

Series : W1XZY



SET ~ 3



रोल नं.

Roll No.

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प्रश्न-पत्र कोड  
Q.P. Code

65/1/3

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

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.



**General Instructions :**

**Read the following instructions very carefully and strictly follow them :**

- (i) *This Question paper contains 38 questions. All questions are compulsory.*
- (ii) *Question paper is divided into FIVE Sections – Section A, B, C, D and E.*
- (iii) *In Section A – Question Number 1 to 18 are Multiple Choice Questions (MCQs) and Question Number 19 & 20 are Assertion-Reason based questions of 1 mark each.*
- (iv) *In Section B – Question Number 21 to 25 are Very Short Answer (VSA) type questions, carrying 2 marks each.*
- (v) *In Section C – Question Number 26 to 31 are Short Answer (SA) type questions, carrying 3 marks each.*
- (vi) *In Section D – Question Number 32 to 35 are Long Answer (LA) type questions, carrying 5 marks each.*
- (vii) *In Section E – Question 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, 3 questions in Section – C, 2 questions in Section – D and 2 questions in Section – E.*
- (ix) *Use of calculator is NOT allowed.*

**SECTION – A**

This section comprises of 20 Multiple Choice Questions (MCQs) of 1 mark each.

$$20 \times 1 = 20$$

1. If the feasible region of a linear programming problem with objective function  $Z = ax + by$ , is bounded, then which of the following is correct ?
- (A) It will only have a maximum value.
  - (B) It will only have a minimum value.
  - (C) It will have both maximum and minimum values.
  - (D) It will have neither maximum nor minimum value.



2. The unit vector perpendicular to the vectors  $\hat{i} - \hat{j}$  and  $\hat{i} + \hat{j}$  is

(A)  $\hat{k}$  (B)  $-\hat{k} + \hat{j}$

(C)  $\frac{\hat{i} - \hat{j}}{\sqrt{2}}$  (D)  $\frac{\hat{i} + \hat{j}}{\sqrt{2}}$

3. If  $\int_0^1 \frac{e^x}{1+x} dx = \alpha$ , then  $\int_0^1 \frac{e^x}{(1+x)^2} dx$  is equal to

(A)  $\alpha - 1 + \frac{e}{2}$  (B)  $\alpha + 1 - \frac{e}{2}$

(C)  $\alpha - 1 - \frac{e}{2}$  (D)  $\alpha + 1 + \frac{e}{2}$

4. If  $\int \frac{2^x}{x^2} dx = k \cdot 2^{\frac{1}{x}} + C$ , then k is equal to

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

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

5. If  $A = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ , then  $A^{-1}$  is

(A)  $\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$

(B)  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$

(C)  $\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

(D)  $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$



6. If  $\begin{bmatrix} x+y & 3y \\ 3x & x+3 \end{bmatrix} = \begin{bmatrix} 9 & 4x+y \\ x+6 & y \end{bmatrix}$ , then  $(x-y) = ?$
- (A)  $-7$  (B)  $-3$   
(C)  $3$  (D)  $7$
7. Let  $M$  and  $N$  be two events such that  $P(M) = 0.6$ ,  $P(N) = 0.2$  and  $P(M \cap N) = 0.5$ , then  $P(M'/N')$  is
- (A)  $\frac{7}{8}$  (B)  $\frac{2}{5}$   
(C)  $\frac{1}{2}$  (D)  $\frac{2}{3}$
8. Which of the following is not a homogeneous function of  $x$  and  $y$  ?
- (A)  $y^2 - xy$  (B)  $x - 3y$   
(C)  $\sin^2 \frac{y}{x} + \frac{y}{x}$  (D)  $\tan x - \sec y$
9. If  $\vec{a} + \vec{b} + \vec{c} = \vec{0}$ ,  $|\vec{a}| = \sqrt{37}$ ,  $|\vec{b}| = 3$  and  $|\vec{c}| = 4$ , then angle between  $\vec{b}$  and  $\vec{c}$  is
- (A)  $\frac{\pi}{6}$  (B)  $\frac{\pi}{4}$   
(C)  $\frac{\pi}{3}$  (D)  $\frac{\pi}{2}$
10. If  $f(x) = |x| + |x-1|$ , then which of the following is correct ?
- (A)  $f(x)$  is both continuous and differentiable, at  $x = 0$  and  $x = 1$ .  
(B)  $f(x)$  is differentiable but not continuous, at  $x = 0$  and  $x = 1$ .  
(C)  $f(x)$  is continuous but not differentiable, at  $x = 0$  and  $x = 1$ .  
(D)  $f(x)$  is neither continuous nor differentiable, at  $x = 0$  and  $x = 1$ .



