



## Series EF1GH/3



SET~3

प्रश्न-पत्र कोड  
Q.P. Code **65/3/3**

रोल नं.

Roll No.

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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.

## गणित

## MATHEMATICS

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निर्धारित समय : 3 घण्टे

Time allowed : 3 hours

अधिकतम अंक : 80

Maximum Marks : 80

### नोट / NOTE :

- (i) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ 23 हैं।  
Please check that this question paper contains 23 printed pages.
- (ii) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें।  
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.
- (iii) कृपया जाँच कर लें कि इस प्रश्न-पत्र में 38 प्रश्न हैं।  
Please check that this question paper contains 38 questions.
- (iv) कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें।  
Please write down the serial number of the question in the answer-book before attempting it.
- (v) इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है। प्रश्न-पत्र का वितरण पूर्वही 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।  
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.



## सामान्य निर्देशः

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सम्भवी संख्या 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 एक-एक अंक के प्रश्न हैं।
- (iv) खण्ड ख में प्रश्न संख्या 21 से 25 तक अति लघु-उत्तरीय (VSA) प्रकार के दो-दो अंकों के प्रश्न हैं।
- (v) खण्ड ग में प्रश्न संख्या 26 से 31 तक लघु-उत्तरीय (SA) प्रकार के तीन-तीन अंकों के प्रश्न हैं।
- (vi) खण्ड घ में प्रश्न संख्या 32 से 35 तक दीर्घ-उत्तरीय (LA) प्रकार के पाँच-पाँच अंकों के प्रश्न हैं।
- (vii) खण्ड ङ में प्रश्न संख्या 36 से 38 प्रकरण अध्ययन आधारित चार-चार अंकों के प्रश्न हैं।
- (viii) प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड ख के 2 प्रश्नों में, खण्ड ग के 3 प्रश्नों में, खण्ड घ के 2 प्रश्नों में तथा खण्ड ङ के 2 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. यदि सदिशों  $\vec{a}$  तथा  $\vec{b}$  के बीच का कोण  $\frac{\pi}{4}$  है तथा  $|\vec{a} \times \vec{b}| = 1$  है, तो  $\vec{a} \cdot \vec{b}$  बराबर है :

  - (a)  $-1$
  - (b)  $1$
  - (c)  $\frac{1}{\sqrt{2}}$
  - (d)  $\sqrt{2}$

2.  $\vec{a}$  तथा  $\vec{b}$  ऐसे दो शून्येतर सदिश हैं कि  $\vec{a}$  का  $\vec{b}$  पर प्रक्षेप शून्य है।  $\vec{a}$  तथा  $\vec{b}$  के बीच का कोण है :

  - (a)  $\frac{\pi}{2}$
  - (b)  $\pi$
  - (c)  $\frac{\pi}{4}$
  - (d)  $0$



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, 3 questions in Section C, 2 questions in Section D and 2 questions in Section E.
- (ix) Use of calculators is **not** allowed.

## SECTION A

This section comprises multiple choice questions (MCQs) of 1 mark each.

- 1. If the angle between the vectors  $\vec{a}$  and  $\vec{b}$  is  $\frac{\pi}{4}$  and  $|\vec{a} \times \vec{b}| = 1$ , then  $\vec{a} \cdot \vec{b}$  is equal to
  - (a)  $-1$
  - (b)  $1$
  - (c)  $\frac{1}{\sqrt{2}}$
  - (d)  $\sqrt{2}$
- 2.  $\vec{a}$  and  $\vec{b}$  are two non-zero vectors such that the projection of  $\vec{a}$  on  $\vec{b}$  is 0. The angle between  $\vec{a}$  and  $\vec{b}$  is :
  - (a)  $\frac{\pi}{2}$
  - (b)  $\pi$
  - (c)  $\frac{\pi}{4}$
  - (d)  $0$



3.  $\Delta ABC$  में,  $\vec{AB} = \hat{i} + \hat{j} + 2\hat{k}$  तथा  $\vec{AC} = 3\hat{i} - \hat{j} + 4\hat{k}$  हैं। यदि  $BC$  का मध्य-बिन्दु  $D$  है, तो सदिश  $\vec{AD}$  बराबर है :

(a)  $4\hat{i} + 6\hat{k}$  (b)  $2\hat{i} - 2\hat{j} + 2\hat{k}$

(c)  $\hat{i} - \hat{j} + \hat{k}$  (d)  $2\hat{i} + 3\hat{k}$

4. बिन्दु  $(2, -1, 0)$  से होकर जाने वाली तथा रेखा  $\frac{x}{1} = \frac{y-1}{2} = \frac{2-z}{2}$  के समांतर एक रेखा का समीकरण है :

(a)  $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{2}$  (b)  $\frac{x-2}{1} = \frac{y-1}{2} = \frac{z}{2}$

(c)  $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{-2}$  (d)  $\frac{x-2}{1} = \frac{y+1}{2} = \frac{z}{-2}$

5.  $X$  तथा  $Y$  ऐसी स्वतंत्र घटनाएँ हैं कि  $P(X \cap \bar{Y}) = \frac{2}{5}$  तथा  $P(X) = \frac{3}{5}$  है। तो  $P(Y)$  बराबर है :

(a)  $\frac{2}{3}$  (b)  $\frac{2}{5}$

(c)  $\frac{1}{3}$  (d)  $\frac{1}{5}$

6.  $k$  का वह मान जिसके लिए फलन  $f(x) = \begin{cases} x^2, & x \geq 0 \\ kx, & x < 0 \end{cases}$   $x = 0$  पर अवकलनीय है, है :

(a) 1 (b) 2

(c) कोई भी वास्तविक संख्या (d) 0

7. यदि  $y = \frac{\cos x - \sin x}{\cos x + \sin x}$  है, तो  $\frac{dy}{dx}$  है :

(a)  $-\sec^2\left(\frac{\pi}{4} - x\right)$  (b)  $\sec^2\left(\frac{\pi}{4} - x\right)$

(c)  $\log \left| \sec\left(\frac{\pi}{4} - x\right) \right|$  (d)  $-\log \left| \sec\left(\frac{\pi}{4} - x\right) \right|$



3. In  $\Delta ABC$ ,  $\vec{AB} = \hat{i} + \hat{j} + 2\hat{k}$  and  $\vec{AC} = 3\hat{i} - \hat{j} + 4\hat{k}$ . If D is mid-point of BC, then vector  $\vec{AD}$  is equal to :

(a)  $4\hat{i} + 6\hat{k}$  (b)  $2\hat{i} - 2\hat{j} + 2\hat{k}$   
(c)  $\hat{i} - \hat{j} + \hat{k}$  (d)  $2\hat{i} + 3\hat{k}$

4. The equation of a line passing through point  $(2, -1, 0)$  and parallel to the line  $\frac{x}{1} = \frac{y-1}{2} = \frac{2-z}{2}$  is :

(a)  $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{2}$  (b)  $\frac{x-2}{1} = \frac{y-1}{2} = \frac{z}{2}$   
(c)  $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{-2}$  (d)  $\frac{x-2}{1} = \frac{y+1}{2} = \frac{z}{-2}$

5. X and Y are independent events such that  $P(X \cap \bar{Y}) = \frac{2}{5}$  and  $P(X) = \frac{3}{5}$ .

Then  $P(Y)$  is equal to :

(a)  $\frac{2}{3}$  (b)  $\frac{2}{5}$   
(c)  $\frac{1}{3}$  (d)  $\frac{1}{5}$

6. The value of k for which function  $f(x) = \begin{cases} x^2, & x \geq 0 \\ kx, & x < 0 \end{cases}$  is differentiable at  $x = 0$  is :

(a) 1 (b) 2  
(c) any real number (d) 0

7. If  $y = \frac{\cos x - \sin x}{\cos x + \sin x}$ , then  $\frac{dy}{dx}$  is :

(a)  $-\sec^2\left(\frac{\pi}{4} - x\right)$  (b)  $\sec^2\left(\frac{\pi}{4} - x\right)$   
(c)  $\log \left| \sec\left(\frac{\pi}{4} - x\right) \right|$  (d)  $-\log \left| \sec\left(\frac{\pi}{4} - x\right) \right|$



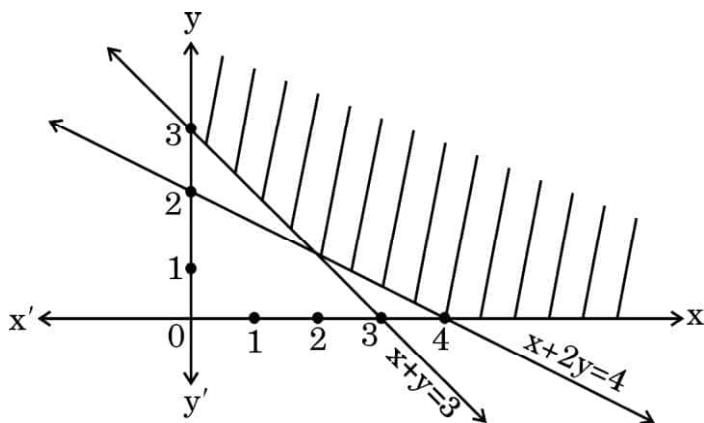
8. रैखिक प्रोग्रामन समस्या,  $z = 15x + 30y$  का अधिकतमीकरण निम्न व्यवरोधों के अंतर्गत कीजिए :

$$3x + y \leq 12, \quad x + 2y \leq 10, \quad x \geq 0, \quad y \geq 0$$

के कितने सुसंगत हल हैं ?

(a) 1 (b) 2  
(c) 3 (d) असंख्य

9. एक रैखिक प्रोग्रामन समस्या का सुसंगत क्षेत्र नीचे आरेख में दर्शाया गया है :



निम्न में से कौन-से व्यवरोध सम्भव हैं ?

