2 \begin{vmatrix} b+c-a & 0 & a^2 \\ 0 & c+a-b & b^2 \\ -b & -a & ab \end{vmatrix}$ 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 $p_0 x_0 = 18 \times 7 = 126$ $\text{PS} = p_0 x_0 - \int_0^7 (x^2 - 5x + 4) dx$ $= 126 - \left[\frac{x^3}{3} - \frac{5x^2}{2} + 4x \right]_0^7$ $= 126 - \frac{119}{6}$ $= \frac{637}{6}$ 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.	<table><tr><th>Year</th><th>Index Number</th><th>4 yearly moving total</th><th>4 yearly moving Average</th><th>Centered Total</th><th>Centered moving average</th></tr><tr><td>2001</td><td>2450</td><td></td><td></td><td></td><td></td></tr><tr><td>2002</td><td>1470</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>7870</td><td>1967.5</td><td></td><td></td></tr><tr><td>2003</td><td>2150</td><td></td><td></td><td>3625</td><td>1812.5</td></tr><tr><td></td><td></td><td>6630</td><td>1657.5</td><td></td><td></td></tr><tr><td>2004</td><td>1800</td><td></td><td></td><td>3435</td><td>1717.5</td></tr><tr><td></td><td></td><td>7110</td><td>1777.5</td><td></td><td></td></tr><tr><td>2005</td><td>1210</td><td></td><td></td><td>3592.5</td><td>1796.25</td></tr><tr><td></td><td></td><td>7260</td><td>1815</td><td></td><td></td></tr><tr><td>2006</td><td>1950</td><td></td><td></td><td>3805</td><td>1902.5</td></tr><tr><td></td><td></td><td>7960</td><td>1990</td><td></td><td></td></tr><tr><td>2007</td><td>2300</td><td></td><td></td><td>4297.5</td><td>2148.75</td></tr><tr><td></td><td></td><td>9230</td><td>2307.5</td><td></td><td></td></tr><tr><td>2008</td><td>2500</td><td></td><td></td><td>4797.5</td><td>2398.75</td></tr><tr><td></td><td></td><td>9960</td><td>2490</td><td></td><td></td></tr><tr><td>2009</td><td>2480</td><td></td><td></td><td></td><td></td></tr><tr><td>2010</td><td>2680</td><td></td><td></td><td></td><td></td></tr></table>						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
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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.																																																																																																																			

	<table><tr><th>Year (x_i)</th><th>Index Number (Y)</th><th>$X = \frac{x_i - A}{0.5}$ $= \frac{x_i - 2013.5}{0.5}$</th><th>$X^2$</th><th>$XY$</th><th>$Y_t = a + bx$</th></tr><tr><td>2011</td><td>210</td><td>-5</td><td>25</td><td>-1050</td><td>234.17 + (-5)1.64 = 225.97</td></tr><tr><td>2012</td><td>225</td><td>-3</td><td>9</td><td>-675</td><td>229.25</td></tr><tr><td>2013</td><td>275</td><td>-1</td><td>1</td><td>-275</td><td>232.53</td></tr><tr><td>2014</td><td>220</td><td>1</td><td>1</td><td>220</td><td>235.81</td></tr><tr><td>2015</td><td>240</td><td>3</td><td>9</td><td>720</td><td>239.09</td></tr><tr><td>2016</td><td>235</td><td>5</td><td>25</td><td>1175</td><td>242.37</td></tr><tr><td>$n = 6$</td><td>1405</td><td>$\sum X = 0$</td><td>$\sum X^2 = 70$</td><td>$\sum XY = 115$</td><td></td></tr></table> $a = \frac{\sum Y}{n} = \frac{1405}{6} = 234.17$ (approx.) $b = \frac{\sum XY}{\sum X^2} = \frac{115}{70} = 1.64$ (approx.) Required line is $Y = a + bx = 234.17 + 1.64 x$	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 1 1 ½
Year (x_i)	Index Number (Y)	$X = \frac{x_i - A}{0.5}$ $= \frac{x_i - 2013.5}{0.5}$	X^2	XY	$Y_t = a + bx$																																													
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$n = 6$	1405	$\sum X = 0$	$\sum X^2 = 70$	$\sum XY = 115$																																														
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 The payments into sinking fund consist of 12 annual payments at the rate of 5% per year. $A = R \left[\frac{(1+i)^n - 1}{i} \right]$ $95000 = R \left[\frac{(1.05)^{12} - 1}{0.05} \right]$ $\Rightarrow R = \frac{95000 \times 0.05}{0.7958} = ₹ 5968.84$ (or $\frac{4750}{0.8} = ₹ 5937.50$ using approximations)	1 2 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) $V = x(36 - 2x)^2$ (ii) $\frac{dV}{dx} = (36 - 2x)^2 + 2x(36 - 2x)(-2)$ $= (36 - 2x)(36 - 2x - 4x)$ $= (36 - 2x)(36 - 6x)$ $= 12(18 - x)(6 - x)$ (iii) $\frac{dV}{dx} = 0 \Rightarrow x = 18$ or $x = 6$ Rejecting $x = 18$, we have $x = 6$ and $\frac{d^2V}{dx^2} = 12(18 - x)(-1) + 12(-1)(6 - x)$ $\Rightarrow \frac{d^2V}{dx^2} < 0$ at $x = 6$ $\therefore$ volume is maximum for $x = 6$ OR (iii) $\frac{dV}{dx} = 0 \Rightarrow x = 18$ or $x = 6$ Rejecting $x = 18$, we have $x = 6$ and $\frac{d^2V}{dx^2} = 12(18 - x)(-1) + 12(-1)(6 - x)$ $\Rightarrow \frac{d^2V}{dx^2} < 0$ at $x = 6$ $\therefore \text{Max } V = 6(36 - 12)^2 = 6(24)^2 = 3456 \text{ cm}^3$	1 1 1 $\frac{1}{2}$ $\frac{1}{2}$ 1 1

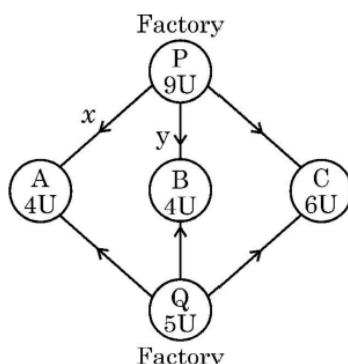
37.

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



- Find (in terms of x and y) how many units of commodity be transported from factory P to depot C.
- Find how many units of commodity be transported from factory Q to A, B and C respectively.
- Using (i) and (ii), find the total transportation cost z .

OR

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

Sol.

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

(ii) Q to A = $(4 - x)$

Q to B = $(4 - y)$

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

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

$= 10x - 70y + 1930$

OR

1

$\frac{1}{2}$

$\frac{1}{2}$

1

1