11. A system of linear equations is represented as  $AX = B$ , where  $A$  is coefficient matrix,  $X$  is variable matrix and  $B$  is the constant matrix. Then the system of equations is

- (A) Consistent, if  $|A| \neq 0$ , solution is given by  $X = BA^{-1}$ .
- (B) Inconsistent if  $|A| = 0$  and  $(\text{adj } A) B = 0$
- (C) Inconsistent if  $|A| \neq 0$
- (D) May or may not be consistent if  $|A| = 0$  and  $(\text{adj } A) B = 0$

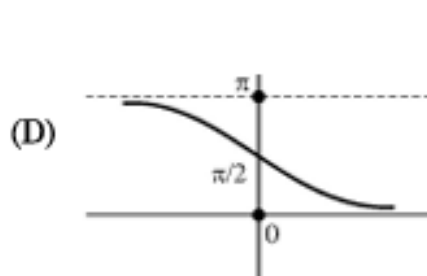
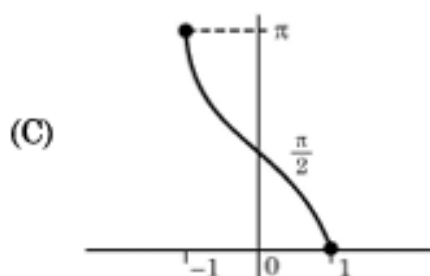
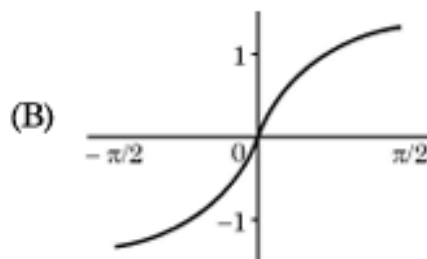
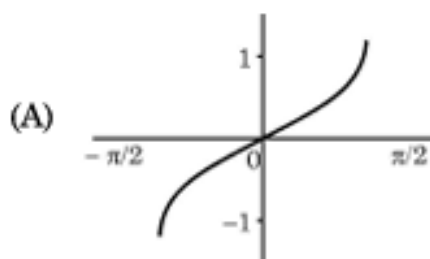
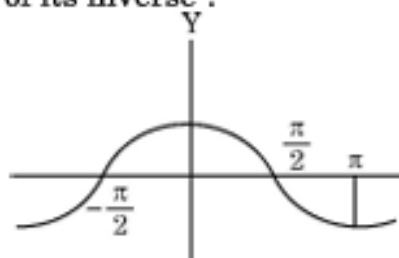
12. The absolute maximum value of function  $f(x) = x^3 - 3x + 2$  in  $[0, 2]$  is :

- (A) 0
- (B) 2
- (C) 4
- (D) 5

13. The order and degree of differential function  $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^5 = \frac{d^2y}{dx^2}$  are

- (A) order 1, degree 1
- (B) order 1, degree 2
- (C) order 2, degree 1
- (D) order 2, degree 2

14. The graph of a trigonometric function is as shown. Which of the following will represent graph of its inverse ?





15. The corner points of the feasible region in graphical representation of a L.P.P. are (2, 72), (15, 20) and (40, 15). If  $Z = 18x + 9y$  be the objective function, then