(a)  $x + 2y \geq 4, x + y \leq 3, x \geq 0, y \geq 0$   
 (b)  $x + 2y \leq 4, x + y \leq 3, x \geq 0, y \geq 0$   
 (c)  $x + 2y \geq 4, x + y \geq 3, x \geq 0, y \geq 0$   
 (d)  $x + 2y \geq 4, x + y \geq 3, x \leq 0, y \leq 0$

10. A तथा B समान कोटि के वर्ग आव्यूह हैं । यदि  $(A + B)^2 = A^2 + B^2$  है, तो :

(a)  $AB = BA$       (b)  $AB = -BA$   
(c)  $AB = O$       (d)  $BA = O$

11. यदि  $A \cdot (\text{adj } A) = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$  है, तो  $|A| + |\text{adj } A|$  का मान बराबर है :

(a) 12 (b) 9  
 (c) 3 (d) 27



8. The number of feasible solutions of the linear programming problem given as

Maximize  $z = 15x + 30y$  subject to constraints :

$3x + y \leq 12$ ,  $x + 2y \leq 10$ ,  $x \geq 0$ ,  $y \geq 0$  is

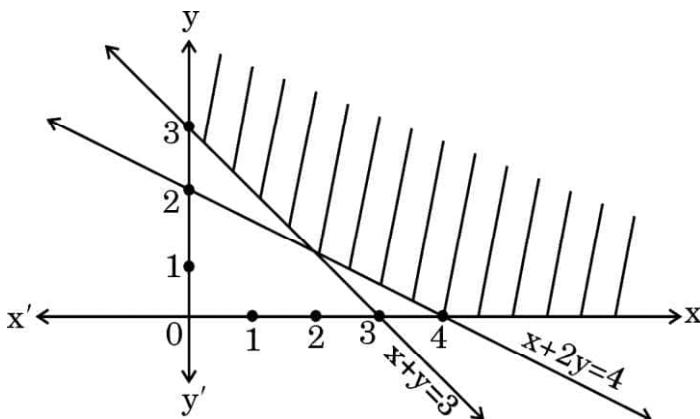
(a) 1

(b) 2

(c) 3

(d) infinite

9. The feasible region of a linear programming problem is shown in the figure below :



Which of the following are the possible constraints ?

(a)  $x + 2y \geq 4$ ,  $x + y \leq 3$ ,  $x \geq 0$ ,  $y \geq 0$

(b)  $x + 2y \leq 4$ ,  $x + y \leq 3$ ,  $x \geq 0$ ,  $y \geq 0$

(c)  $x + 2y \geq 4$ ,  $x + y \geq 3$ ,  $x \geq 0$ ,  $y \geq 0$

(d)  $x + 2y \geq 4$ ,  $x + y \geq 3$ ,  $x \leq 0$ ,  $y \leq 0$

10. A and B are square matrices of same order. If  $(A + B)^2 = A^2 + B^2$ , then :

(a)  $AB = BA$

(b)  $AB = -BA$

(c)  $AB = O$

(d)  $BA = O$

11. If  $A \cdot (\text{adj } A) = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ , then the value of  $|A| + |\text{adj } A|$  is equal to :

(a) 12

(b) 9

(c) 3

(d) 27



12. A तथा B दोनों समान कोटि के विषम-सममित आव्यूह हैं । AB सममित होगा, यदि :

(a)  $AB = O$       (b)  $AB = -BA$   
(c)  $AB = BA$       (d)  $BA = O$

13.  $x \in \left[0, \frac{\pi}{2}\right]$  के किस मान के लिए  $A + A' = \sqrt{3} I$  है, जहाँ  $A = \begin{bmatrix} \cos x & \sin x \\ -\sin x & \cos x \end{bmatrix}$  है ?

(a)  $\frac{\pi}{3}$  (b)  $\frac{\pi}{6}$   
 (c) 0 (d)  $\frac{\pi}{2}$

14. माना एक त्रिभुज जिसके शीर्ष  $(x_1, y_1)$ ,  $(x_2, y_2)$  तथा  $(x_3, y_3)$  हैं, का क्षेत्रफल A है । निम्न में से कौन-सा सही है ?

$$(a) \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm A \quad (b) \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm 2A$$

$$(c) \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm \frac{A}{2} \quad (d) \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}^2 = A^2$$

15.  $\int 2^{x+2} dx$  बराबर है :

(a)  $2^{x+2} + C$       (b)  $2^{x+2} \log 2 + C$   
  
(c)  $\frac{2^{x+2}}{\log 2} + C$       (d)  $2 \cdot \frac{2^x}{\log 2} + C$



12. A and B are skew-symmetric matrices of same order. AB is symmetric, if :

(a)  $AB = O$       (b)  $AB = -BA$   
(c)  $AB = BA$       (d)  $BA = O$

13. For what value of  $x \in \left[0, \frac{\pi}{2}\right]$ , is  $A + A' = \sqrt{3} I$ , where

$$A = \begin{bmatrix} \cos x & \sin x \\ -\sin x & \cos x \end{bmatrix} ?$$

(a)  $\frac{\pi}{3}$       (b)  $\frac{\pi}{6}$   
(c) 0      (d)  $\frac{\pi}{2}$

14. Let A be the area of a triangle having vertices  $(x_1, y_1)$ ,  $(x_2, y_2)$  and  $(x_3, y_3)$ . Which of the following is correct ?

(a)  $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm A$       (b)  $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm 2A$   
(c)  $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm \frac{A}{2}$       (d)  $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}^2 = A^2$

15.  $\int 2^{x+2} dx$  is equal to :

(a)  $2^{x+2} + C$       (b)  $2^{x+2} \log 2 + C$   
(c)  $\frac{2^{x+2}}{\log 2} + C$       (d)  $2 \cdot \frac{2^x}{\log 2} + C$



16.  $\int e^{-x} \left( \frac{x+1}{x^2} \right) dx$  बराबर है :

(a) $\frac{e^{-x}}{x} + C$	(b) $\frac{e^x}{x} + C$
(c) $\frac{e^x}{x^2} + C$	(d) $-\frac{e^{-x}}{x} + C$

17.  $\int_0^{\pi/2} \log \tan x dx$  का मान है :

(a) $\frac{\pi}{2}$	(b) 0
(c) $-\frac{\pi}{2}$	(d) 1

18. अवकल समीकरण  $\frac{d^2y}{dx^2} \sin y + \left( \frac{dy}{dx} \right)^3 \cos y = \sqrt{y}$  की कोटि तथा घात का गुणनफल क्या है ?

(a) 3	(b) 2
(c) 6	(d) परिभाषित नहीं

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 तथा तर्क (R) गलत है।
(d) अभिकथन (A) गलत है तथा तर्क (R) सही है।



16.  $\int e^{-x} \left( \frac{x+1}{x^2} \right) dx$  is equal to :

(a)  $\frac{e^{-x}}{x} + C$       (b)  $\frac{e^x}{x} + C$   
(c)  $\frac{e^x}{x^2} + C$       (d)  $-\frac{e^{-x}}{x} + C$

17. The value of  $\int_0^{\pi/2} \log \tan x dx$  is :

(a)  $\frac{\pi}{2}$       (b) 0  
(c)  $-\frac{\pi}{2}$       (d) 1

18. What is the product of the order and degree of the differential equation  
$$\frac{d^2y}{dx^2} \sin y + \left( \frac{dy}{dx} \right)^3 \cos y = \sqrt{y} ?$$

(a) 3      (b) 2  
(c) 6      (d) not defined

Questions number 19 and 20 are Assertion and Reason based questions carrying 1 mark each. 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 and Reason (R) is false.  
(d) Assertion (A) is false and Reason (R) is true.



19. अभिकथन (A) :  $[\sin^{-1} x + 2 \cos^{-1} x]$  का परिसर  $[0, \pi]$  है ।

तर्क (R) :  $\sin^{-1} x$  की मुख्य मान शाखा का परिसर  $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$  है ।

20. अभिकथन (A) : बिन्दुओं  $(4, 7, 8)$  तथा  $(2, 3, 4)$  से होकर जाने वाली रेखा, बिन्दुओं  $(-1, -2, 1)$  तथा  $(1, 2, 5)$  से होकर जाने वाली रेखा के समांतर है ।

तर्क (R) : रेखाएँ  $\vec{r} = \vec{a}_1 + \lambda \vec{b}_1$  तथा  $\vec{r} = \vec{a}_2 + \mu \vec{b}_2$  परस्पर समांतर हैं यदि  $\vec{b}_1 \cdot \vec{b}_2 = 0$  है ।

### खण्ड ख

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

21. (क) यदि  $y = x^{\frac{1}{x}}$  है, तो  $x = 1$  पर  $\frac{dy}{dx}$  ज्ञात कीजिए ।

अथवा

(ख) यदि  $x = a \sin 2t$ ,  $y = a(\cos 2t + \log \tan t)$  है, तो  $\frac{dy}{dx}$  ज्ञात कीजिए ।

22. यदि  $\vec{r} = 3\hat{i} - 2\hat{j} + 6\hat{k}$  है, तो  $(\vec{r} \times \hat{j}) \cdot (\vec{r} \times \hat{k}) - 12$  का मान ज्ञात कीजिए ।

23. उस रेखा के दिक्-कोसाइन ज्ञात कीजिए, जिसके कार्तीय समीकरण

$$5x - 3 = 15y + 7 = 3 - 10z \text{ हैं ।}$$

24. वक्र  $6y = x^3 + 2$  पर वे बिंदु ज्ञात कीजिए, जहाँ  $y$ -निर्देशांक के बदलने की दर  $x$ -निर्देशांक के बदलने की दर का 8 गुना है ।

25. (क)  $3 \sin^{-1} \left( \frac{1}{\sqrt{2}} \right) + 2 \cos^{-1} \left( \frac{\sqrt{3}}{2} \right) + \cos^{-1} (0)$  का मान ज्ञात कीजिए ।

अथवा

(ख)  $f(x) = \sin^{-1} x$ ,  $x \in \left[-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right]$  का आलेख खींचिए । इस फलन  $f(x)$  का परिसर भी लिखिए ।



19. Assertion (A) : Range of  $[\sin^{-1} x + 2 \cos^{-1} x]$  is  $[0, \pi]$ .

Reason (R) : Principal value branch of  $\sin^{-1} x$  has range  $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ .

20. Assertion (A) : A line through the points  $(4, 7, 8)$  and  $(2, 3, 4)$  is parallel to a line through the points  $(-1, -2, 1)$  and  $(1, 2, 5)$ .

Reason (R) : Lines  $\vec{r} = \vec{a}_1 + \lambda \vec{b}_1$  and  $\vec{r} = \vec{a}_2 + \mu \vec{b}_2$  are parallel if  $\vec{b}_1 \cdot \vec{b}_2 = 0$ .

## SECTION B

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

21. (a) If  $y = x^{\frac{1}{x}}$ , then find  $\frac{dy}{dx}$  at  $x = 1$ .

**OR**

(b) If  $x = a \sin 2t$ ,  $y = a(\cos 2t + \log \tan t)$ , then find  $\frac{dy}{dx}$ .

22. If  $\vec{r} = 3\hat{i} - 2\hat{j} + 6\hat{k}$ , find the value of  $(\vec{r} \times \hat{j}) \cdot (\vec{r} \times \hat{k}) - 12$ .