- (A)  $Z$  is maximum at (2, 72), minimum at (15, 20)  
 (B)  $Z$  is maximum at (15, 20) minimum at (40, 15)  
 (C)  $Z$  is maximum at (40, 15), minimum at (15, 20)  
 (D)  $Z$  is maximum at (40, 15), minimum at (2, 72)

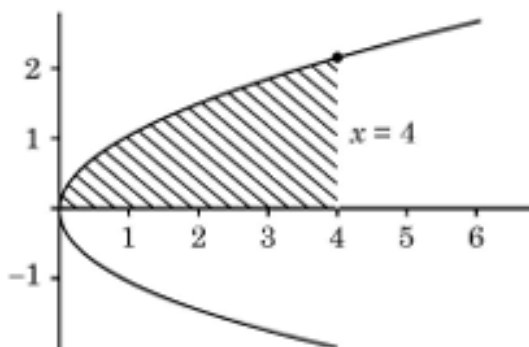
16. Let  $A = \begin{bmatrix} 1 & -2 & -1 \\ 0 & 4 & -1 \\ -3 & 2 & 1 \end{bmatrix}$ ,  $B = \begin{bmatrix} -2 \\ -5 \\ -7 \end{bmatrix}$ ,  $C = [9 \ 8 \ 7]$ , which of the following is defined ?

- (A) Only AB (B) Only AC  
 (C) Only BA (D) All AB, AC and BA

17. If  $A$  and  $B$  are invertible matrices, then which of the following is not correct ?

- (A)  $(A + B)^{-1} = B^{-1} + A^{-1}$  (B)  $(AB)^{-1} = B^{-1}A^{-1}$   
 (C)  $\text{adj}(A) = |A| A^{-1}$  (D)  $|A|^{-1} = |A^{-1}|$

18. The area of the shaded region bounded by the curves  $y^2 = x$ ,  $x = 4$  and the  $x$ -axis is given by



- (A)  $\int_0^4 x \, dx$  (B)  $\int_0^2 y^2 \, dy$   
 (C)  $2 \int_0^4 \sqrt{x} \, dx$  (D)  $\int_0^4 \sqrt{x} \, dx$



### Assertion – Reason Based Questions

**Direction :** Question numbers 19 and 20 are Assertion (A) and Reason (R) based questions carrying 1 mark each. Two statements are given, one labelled Assertion (A) and other labelled Reason (R). Select the correct answer from the options (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and the 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) :**  $f(x) = \begin{cases} 3x - 8, & x \leq 5 \\ 2k, & x > 5 \end{cases}$

is continuous at  $x = 5$  for  $k = \frac{5}{2}$ .

**Reason (R) :** For a function  $f$  to be continuous at  $x = a$ ,

$$\lim_{x \rightarrow a^-} f(x) = \lim_{x \rightarrow a^+} f(x) = f(a).$$

20. **Assertion (A) :** Let  $Z$  be the set of integers. A function  $f : Z \rightarrow Z$  defined as  $f(x) = 3x - 5, \forall x \in Z$  is a bijective.

**Reason (R) :** A function is a bijective if it is both surjective and injective.

### SECTION – B

5 × 2 = 10

This section comprises of 5 Very Short Answer (VSA) type questions of 2 marks each.

21. The diagonals of a parallelogram are given by  $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$  and  $\vec{b} = \hat{i} + 3\hat{j} - \hat{k}$ . Find the area of the parallelogram.

22. Find the values of 'a' for which  $f(x) = \sqrt{3} \sin x - \cos x - 2ax + b$  is decreasing on  $\mathbb{R}$ .



23. (a) Two friends while flying kites from different locations, find the strings of their kites crossing each other. The strings can be represented by vectors  $\vec{a} = 3\hat{i} + \hat{j} + 2\hat{k}$  and  $\vec{b} = 2\hat{i} - 2\hat{j} + 4\hat{k}$ . Determine the angle formed between the kite strings. Assume there is no slack in the strings.

**OR**

- (b) Find a vector of magnitude 21 units in the direction opposite to that of  $\vec{AB}$  where A and B are the points A(2, 1, 3) and B(8, -1, 0) respectively.