23. Find the direction cosines of the line whose Cartesian equations are  $5x - 3 = 15y + 7 = 3 - 10z$ .

24. Find the points on the curve  $6y = x^3 + 2$  at which ordinate is changing 8 times as fast as abscissa.

25. (a) Evaluate :  $3 \sin^{-1} \left( \frac{1}{\sqrt{2}} \right) + 2 \cos^{-1} \left( \frac{\sqrt{3}}{2} \right) + \cos^{-1} (0)$

**OR**

(b) Draw the graph of  $f(x) = \sin^{-1} x$ ,  $x \in \left[-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right]$ . Also, write range of  $f(x)$ .



## खण्ड ग

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

26. (क) पासों के एक युग्म को एक साथ उछाला गया। यदि दोनों पासों पर आई संख्याओं के निरपेक्ष अंतर को X द्वारा निरूपित किया गया है, तो X का प्रायिकता बंटन ज्ञात कीजिए।

अथवा

(ख) दो सिक्कों में से एक अभिनत सिक्का इस प्रकार का है कि  $P(\text{चित}) : P(\text{पट}) = 1 : 3$  है, जबकि दूसरा सिक्का न्याय्य (अनभिनत) सिक्का है। एक सिक्का यादृच्छ्या चुना जाता है तथा उछाला जाता है। यदि इस सिक्के पर चित आया, तो प्रायिकता ज्ञात कीजिए कि यह अभिनत सिक्का है।

27. (क) अवकल समीकरण  $\frac{d}{dx}(xy^2) = 2y(1+x^2)$  का व्यापक हल ज्ञात कीजिए।

अथवा

(ख) अवकल समीकरण  $xe^{\frac{y}{x}} - y + x\frac{dy}{dx} = 0$  को हल कीजिए।

28. मान ज्ञात कीजिए :

$$\int_0^{\pi/4} \log(1 + \tan x) dx$$

29. (क) ज्ञात कीजिए :

$$\int \frac{\cos x}{\sin 3x} dx$$

अथवा

(ख) ज्ञात कीजिए :

$$\int x^2 \log(x^2 + 1) dx$$



## SECTION C

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

**26.** (a) A pair of dice is thrown simultaneously. If  $X$  denotes the absolute difference of numbers obtained on the pair of dice, then find the probability distribution of  $X$ .

**OR**

(b) There are two coins. One of them is a biased coin such that  $P(\text{head}) : P(\text{tail})$  is  $1 : 3$  and the other coin is a fair coin. A coin is selected at random and tossed once. If the coin showed head, then find the probability that it is a biased coin.

**27.** (a) Find the general solution of the differential equation :

$$\frac{d}{dx}(xy^2) = 2y(1+x^2)$$

**OR**

(b) Solve the following differential equation :

$$xe^{\frac{y}{x}} - y + x\frac{dy}{dx} = 0$$

**28.** Evaluate :

$$\int_0^{\pi/4} \log(1 + \tan x) dx$$

**29.** (a) Find :

$$\int \frac{\cos x}{\sin 3x} dx$$

**OR**

(b) Find :

$$\int x^2 \log(x^2 + 1) dx$$



30. ज्ञात कीजिए :

$$\int_1^4 \frac{1}{\sqrt{2x+1} - \sqrt{2x-1}} dx$$

31. निम्न रैखिक प्रोग्रामन समस्या को आलेख द्वारा हल कीजिए :

व्यवरोधों       $2x + y \geq 3,$   
 $x + 2y \geq 6,$   
 $x \geq 0,$   
 $y \geq 0$

के अंतर्गत  $z = x + 2y$  का न्यूनतम मान ज्ञात कीजिए।

### खण्ड घ

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

32. (क)  $b$  का वह मान ज्ञात कीजिए जिससे रेखाएँ  $\frac{x-1}{2} = \frac{y-b}{3} = \frac{z-3}{4}$  तथा  $\frac{x-4}{5} = \frac{y-1}{2} = z$  परस्पर प्रतिच्छेदी रेखाएँ हों। इन दी गई रेखाओं का प्रतिच्छेदन बिन्दु भी ज्ञात कीजिए।

#### अथवा

(ख) एक समांतर चतुर्भुज ABCD जिसके शीर्ष A(4, 7, 8), B(2, 3, 4), C(-1, -2, 1) तथा D(1, 2, 5) हैं, की सभी भुजाओं के समीकरण ज्ञात कीजिए। अतः बिन्दु A से CD पर डाले गए लंब के पाद के निरेशांक भी ज्ञात कीजिए।

33. जाँच कीजिए कि क्या फलन  $f : \mathbb{R} \rightarrow \left[ -\frac{1}{2}, \frac{1}{2} \right]$  जो कि  $f(x) = \frac{x}{1+x^2}$  द्वारा परिभाषित है, एकैकी तथा आच्छादक है या नहीं।

34. दिया है कि रेखा  $y = mx$  ( $m > 0$ ), वक्र  $x^2 + y^2 = 4$  तथा x-अक्ष द्वारा घिरे प्रथम चतुर्थांश में क्षेत्र का क्षेत्रफल  $\frac{\pi}{2}$  इकाई है। समाकलन के प्रयोग से,  $m$  का मान ज्ञात कीजिए।



30. Find :

$$\int_1^4 \frac{1}{\sqrt{2x+1} - \sqrt{2x-1}} dx$$

31. Solve the following linear programming problem graphically :

Minimize  $z = x + 2y$

subject to the constraints

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

$$x + 2y \geq 6,$$

$$x \geq 0,$$

$$y \geq 0.$$

## SECTION D

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

32. (a) Find the value of  $b$  so that the lines  $\frac{x-1}{2} = \frac{y-b}{3} = \frac{z-3}{4}$  and  $\frac{x-4}{5} = \frac{y-1}{2} = z$  are intersecting lines. Also, find the point of intersection of these given lines.

## OR

(b) Find the equations of all the sides of the parallelogram ABCD whose vertices are A(4, 7, 8), B(2, 3, 4), C(-1, -2, 1) and D(1, 2, 5). Also, find the coordinates of the foot of the perpendicular from A to CD.

33. Check whether a function  $f : \mathbb{R} \rightarrow \left[-\frac{1}{2}, \frac{1}{2}\right]$  defined as  $f(x) = \frac{x}{1+x^2}$  is one-one and onto or not.

34. The area of the region bounded by the line  $y = mx$  ( $m > 0$ ), the curve  $x^2 + y^2 = 4$  and the x-axis in the first quadrant is  $\frac{\pi}{2}$  units. Using integration, find the value of  $m$ .



35. (क) यदि  $A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$  है, तो दर्शाइए कि  $A^3 - 6A^2 + 7A + 2I = O$ .

अथवा

(ख) यदि  $A = \begin{bmatrix} 3 & 2 \\ 5 & -7 \end{bmatrix}$  है, तो  $A^{-1}$  ज्ञात कीजिए तथा इसके प्रयोग से समीकरण निकाय  $3x + 5y = 11$ ,  $2x - 7y = -3$  को हल कीजिए।

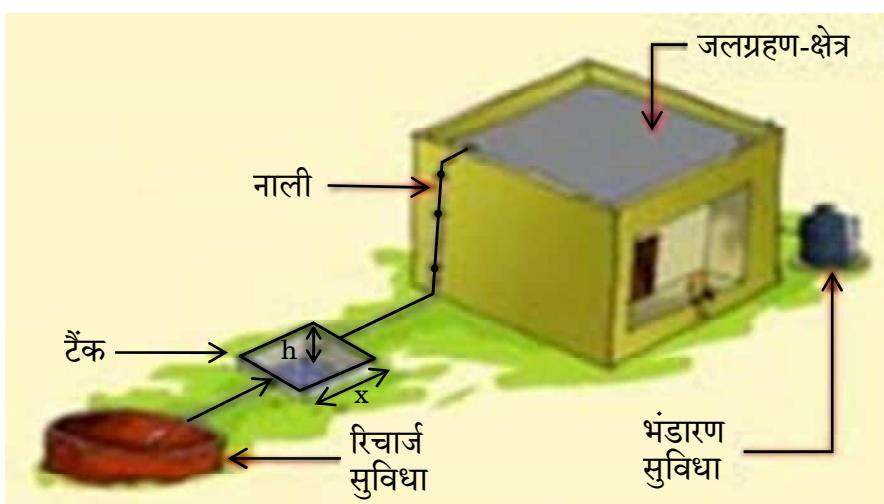
### खण्ड ड

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

#### प्रकरण अध्ययन - 1

36. बारिश के पानी को एकत्र करने के लिए एक गङ्गा (टैंक) खोदना है। यह टैंक वर्गाकार आधार का होना चाहिए तथा इसका आयतन  $250 \text{ m}^3$  चाहिए। भूमि का मूल्य ₹ 5,000 प्रति वर्ग मीटर है तथा इसे खोदने का खर्च इसकी गहराई के अनुसार बढ़ता जाता है तथा पूरे टैंक के लिए यह खर्च ₹ 40,000  $\text{m}^2$  है, जहाँ  $h$  टैंक की मीटरों में गहराई है। टैंक के वर्गाकार आधार की भुजा  $x$  मीटर है।

एक विशिष्ट वर्षा जल संग्रहण व्यवस्था के तत्व



उपर्युक्त सूचना के आधार पर निम्न प्रश्नों के उत्तर दीजिए :

(i) टैंक को खोदने का कुल खर्च ( $C$ ),  $x$  के पदों में ज्ञात कीजिए। 1

(ii)  $\frac{dC}{dx}$  ज्ञात कीजिए। 1



35. (a) If  $A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$ , then show that  $A^3 - 6A^2 + 7A + 2I = O$ .