24. Solve for  $x$ ,

$$2 \tan^{-1} x + \sin^{-1} \left( \frac{2x}{1+x^2} \right) = 4\sqrt{3}$$

25. (a) Differentiate  $2^{\cos^2 x}$  w.r.t  $\cos^2 x$ .

**OR**

- (b) If  $\tan^{-1}(x^2 + y^2) = a^2$ , then find  $\frac{dy}{dx}$ .

### SECTION – C

**6 × 3 = 18**

This section comprises of 6 Short Answer (SA) type questions of 3 marks each.

26. Solve the following linear programming problem graphically :

Maximize  $Z = 8x + 9y$

Subject to the constraints :

$$2x + 3y \leq 6$$

$$3x - 2y \leq 6$$

$$y \leq 1$$

$$x \geq 0, y \geq 0$$

27. (a) Find :  $\int \frac{2x-1}{(x-1)(x+2)(x-3)} dx$

**OR**

- (b) Evaluate :  $\int_0^5 (|x-1| + |x-2| + |x-5|) dx$





28. A spherical medicine ball when dropped in water dissolves in such a way that the rate of decrease of volume at any instant is proportional to its surface area. Calculate the rate of decrease of its radius.
29. Sketch the graph of  $y = |x + 3|$  and find the area of the region enclosed by the curve,  $x$ -axis, between  $x = -6$  and  $x = 0$ , using integration.
30. (a) Verify that lines given by  $\vec{r} = (1 - \lambda)\hat{i} + (\lambda - 2)\hat{j} + (3 - 2\lambda)\hat{k}$  and  $\vec{r} = (\mu + 1)\hat{i} + (2\mu - 1)\hat{j} - (2\mu + 1)\hat{k}$  are skew lines. Hence, find shortest distance between the lines.

**OR**

- (b) During a cricket match, the position of the bowler, the wicket keeper and the leg slip fielder are in a line given by  $\vec{B} = 2\hat{i} + 8\hat{j}$ ,  $\vec{W} = 6\hat{i} + 12\hat{j}$  and  $\vec{F} = 12\hat{i} + 18\hat{j}$  respectively. Calculate the ratio in which the wicketkeeper divides the line segment joining the bowler and the leg slip fielder.
31. (a) The probability distribution for the number of students being absent in a class on a Saturday is as follows :

<b>X</b>	0	2	4	5
<b>P(X)</b>	p	2p	3p	p

Where X is the number of students absent.

- (i) Calculate p. 1
- (ii) Calculate the mean of the number of absent students on Saturday. 2

**OR**

- (b) For the vacancy advertised in the newspaper, 3000 candidates submitted their applications. From the data it was revealed that two third of the total applicants were females and other were males. The selection for the job was done through a written test. The performance of the applicants indicates that the probability of a male getting a distinction in written test is 0.4 and that a female getting a distinction is 0.35. Find the probability that the candidate chosen at random will have a distinction in the written test.

**SECTION – D** **$4 \times 5 = 20$** 

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

32. A school wants to allocate students into three clubs : Sports, Music and Drama, under following conditions :

- The number of students in Sports club should be equal to the sum of the number of students in Music and Drama club.
- The number of students in Music club should be 20 more than half the number of students in Sports club.
- The total number of students to be allocated in all three clubs are 180.

Find the number of students allocated to different clubs, using matrix method.

33. Find :  $\int \sin^{-1} \sqrt{\frac{x}{a+x}} dx$ .

34. (a) If  $\sqrt{1-x^2} + \sqrt{1-y^2} = a(x-y)$ , then prove that  $\frac{dy}{dx} = \sqrt{\frac{1-y^2}{1-x^2}}$ .

**OR**

(b) If  $x = a \left( \cos \theta + \log \tan \frac{\theta}{2} \right)$  and  $y = \sin \theta$ , then find  $\frac{d^2y}{dx^2}$  at  $\theta = \frac{\pi}{4}$ .