**OR**

(b) If  $A = \begin{bmatrix} 3 & 2 \\ 5 & -7 \end{bmatrix}$ , then find  $A^{-1}$  and use it to solve the following system of equations :

$$3x + 5y = 11, \quad 2x - 7y = -3.$$

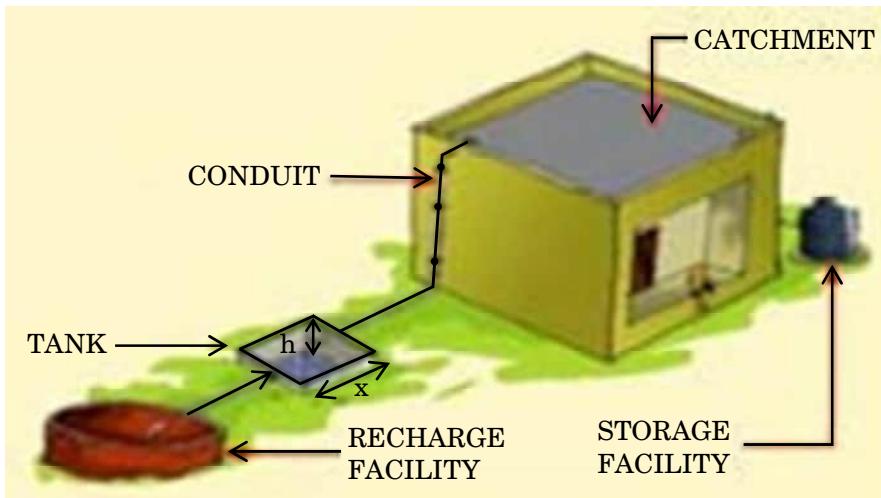
## SECTION E

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

### Case Study – 1

36. In order to set up a rain water harvesting system, a tank to collect rain water is to be dug. The tank should have a square base and a capacity of  $250 \text{ m}^3$ . The cost of land is ₹ 5,000 per square metre and cost of digging increases with depth and for the whole tank, it is ₹  $40,000 h^2$ , where  $h$  is the depth of the tank in metres.  $x$  is the side of the square base of the tank in metres.

#### ELEMENTS OF A TYPICAL RAIN WATER HARVESTING SYSTEM



Based on the above information, answer the following questions :

(i) Find the total cost  $C$  of digging the tank in terms of  $x$ . 1  
(ii) Find  $\frac{dC}{dx}$ . 1



(iii) (क)  $x$  का वह मान ज्ञात कीजिए जिसके लिए खर्च  $C$  न्यूनतम हो ।

2

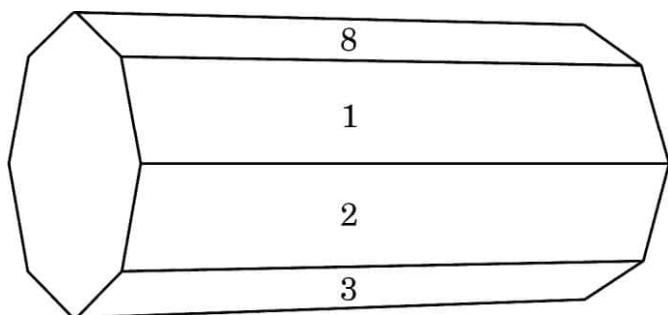
अथवा

(iii) (ख) जाँच कीजिए कि खर्च फलन  $C(x)$ , जो कि  $x$  के पदों में व्यक्त है, वर्धमान है या नहीं, जहाँ  $x > 0$  है ।

2

### प्रकरण अध्ययन – 2

37. अष्टभुजाकार प्रिज्म, एक तीन विमाओं वाली बहुफलक है, जो कि दो अष्टभुजाकार आधारों तथा आठ आयताकार फलकों से घिरा है । इसमें 24 किनारे तथा 16 शीर्ष हैं ।



इस प्रिज्म को आयताकार फलकों की दिशा में लुढ़काया गया तथा नीचे वाले फलक (जो भूमि को स्पर्श करता है) पर लिखी संख्या नोट की गई । माना नीचे आने वाले फलकों की संख्या को  $X$  से निरूपित किया गया और निम्न सारणी  $X$  का प्रायिकता बंटन दर्शाती है ।

$X :$	1	2	3	4	5	6	7	8
$P(X) :$	$p$	$2p$	$2p$	$p$	$2p$	$p^2$	$2p^2$	$7p^2 + p$

उपर्युक्त सूचना के आधार पर निम्न प्रश्नों के उत्तर दीजिए :

(i)  $p$  का मान ज्ञात कीजिए ।

1

(ii)  $P(X > 6)$  ज्ञात कीजिए ।

1

(iii) (क)  $P(X = 3m)$  ज्ञात कीजिए जहाँ  $m$  एक प्राकृत संख्या है ।

2

अथवा

(iii) (ख) माध्य  $E(X)$  ज्ञात कीजिए ।

2



(iii) (a) Find the value of  $x$  for which cost  $C$  is minimum.

2

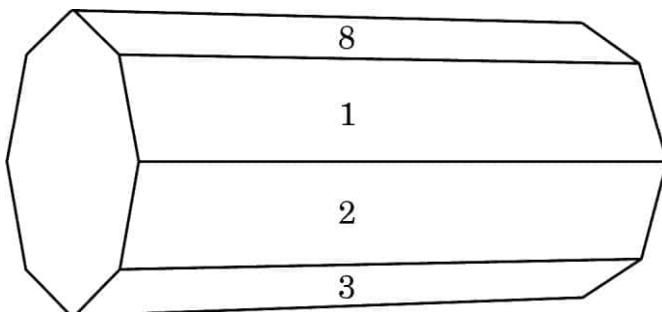
**OR**

(iii) (b) Check whether the cost function  $C(x)$  expressed in terms of  $x$  is increasing or not, where  $x > 0$ .

2

### **Case Study – 2**

37. An octagonal prism is a three-dimensional polyhedron bounded by two octagonal bases and eight rectangular side faces. It has 24 edges and 16 vertices.



The prism is rolled along the rectangular faces and number on the bottom face (touching the ground) is noted. Let  $X$  denote the number obtained on the bottom face and the following table give the probability distribution of  $X$ .

X :	1	2	3	4	5	6	7	8
P(X) :	$p$	$2p$	$2p$	$p$	$2p$	$p^2$	$2p^2$	$7p^2 + p$

Based on the above information, answer the following questions :

(i) Find the value of  $p$ .

1

(ii) Find  $P(X > 6)$ .

1

(iii) (a) Find  $P(X = 3m)$ , where  $m$  is a natural number.

2

**OR**

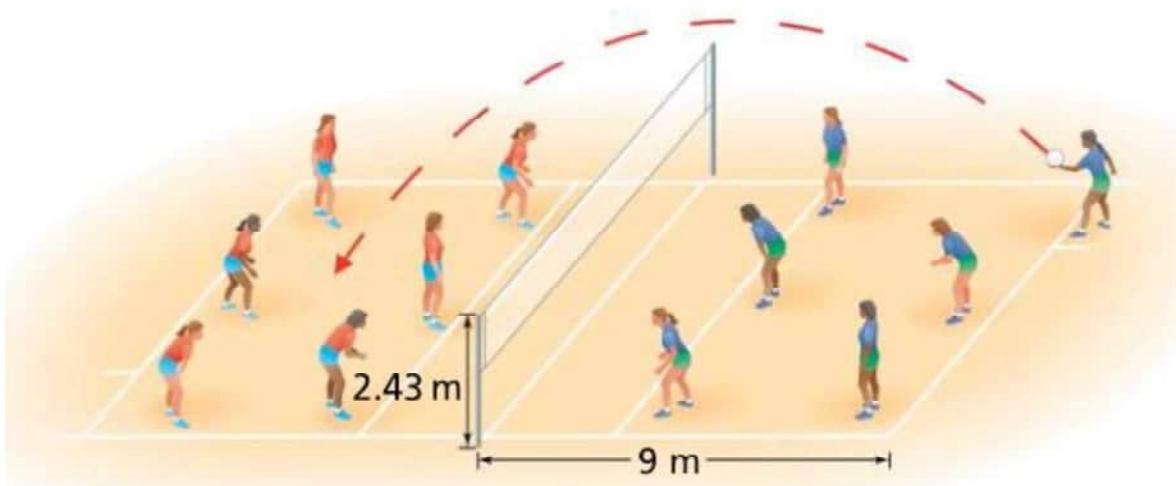
(iii) (b) Find the mean  $E(X)$ .

2



### प्रकरण अध्ययन – 3

38. एक वॉलीबॉल का खिलाड़ी बॉल से सर्विस करता है, तो यह बॉल एक परवलय का पथ लेती है, जो निम्न समीकरण द्वारा प्रदत्त है :  $h(t) = -\frac{7}{2}t^2 + \frac{13}{2}t + 1$ , जहाँ  $h(t)$  बॉल की किसी समय  $t$  (सेकंड में) पर ऊँचाई है, ( $t \geq 0$ ).



उपर्युक्त सूचना के आधार पर निम्न प्रश्नों के उत्तर दीजिए :

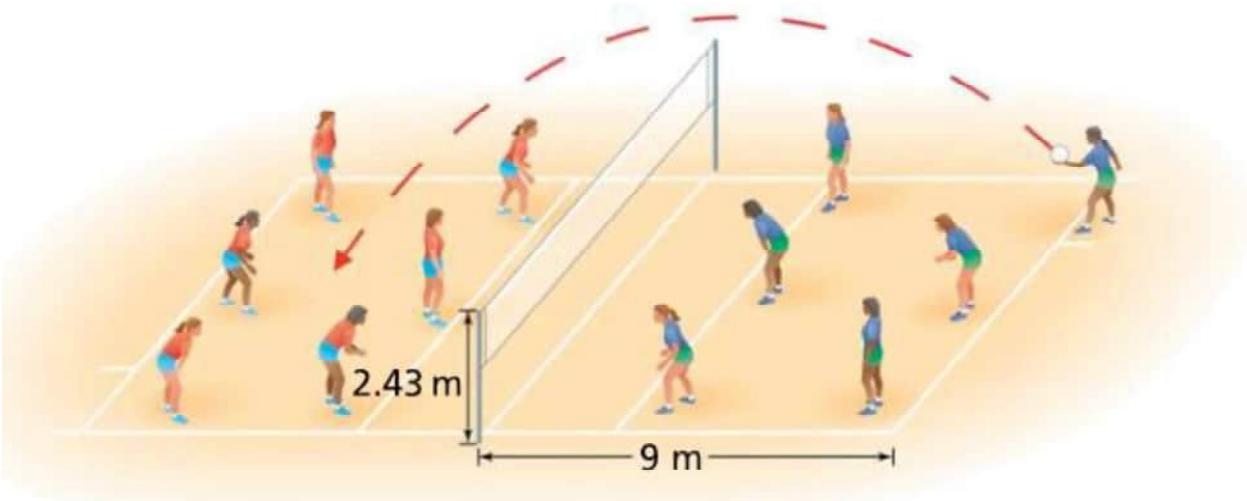
(i) क्या  $h(t)$  एक संतत फलन है ? औचित्य दीजिए । 2

(ii) वह समय ज्ञात कीजिए जब बॉल की ऊँचाई अधिकतम हो । 2



### Case Study – 3

38. A volleyball player serves the ball which takes a parabolic path given by the equation  $h(t) = -\frac{7}{2}t^2 + \frac{13}{2}t + 1$ , where  $h(t)$  is the height of ball at any time  $t$  (in seconds), ( $t \geq 0$ ).



Based on the above information, answer the following questions :

(i) Is  $h(t)$  a continuous function ? Justify. 2

(ii) Find the time at which the height of the ball is maximum. 2

**Marking Scheme**  
**Strictly Confidential**  
**(For Internal and Restricted use only)**  
**Senior School Certificate Examination, 2023**  
**MATHEMATICS PAPER CODE 65/3/3**

**General Instructions: -**

<b>1</b>	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.
<b>2</b>	<b>"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."</b>
<b>3</b>	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. <b>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.</b>
<b>4</b>	The Marking scheme carries only suggested value points for the answers. These are Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
<b>5</b>	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.
<b>6</b>	Evaluators will mark (✓) wherever answer is correct. For wrong answer CROSS 'X' be marked. Evaluators will not put right (✓) while evaluating which gives the impression that answer is correct, and no marks are awarded. <b>This is most common mistake which evaluators are committing.</b>
<b>7</b>	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.
<b>8</b>	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.
<b>9</b>	<b>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".</b>
<b>10</b>	<b>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".</b>
<b>11</b>	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
<b>12</b>	A full scale of marks _____ (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) must be used. Please do not hesitate to award full marks if the answer deserves it.
<b>13</b>	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 (Details are given in Spot Guidelines). This is in view of the reduced syllabus and number of questions in question paper.

14	<p>Ensure that you do not make the following common types of errors committed by the Examiner in the past: -</p> <ul style="list-style-type: none"> <li>● Leaving answer or part thereof unassessed in an answer book.</li> <li>● Giving more marks for an answer than assigned to it.</li> <li>● Wrong totaling of marks awarded on an answer.</li> <li>● Wrong transfer of marks from the inside pages of the answer book to the title page.</li> <li>● Wrong question wise totaling on the title page.</li> <li>● Wrong totaling of marks of the two columns on the title page.</li> <li>● Wrong grand total.</li> <li>● Marks in words and figures not tallying/not same.</li> <li>● Wrong transfer of marks from the answer book to online award list.</li> <li>● 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.)</li> <li>● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.</li> </ul>
15	<p>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.</p>
16	<p>Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.</p>
17	<p>The Examiners should acquaint themselves with the guidelines given in the "<b>Guidelines for spot Evaluation</b>" before starting the actual evaluation.</p>
18	<p>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.</p>
19	<p>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.</p>

SECTION A		
Q. No.	Expected Answers/Value Points	Marks
Q1	If the angle between the vectors $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{4}$ and $ \vec{a} \times \vec{b}  = 1$ , then $\vec{a} \cdot \vec{b}$ is equal to (a) -1 (b) 1 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$	
Ans	(b) 1	1
Q2	$\vec{a}$ and $\vec{b}$ are two non-zero vectors such that the projection of $\vec{a}$ on $\vec{b}$ is 0. The angle between $\vec{a}$ and $\vec{b}$ is : (a) $\frac{\pi}{2}$ (b) $\pi$ (c) $\frac{\pi}{4}$ (d) 0	
Ans	(a) $\frac{\pi}{2}$	1
Q3	In $\Delta ABC$ , $\vec{AB} = \hat{i} + \hat{j} + 2\hat{k}$ and $\vec{AC} = 3\hat{i} - \hat{j} + 4\hat{k}$ . If D is mid-point of BC, then vector $\vec{AD}$ is equal to : (a) $4\hat{i} + 6\hat{k}$ (b) $2\hat{i} - 2\hat{j} + 2\hat{k}$ (c) $\hat{i} - \hat{j} + \hat{k}$ (d) $2\hat{i} + 3\hat{k}$	
Ans	(d) $2\hat{i} + 3\hat{k}$	1
Q4	The equation of a line passing through point $(2, -1, 0)$ and parallel to the line $\frac{x}{1} = \frac{y-1}{2} = \frac{2-z}{2}$ is : (a) $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{2}$ (b) $\frac{x-2}{1} = \frac{y-1}{2} = \frac{z}{2}$ (c) $\frac{x+2}{1} = \frac{y-1}{2} = \frac{z}{-2}$ (d) $\frac{x-2}{1} = \frac{y+1}{2} = \frac{z}{-2}$	
Ans	(d) $\frac{x-1}{2} = \frac{y+1}{2} = \frac{z}{-2}$	1
Q5	X and Y are independent events such that $P(X \cap \bar{Y}) = \frac{2}{5}$ and $P(X) = \frac{3}{5}$ . Then $P(Y)$ is equal to : (a) $\frac{2}{3}$ (b) $\frac{2}{5}$ (c) $\frac{1}{3}$ (d) $\frac{1}{5}$	
Ans	(c) $\frac{1}{3}$	1



Q10	<p>A and B are square matrices of same order. If <math>(A + B)^2 = A^2 + B^2</math>, then :</p> <p>(a) <math>AB = BA</math>      (b) <math>AB = -BA</math>      (c) <math>AB = O</math>      (d) <math>BA = O</math></p>	
Ans	<p><b>(b)</b> <math>AB = -BA</math></p>	1
Q11	<p>If <math>A \cdot (\text{adj } A) = \begin{bmatrix} 3 &amp; 0 &amp; 0 \\ 0 &amp; 3 &amp; 0 \\ 0 &amp; 0 &amp; 3 \end{bmatrix}</math>, then the value of <math> A  +  \text{adj } A </math> is equal to :</p> <p>(a) 12      (b) 9      (c) 3      (d) 27</p>	
Ans	<p><b>(a) 12</b></p>	1
Q12	<p>A and B are skew-symmetric matrices of same order. AB is symmetric, if :</p>	
	<p>(a) <math>AB = O</math>      (b) <math>AB = -BA</math>      (c) <math>AB = BA</math>      (d) <math>BA = O</math></p>	
Ans	<p><b>(c) <math>AB = BA</math></b></p>	1
Q13	<p>For what value of <math>x \in \left[0, \frac{\pi}{2}\right]</math>, is <math>A + A' = \sqrt{3} I</math>, where  <math>A = \begin{bmatrix} \cos x &amp; \sin x \\ -\sin x &amp; \cos x \end{bmatrix}</math> ?</p> <p>(a) <math>\frac{\pi}{3}</math>      (b) <math>\frac{\pi}{6}</math>      (c) 0      (d) <math>\frac{\pi}{2}</math></p>	
Ans	<p><b>(b) <math>\frac{\pi}{6}</math></b></p>	1
Q14	<p>Let A be the area of a triangle having vertices <math>(x_1, y_1)</math>, <math>(x_2, y_2)</math> and <math>(x_3, y_3)</math>. Which of the following is correct ?</p> <p>(a) <math>\begin{vmatrix} x_1 &amp; y_1 &amp; 1 \\ x_2 &amp; y_2 &amp; 1 \\ x_3 &amp; y_3 &amp; 1 \end{vmatrix} = \pm A</math>      (b) <math>\begin{vmatrix} x_1 &amp; y_1 &amp; 1 \\ x_2 &amp; y_2 &amp; 1 \\ x_3 &amp; y_3 &amp; 1 \end{vmatrix} = \pm 2A</math>      (c) <math>\begin{vmatrix} x_1 &amp; y_1 &amp; 1 \\ x_2 &amp; y_2 &amp; 1 \\ x_3 &amp; y_3 &amp; 1 \end{vmatrix} = \pm \frac{A}{2}</math>      (d) <math>\begin{vmatrix} x_1 &amp; y_1 &amp; 1 \\ x_2 &amp; y_2 &amp; 1 \\ x_3 &amp; y_3 &amp; 1 \end{vmatrix}^2 = A^2</math></p>	

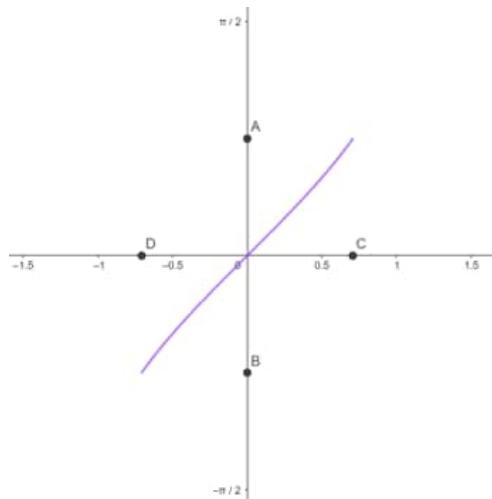
Ans	(b) $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \pm 2A$	1
Q15	$\int 2^{x+2} dx$ is equal to : (a) $2^{x+2} + C$ (b) $2^{x+2} \log 2 + C$ (c) $\frac{2^{x+2}}{\log 2} + C$ (d) $2 \cdot \frac{2^x}{\log 2} + C$	
Ans	(c) $\frac{2^{x+2}}{\log 2} + C$	1
Q16	$\int e^{-x} \left( \frac{x+1}{x^2} \right) dx$ is equal to : (a) $\frac{e^{-x}}{x} + C$ (b) $\frac{e^x}{x} + C$ (c) $\frac{e^x}{x^2} + C$ (d) $-\frac{e^{-x}}{x} + C$	
Ans	(d) $-\frac{e^{-x}}{x} + C$	1
Q17	The value of $\int_0^{\pi/2} \log \tan x dx$ is : (a) $\frac{\pi}{2}$ (b) 0 (c) $-\frac{\pi}{2}$ (d) 1	
Ans	(b) 0	1
Q18	What is the product of the order and degree of the differential equation $\frac{d^2y}{dx^2} \sin y + \left( \frac{dy}{dx} \right)^3 \cos y = \sqrt{y}$ ? (a) 3      (b) 2 (c) 6      (d) not defined	
Ans	(b) 2	1

Questions number 19 and 20 are Assertion and Reason based questions carrying 1 mark each. 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 and Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is true.