35. (a) Find the image A' of the point A(1, 6, 3) in the line  $\frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3}$ .  
Also, find the equation of the line joining A and A'.

**OR**

- (b) Find a point P on the line  $\frac{x+5}{1} = \frac{y+3}{4} = \frac{z-6}{-9}$  such that its distance from point Q(2, 4, -1) is 7 units. Also, find the equation of line joining P and Q.



### SECTION – E

3 × 4 = 12

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

36. A class-room teacher is keen to assess the learning of her students the concept of “relations” taught to them. She writes the following five relations each defined on the set  $A = \{1, 2, 3\}$  :

$$R_1 = \{(2, 3), (3, 2)\}$$

$$R_2 = \{(1, 2), (1, 3), (3, 2)\}$$

$$R_3 = \{(1, 2), (2, 1), (1, 1)\}$$

$$R_4 = \{(1, 1), (1, 2), (3, 3), (2, 2)\}$$

$$R_5 = \{(1, 1), (1, 2), (3, 3), (2, 2), (2, 1), (2, 3), (3, 2)\}$$

The students are asked to answer the following questions about the above relations :

- (i) Identify the relation which is reflexive, transitive but not symmetric.
- (ii) Identify the relation which is reflexive and symmetric but not transitive.
- (iii) (a) Identify the relations which are symmetric but neither reflexive nor transitive.

**OR**

- (iii) (b) What pairs should be added to the relation  $R_2$  to make it an equivalence relation ?

37.



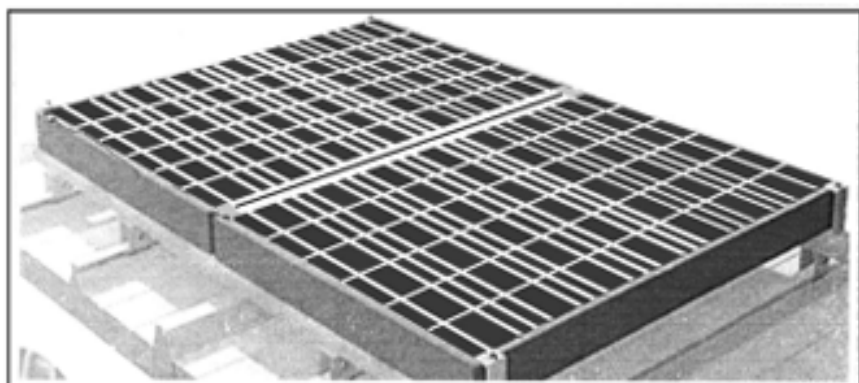
A bank offers loan to its customers on different types of interest namely, fixed rate, floating rate and variable rate. From the past data with the bank, it is known that a customer avails loan on fixed rate, floating rate or variable rate with probabilities 10%, 20% and 70% respectively. A customer after availing loan can pay the loan or default on loan repayment. The bank data suggests that the probability that a person defaults on loan after availing it at fixed rate, floating rate and variable rate is 5%, 3% and 1% respectively.

Based on the above information, answer the following :

- (i) What is the probability that a customer after availing the loan will default on the loan repayment ? 2
- (ii) A customer after availing the loan, defaults on loan repayment. What is the probability that he availed the loan at a variable rate of interest ? 2



38.



A technical company is designing a rectangular solar panel installation on a roof using 300 metres of boundary material. The design includes a partition running parallel to one of the sides dividing the area (roof) into two sections.

Let the length of the side perpendicular to the partition be  $x$  metres and with parallel to the partition be  $y$  metres.

Based on this information, answer the following questions :

- (i) Write the equation for the total boundary material used in the boundary and parallel to the partition in terms of  $x$  and  $y$ . 1
- (ii) Write the area of the solar panel as a function of  $x$ . 1
- (iii) (a) Find the critical points of the area function. Use second derivative test to determine critical points at the maximum area. Also, find the maximum area. 2

**OR**

- (iii) (b) Using first derivative test, calculate the maximum area the company can enclose with the 300 metres of boundary material, considering the parallel partition. 2