Q19	<p><i>Assertion (A) :</i> Range of <math>[\sin^{-1} x + 2 \cos^{-1} x]</math> is <math>[0, \pi]</math>.</p> <p><i>Reason (R) :</i> Principal value branch of <math>\sin^{-1} x</math> has range <math>\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]</math>.</p>	
Ans	(d) Assertion (A) is false and Reason (R) is true.	1
Q20	<p><i>Assertion (A) :</i> A line through the points <math>(4, 7, 8)</math> and <math>(2, 3, 4)</math> is parallel to a line through the points <math>(-1, -2, 1)</math> and <math>(1, 2, 5)</math>.</p> <p><i>Reason (R) :</i> Lines <math>\vec{r} = \vec{a}_1 + \lambda \vec{b}_1</math> and <math>\vec{r} = \vec{a}_2 + \mu \vec{b}_2</math> are parallel if <math>\vec{b}_1 \cdot \vec{b}_2 = 0</math>.</p>	
Ans	(c) Assertion (A) is true and Reason (R) is false.	1
<b>SECTION B</b>		
Q21(a)	If $y = x^{\frac{1}{x}}$ , then find $\frac{dy}{dx}$ at $x = 1$ .	
Ans	<p>(a) <math>y = x^{\frac{1}{x}}</math></p> $\Rightarrow \log y = \frac{1}{x} \log x$ $\Rightarrow \frac{1}{y} \frac{dy}{dx} = -\frac{\log x}{x^2} + \frac{1}{x^2} \Rightarrow \frac{dy}{dx} = x^{\frac{1}{x}} \frac{(1 - \log x)}{x^2}$ $\Rightarrow \left(\frac{dy}{dx}\right)_{x=1} = 1$ <p style="text-align: center;"><b>OR</b></p>	$\frac{1}{2}$ $1$ $\frac{1}{2}$
Q21(b)	If $x = a \sin 2t$ , $y = a(\cos 2t + \log \tan t)$ , then find $\frac{dy}{dx}$ .	
Ans	<p>(b) <math>\frac{dx}{dt} = 2a \cos 2t</math></p> $\frac{dy}{dt} = 2a \left( -\sin 2t + \frac{\sec^2 t}{2 \tan t} \right) = 2a \frac{\cos^2 2t}{\sin 2t}$ $\frac{dy}{dx} = \cot 2t$	$\frac{1}{2}$ $1$ $\frac{1}{2}$
Q22	If $\vec{r} = 3\hat{i} - 2\hat{j} + 6\hat{k}$ , find the value of $(\vec{r} \times \hat{j}) \cdot (\vec{r} \times \hat{k}) - 12$ .	

Ans	$(\vec{r} \times \hat{j}) \cdot (\vec{r} \times \hat{k}) - 12 = (3\hat{k} - 6\hat{i}) \cdot (-3\hat{j} - 2\hat{i}) - 12$ $= 12 - 12 = 0$	$1\frac{1}{2}$ $\frac{1}{2}$
Q23	Find the direction cosines of the line whose Cartesian equations are $5x - 3 = 15y + 7 = 3 - 10z$ .	
Ans	<p>Equations of given line can be written as</p> $\frac{x - \frac{3}{5}}{\frac{1}{5}} = \frac{y + \frac{7}{15}}{\frac{1}{15}} = \frac{z - \frac{3}{10}}{-\frac{1}{10}}$ <p>d.r.'s are <math>\left\langle \frac{1}{5}, \frac{1}{15}, -\frac{1}{10} \right\rangle</math> or <math>\langle 6, 2, -3 \rangle</math></p> <p>d.c.'s are <math>\left\langle \frac{6}{7}, \frac{2}{7}, -\frac{3}{7} \right\rangle</math></p>	$1$ $\frac{1}{2}$ $\frac{1}{2}$
Q24	Find the points on the curve $6y = x^3 + 2$ at which ordinate is changing 8 times as fast as abscissa.	
Ans	<p>Differentiating both sides w.r.to t, we get <math>6 \frac{dy}{dt} = 3x^2 \frac{dx}{dt}</math></p> $6 \cdot 8 \frac{dx}{dt} = 3x^2 \frac{dx}{dt} \Rightarrow x = \pm 4$ <p>Points are <math>(4, 11)</math> and <math>(-4, -\frac{31}{3})</math></p>	$\frac{1}{2}$ $1$ $\frac{1}{2}$
Q25(a)	Evaluate : $3 \sin^{-1} \left( \frac{1}{\sqrt{2}} \right) + 2 \cos^{-1} \left( \frac{\sqrt{3}}{2} \right) + \cos^{-1} (0)$	
Ans	<p>(a) Given expression = <math>\frac{3\pi}{4} + \frac{2\pi}{6} + \frac{\pi}{2}</math></p> $= \frac{19\pi}{12}$ <p><b>OR</b></p>	$1\frac{1}{2}$ $\frac{1}{2}$
Q25(b)	Draw the graph of $f(x) = \sin^{-1} x$ , $x \in \left[ -\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right]$ . Also, write range of $f(x)$ .	
Ans	(b)	



Correct graph

1

Here, the points A, B, C and D are respectively  $\left(0, \frac{\pi}{4}\right)$ ,  $\left(0, -\frac{\pi}{4}\right)$ ,  $\left(\frac{1}{\sqrt{2}}, 0\right)$ ,  $\left(-\frac{1}{\sqrt{2}}, 0\right)$ .

$$\text{Range} = \left[-\frac{\pi}{4}, \frac{\pi}{4}\right]$$

1

### SECTION C

Q26(a) (a) A pair of dice is thrown simultaneously. If  $X$  denotes the absolute difference of numbers obtained on the pair of dice, then find the probability distribution of  $X$ .

Ans

(a)

X	0	1	2	3	4	5
P(X)	$\frac{6}{36}$	$\frac{10}{36}$	$\frac{8}{36}$	$\frac{6}{36}$	$\frac{4}{36}$	$\frac{2}{36}$

OR

Q26(b) There are two coins. One of them is a biased coin such that  $P(\text{head}) : P(\text{tail})$  is  $1 : 3$  and the other coin is a fair coin. A coin is selected at random and tossed once. If the coin showed head, then find the probability that it is a biased coin.

Ans

$$(b) E_1 = \text{Biased coin is selected} \Rightarrow P(E_1) = \frac{1}{2}$$

$$E_2 = \text{Fair coin is selected} \Rightarrow P(E_2) = \frac{1}{2}$$

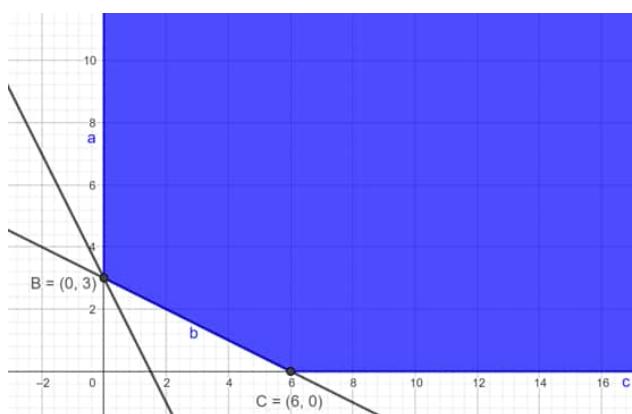
A = Head appeared on tossing a selected coin.

1/2

	$P\left(\frac{A}{E_1}\right) = \frac{1}{4}, P\left(\frac{A}{E_2}\right) = \frac{1}{2}$ <p>By Bayes' Theorem <math>P\left(\frac{E_1}{A}\right) = \frac{P(E_1) P\left(\frac{A}{E_1}\right)}{P(E_1) P\left(\frac{A}{E_1}\right) + P(E_2) P\left(\frac{A}{E_2}\right)}</math></p> $= \frac{\frac{1}{2} \cdot \frac{1}{4}}{\frac{1}{2} \cdot \frac{1}{4} + \frac{1}{2} \cdot \frac{1}{2}}$ $= \frac{1}{3}$	1
Q27(a)	<p>Find the general solution of the differential equation :</p> $\frac{dy}{dx} (xy^2) = 2y(1+x^2)$	
Ans	<p>(a) Given differential equation is</p> $2xy\frac{dy}{dx} + y^2 = 2y(1+x^2)$ $\Rightarrow \frac{dy}{dx} + \frac{y}{2x} = \frac{1}{x} + x$ <p>Integrating factor = <math>e^{\int \frac{1}{2x} dx} = e^{\log \sqrt{x}} = \sqrt{x}</math></p> <p>Solution is given by <math>y\sqrt{x} = \int \left(\frac{1}{\sqrt{x}} + x^{\frac{3}{2}}\right) dx</math></p> $\Rightarrow y\sqrt{x} = 2\sqrt{x} + \frac{2x^{\frac{5}{2}}}{5} + C, \text{ or } y = 2 + \frac{2x^{\frac{5}{2}}}{5\sqrt{x}} + \frac{C}{\sqrt{x}}$ <p><b>OR</b></p>	1/2
Q27(b)	<p>Solve the following differential equation :</p> $xe^{\frac{y}{x}} - y + x\frac{dy}{dx} = 0$	1
Ans	<p>(b) Given differential equation is <math>\frac{dy}{dx} = \frac{y}{x} - e^{\frac{y}{x}}</math></p> <p>Let <math>y = vx \Rightarrow \frac{dy}{dx} = v + x\frac{dv}{dx}</math></p> <p>The given equation becomes <math>v + x\frac{dv}{dx} = v - e^v</math></p> $\Rightarrow -e^{-v} dv = \frac{dx}{x}$ <p>Integrating both sides, we get</p> $e^{-v} = \log x  + C$ $\Rightarrow e^{-\frac{y}{x}} = \log x  + C$	1/2
Q28	<p>Evaluate :</p> $\int_0^{\pi/4} \log(1 + \tan x) dx$	1/2

Ans	$\text{Let } I = \int_0^{\pi/4} \log(1 + \tan x) dx$ $= \int_0^{\pi/4} \log(1 + \tan(\frac{\pi}{4} - x)) dx \quad [\text{Using } \int_0^a f(x) dx = \int_0^a f(a - x) dx]$ $= \int_0^{\pi/4} \log \left(1 + \frac{1 - \tan x}{1 + \tan x}\right) dx$ $= \int_0^{\pi/4} \log \frac{2}{1 + \tan x} dx$ $2I = \int_0^{\pi/4} \log 2 dx = \frac{\pi}{4} \log 2$ $I = \frac{\pi}{8} \log 2$	1 1 1
Q29(a)	<b>Find:</b> $\int \frac{\cos x}{\sin 3x} dx$	
Ans	(a) $I = \int \frac{\cos x}{3 \sin x - 4 \sin^3 x} dx$ Let $\sin x = t \Rightarrow \cos x dx = dt$ $I = \int \frac{dt}{3t - 4t^3}$ $= \int \frac{1}{t^3( \frac{3}{t^2} - 4)} dt$ Let $\frac{3}{t^2} - 4 = z \Rightarrow -\frac{6}{t^3} dt = dz$ $I = -\frac{1}{6} \int \frac{dz}{z}$ $= -\frac{1}{6} \log  z  + C$ $= -\frac{1}{6} \log  3 \cosec^2 x - 4  + C$	1/2 1/2 1/2 1/2 1/2 1/2
OR		
Q29(b)	<b>Find:</b>	
	$\int x^2 \log(x^2 + 1) dx$	
Ans	(b) Let $I = \int x^2 \log(x^2 + 1) dx$ $= \log(x^2 + 1) \cdot \frac{x^3}{3} - \int \frac{2x}{x^2 + 1} \cdot \frac{x^3}{3} dx$ $= \frac{x^3}{3} \log(x^2 + 1) - \frac{2}{3} \int \frac{x^4}{x^2 + 1} dx$	1 1/2

	$= \frac{x^3}{3} \log(x^2 + 1) - \frac{2}{3} \int \left( x^2 - 1 + \frac{1}{x^2 + 1} \right) dx$ $= \frac{x^3}{3} \log(x^2 + 1) - \frac{2}{3} \left[ \frac{x^3}{3} - x + \tan^{-1} x \right] + C$	1½
Q30	<p>Find :</p> $\int_1^4 \frac{1}{\sqrt{2x+1} - \sqrt{2x-1}} dx$	1
Ans	<p>Let <math>I = \int_1^4 \frac{1}{\sqrt{2x+1} - \sqrt{2x-1}} dx</math></p> $= \int_1^4 \frac{\sqrt{2x+1} + \sqrt{2x-1}}{2} dx$ $= \frac{(2x+1)^{3/2}}{3 \times 2} + \frac{(2x-1)^{3/2}}{3 \times 2} \Big _1^4$ $= \left( \frac{27}{6} + \frac{7^{3/2}}{6} \right) - \left( \frac{3^{3/2}}{6} + \frac{1}{6} \right)$ $= \frac{26 + 7^{3/2} - 3^{3/2}}{6} \text{ or } \frac{26 + 7\sqrt{7} - 3\sqrt{3}}{6}$	1½
Q31	<p>Solve the following linear programming problem graphically :</p> <p>Minimize <math>z = x + 2y</math></p> <p>subject to the constraints</p> $2x + y \geq 3,$ $x + 2y \geq 6,$ $x \geq 0,$ $y \geq 0.$	
Ans	Correct graph	2



	<p>Corner points</p> <p>(0, 3)</p> <p>(6, 0)</p> <p>The half plane <math>x + 2y &lt; 6</math> has no point common with feasible region. Hence, minimum <math>z = 6</math> at all points on line segment AB</p>	<p>Value of <math>Z = x + 2y</math></p> <p><math>6 \rightarrow</math> Minimum</p> <p><math>6 \rightarrow</math> Minimum</p>	1
	<b>SECTION D</b>		
Q32(a)	<p>Find the value of <math>b</math> so that the lines <math>\frac{x-1}{2} = \frac{y-b}{3} = \frac{z-3}{4}</math> and <math>\frac{x-4}{5} = \frac{y-1}{2} = z</math> are intersecting lines. Also, find the point of intersection of these given lines.</p>		
Ans	<p>(a) As lines are intersecting, <math>(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2) = 0</math></p> $\Rightarrow \begin{vmatrix} 3 & 1-b & -3 \\ 2 & 3 & 4 \\ 5 & 2 & 1 \end{vmatrix} = 0$ $\Rightarrow b = 2$ <p>Any point on the line <math>\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}</math> is <math>(2\lambda + 1, 3\lambda + 2, 4\lambda + 3)</math>, <math>\lambda \in \mathbb{R}</math></p> <p>For the point of intersection, this point must lie on the line</p> $\frac{x-4}{5} = \frac{y-1}{2} = z$ $\Rightarrow \frac{2\lambda + 1 - 4}{5} = \frac{3\lambda + 2 - 1}{2} = 4\lambda + 3$ $\Rightarrow \lambda = -1$ <p><math>\therefore</math> point of intersection is <math>(-1, -1, -1)</math></p> <p style="text-align: center;"><b>OR</b></p>		
Q32(b)	<p>Find the equations of all the sides of the parallelogram ABCD whose vertices are A(4, 7, 8), B(2, 3, 4), C(-1, -2, 1) and D(1, 2, 5). Also, find the coordinates of the foot of the perpendicular from A to CD.</p>		
Ans	<p>(b) Equation of the line AB : <math>\frac{x-4}{2} = \frac{y-7}{4} = \frac{z-8}{4}</math></p>		

	<p>Equation of the line BC : <math>\frac{x-2}{3} = \frac{y-3}{5} = \frac{z-4}{3}</math></p> <p>Equation of the line CD : <math>\frac{x+1}{1} = \frac{y+2}{2} = \frac{z-1}{2}</math></p> <p>Equation of the line DA : <math>\frac{x-4}{3} = \frac{y-7}{5} = \frac{z-8}{3}</math></p> <p>Let P be foot of perpendicular from A to CD.</p> <p><math>\therefore</math> Coordinates of P are <math>(\lambda - 1, 2\lambda - 2, 2\lambda + 1)</math> for some <math>\lambda</math></p> <p>d.r.'s of AP are <math>(\lambda - 5, 2\lambda - 9, 2\lambda - 7)</math></p> <p>since <math>AP \perp CD</math></p> <p><math>\Rightarrow 1(\lambda - 5) + 2(2\lambda - 9) + 2(2\lambda - 7) = 0</math></p> <p><math>\Rightarrow 9\lambda = 37 \Rightarrow \lambda = \frac{37}{9}</math></p> <p><math>\therefore</math> Coordinates of P are <math>\left(\frac{28}{9}, \frac{56}{9}, \frac{83}{9}\right)</math></p>	$\frac{1}{2}$
Q33	<p>Check whether a function <math>f : \mathbb{R} \rightarrow \left[-\frac{1}{2}, \frac{1}{2}\right]</math> defined as <math>f(x) = \frac{x}{1+x^2}</math> is one-one and onto or not.</p>	
Ans	<p>Let <math>f(x_1) = f(x_2) \Rightarrow \frac{x_1}{1+x_1^2} = \frac{x_2}{1+x_2^2}</math></p> <p><math>\Rightarrow x_1 + x_1 x_2^2 = x_2 + x_1^2 x_2</math></p> <p><math>\Rightarrow (x_1 - x_2)(1 - x_1 x_2) = 0</math></p> <p>for <math>x_1 = 2, x_2 = \frac{1}{2}</math></p> <p>we have <math>(x_1 - x_2)(1 - x_1 x_2) = 0</math> but <math>x_1 \neq x_2</math></p> <p><math>\Rightarrow f</math> is not one-one.</p> <p>Let <math>x \in R</math> such that <math>f(x) = y \Rightarrow y = \frac{x}{1+x^2}</math></p> <p><math>x^2 y - x + y = 0</math></p> <p><math>\Rightarrow x = \frac{1 \pm \sqrt{1-4y^2}}{2y} (y \neq 0)</math>.</p> <p>[For <math>y = 0 \in [-\frac{1}{2}, \frac{1}{2}]</math>, we have <math>0 \in R</math> such that <math>f(0) = 0</math>]</p> <p><math>x \neq 0, x \in R \Rightarrow 1 - 4y^2 \geq 0, y \neq 0</math></p>	$\frac{1}{2}$ for one-one

	$\Rightarrow y \in \left[-\frac{1}{2}, \frac{1}{2}\right] - \{0\}$ . Also, $y = 0$ when $x = 0$ $\therefore \text{Range} = \left[-\frac{1}{2}, \frac{1}{2}\right] = \text{Codomain}$ $\therefore f$ is onto.	$2\frac{1}{2}$ for onto
Q34	<p>The area of the region bounded by the line <math>y = mx</math> (<math>m &gt; 0</math>), the curve <math>x^2 + y^2 = 4</math> and the x-axis in the first quadrant is <math>\frac{\pi}{2}</math> units. Using integration, find the value of <math>m</math>.</p>	
Ans	<p><math>x^2 + y^2 = 4</math> and <math>y = mx</math></p> $\Rightarrow x^2 + m^2 x^2 = 4 \Rightarrow x = \frac{2}{\sqrt{1+m^2}}$ <p>x- coordinate of the required point of intersection is <math>\frac{2}{\sqrt{1+m^2}}</math>.</p> <p>According to question,</p> $\int_0^{\frac{2}{\sqrt{1+m^2}}} mx \, dx + \int_{\frac{2}{\sqrt{1+m^2}}}^2 \sqrt{4-x^2} \, dx = \frac{\pi}{2}$ $\Rightarrow m \frac{x^2}{2} \Big _0^{\frac{2}{\sqrt{1+m^2}}} + \frac{x}{2} \sqrt{4-x^2} + 2 \sin^{-1} \frac{x}{2} \Big _{\frac{2}{\sqrt{1+m^2}}}^2 = \frac{\pi}{2}$ $\Rightarrow \frac{2m}{1+m^2} + \pi - \frac{2m}{1+m^2} - 2 \sin^{-1} \frac{1}{\sqrt{1+m^2}} = \frac{\pi}{2}$ $\Rightarrow \frac{\pi}{4} = \sin^{-1} \frac{1}{\sqrt{1+m^2}}$	1 for correct figure 1 1+1 1/2

	$\Rightarrow \frac{1}{\sqrt{2}} = \frac{1}{\sqrt{1+m^2}} \Rightarrow m^2 + 1 = 2$ $\Rightarrow m = 1 \text{ (as } m > 0)$	$\frac{1}{2}$
Q35(a)	<p>If <math>A = \begin{bmatrix} 1 &amp; 0 &amp; 2 \\ 0 &amp; 2 &amp; 1 \\ 2 &amp; 0 &amp; 3 \end{bmatrix}</math>, then show that <math>A^3 - 6A^2 + 7A + 2I = 0</math></p>	
Ans	<p>(a) getting, <math>A^2 = \begin{bmatrix} 5 &amp; 0 &amp; 8 \\ 2 &amp; 4 &amp; 5 \\ 8 &amp; 0 &amp; 13 \end{bmatrix}</math></p> <p>getting, <math>A^3 = \begin{bmatrix} 21 &amp; 0 &amp; 34 \\ 12 &amp; 8 &amp; 23 \\ 34 &amp; 0 &amp; 55 \end{bmatrix}</math></p> $\therefore A^3 - 6A^2 + 7A + 2I =$ $\begin{bmatrix} 21 & 0 & 34 \\ 12 & 8 & 23 \\ 34 & 0 & 55 \end{bmatrix} - \begin{bmatrix} 30 & 0 & 48 \\ 12 & 24 & 30 \\ 48 & 0 & 78 \end{bmatrix} + \begin{bmatrix} 7 & 0 & 14 \\ 0 & 14 & 7 \\ 14 & 0 & 21 \end{bmatrix} + \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$ $= \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = 0$ <p style="text-align: center;"><b>OR</b></p>	$\frac{1}{2}$ $\frac{1}{2}$ 1 1
Q35(b)	<p>If <math>A = \begin{bmatrix} 3 &amp; 2 \\ 5 &amp; -7 \end{bmatrix}</math>, then find <math>A^{-1}</math> and use it to solve the following system of equations :</p> $3x + 5y = 11, \quad 2x - 7y = -3.$	
Ans	<p>(b) <math>\text{adj } A = \begin{bmatrix} -7 &amp; -2 \\ -5 &amp; 3 \end{bmatrix}</math></p> $ A  = -31$ $A^{-1} = \frac{-1}{31} \begin{bmatrix} -7 & -2 \\ -5 & 3 \end{bmatrix}$ <p>Given system of equations is <math>\begin{bmatrix} 3 &amp; 5 \\ 2 &amp; -7 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 11 \\ -3 \end{bmatrix}</math></p> <p>which is <math>A'X = B</math>, where <math>X = \begin{bmatrix} x \\ y \end{bmatrix}, B = \begin{bmatrix} 11 \\ -3 \end{bmatrix}</math></p> $\Rightarrow X = (A')^{-1}B$	1 1 $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

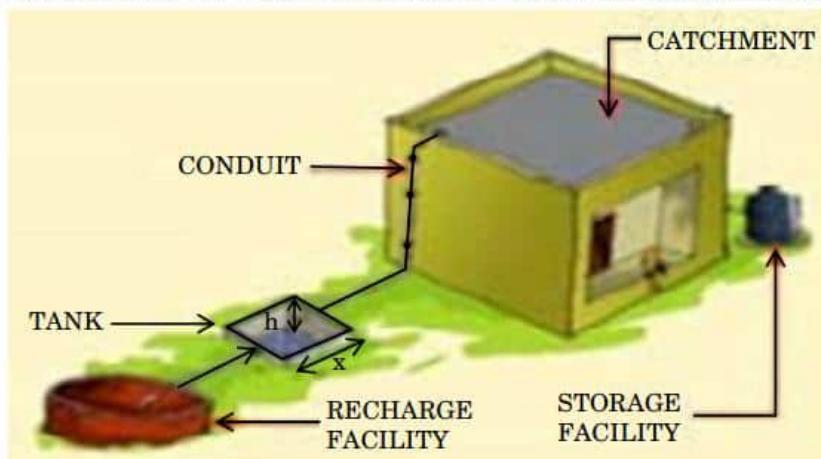
	$\Rightarrow X = (A^{-1})'B$ $= \frac{-1}{31} \begin{bmatrix} -7 & -5 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} 11 \\ -3 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$ $\therefore x = 2, y = 1$	$\frac{1}{2}$ $1$
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### SECTION E

Q36

In order to set up a rain water harvesting system, a tank to collect rain water is to be dug. The tank should have a square base and a capacity of  $250 \text{ m}^3$ . The cost of land is ₹ 5,000 per square metre and cost of digging increases with depth and for the whole tank, it is ₹  $40,000 h^2$ , where  $h$  is the depth of the tank in metres.  $x$  is the side of the square base of the tank in metres.

#### ELEMENTS OF A TYPICAL RAIN WATER HARVESTING SYSTEM



Based on the above information, answer the following questions :

(i) Find the total cost  $C$  of digging the tank in terms of  $x$ .

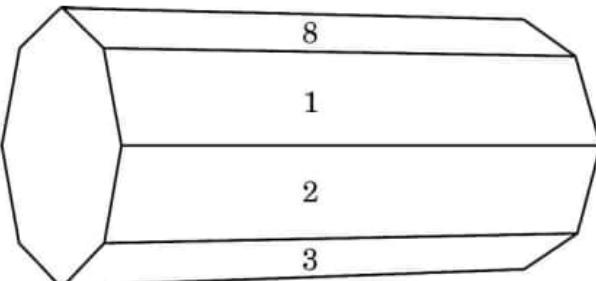
(ii) Find  $\frac{dC}{dx}$ .

(iii) (a) Find the value of  $x$  for which cost  $C$  is minimum.

**OR**

(iii) (b) Check whether the cost function  $C(x)$  expressed in terms of  $x$  is increasing or not, where  $x > 0$ .

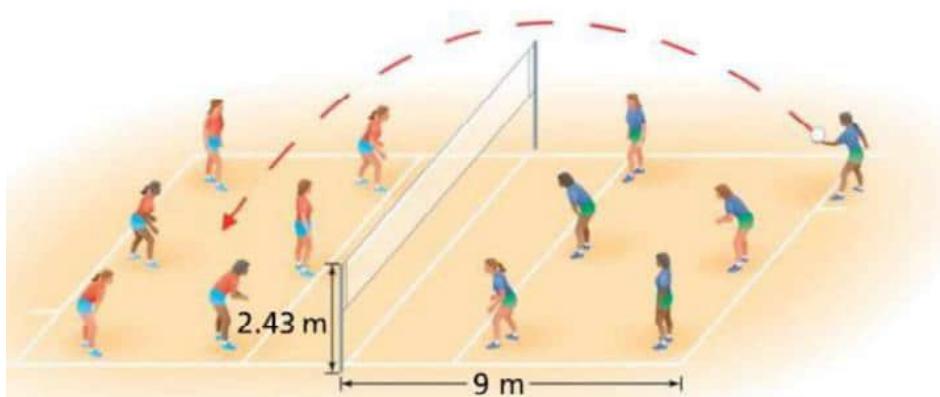
Ans(i)	$(i) C = 40000h^2 + 5000x^2$ $\text{as } x^2h = 250$ $\Rightarrow C = \frac{40000(250)^2}{x^4} + 5000x^2$	$\frac{1}{2}$ $\frac{1}{2}$
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Ans(ii)	(ii) $\frac{dC}{dx} = \frac{-160000 (250)^2}{x^5} + 10000x$	1																		
Ans(iii)	<p>(iii)(a) For minimum cost <math>\frac{dC}{dx} = 0</math></p> $\Rightarrow 10000x^6 = 250 \times 250 \times 160000$ $\Rightarrow x = 10$ <p>showing <math>\frac{d^2C}{dx^2} &gt; 0</math> at <math>x = 10</math></p> <p><math>\therefore</math> cost is minimum when <math>x = 10</math></p>	$\frac{1}{2}$ 1 $\frac{1}{2}$																		
	<b>OR</b>																			
Ans(iii)	<p>(iii)(b) <math>\frac{dC}{dx} = \frac{-160000 (250)^2}{x^4} + 10000x</math></p> $\frac{dC}{dx} = 0$ gives $x = 10$ <p><math>\frac{dC}{dx} &gt; 0</math> in <math>(10, \infty)</math> and <math>\frac{dC}{dx} &lt; 0</math> in <math>(0, 10)</math>.</p> <p>Hence, cost function is neither increasing nor decreasing for <math>x &gt; 0</math></p>	$\frac{1}{2}$ 1 $\frac{1}{2}$																		
Q37	<p>An octagonal prism is a three-dimensional polyhedron bounded by two octagonal bases and eight rectangular side faces. It has 24 edges and 16 vertices.</p>  <p>The prism is rolled along the rectangular faces and number on the bottom face (touching the ground) is noted. Let <math>X</math> denote the number obtained on the bottom face and the following table give the probability distribution of <math>X</math>.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td><math>X :</math></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> </tr> <tr> <td><math>P(X) :</math></td> <td><math>p</math></td> <td><math>2p</math></td> <td><math>2p</math></td> <td><math>p</math></td> <td><math>2p</math></td> <td><math>p^2</math></td> <td><math>2p^2</math></td> <td><math>7p^2 + p</math></td> </tr> </table>	$X :$	1	2	3	4	5	6	7	8	$P(X) :$	$p$	$2p$	$2p$	$p$	$2p$	$p^2$	$2p^2$	$7p^2 + p$	
$X :$	1	2	3	4	5	6	7	8												
$P(X) :$	$p$	$2p$	$2p$	$p$	$2p$	$p^2$	$2p^2$	$7p^2 + p$												

	<p>Based on the above information, answer the following questions :</p> <p>(i) Find the value of p.</p> <p>(ii) Find <math>P(X &gt; 6)</math>.</p> <p>(iii) (a) Find <math>P(X = 3m)</math>, where m is a natural number.</p> <p style="text-align: center;"><b>OR</b></p> <p>(iii) (b) Find the mean <math>E(X)</math>.</p>	
Ans(i)	<p>(i) <math>10p^2 + 9p = 1</math></p> $\Rightarrow p = \frac{1}{10}$	$\frac{1}{2}$ $\frac{1}{2}$
Ans(ii)	<p>(ii) <math>P(X &gt; 6) = 9p^2 + p</math></p> $= \frac{9}{100} + \frac{1}{10}$ $= \frac{19}{100}$	$\frac{1}{2}$ $\frac{1}{2}$
Ans(iii)	<p>(iii)(a) <math>P(X = 3 m) = P(3) + P(6)</math></p> $\Rightarrow 2p + p^2 = \frac{21}{100}$ <p style="text-align: center;"><b>OR</b></p>	1 1
Ans(iii)	<p>(iii)(b)</p> $E(X) = \sum X P(X) = p + 4p + 6p + 4p + 10p + 6p^2 + 14p^2 + 56p^2 + 8p$ $= 33p + 76p^2$ $= \frac{406}{100} \text{ or } \frac{203}{50}$	1 $\frac{1}{2}$ $\frac{1}{2}$

Q38

A volleyball player serves the ball which takes a parabolic path given by the equation  $h(t) = -\frac{7}{2}t^2 + \frac{13}{2}t + 1$ , where  $h(t)$  is the height of ball at any time  $t$  (in seconds),  $(t \geq 0)$ .



Based on the above information, answer the following questions :

- Is  $h(t)$  a continuous function ? Justify.
- Find the time at which the height of the ball is maximum.

Ans(i)

$$(i) h(t) = -\frac{7}{2}t^2 + \frac{13}{2}t + 1$$

Clearly  $h(t)$  is a polynomial function, hence continuous.

2

Hence  $h(t)$  is a continuous function.

Ans(ii)

(ii) For maximum height ,

$$\frac{dh}{dt} = 0 \Rightarrow -7t + \frac{13}{2} = 0$$

$$\Rightarrow t = \frac{13}{14}$$

$$\frac{d^2h}{dt^2} = -7 < 0 \therefore \text{height is maximum at } t = \frac{13}{14}$$

1

1/2

1/2