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Your JEE Guide

ISC Class XII · Mathematics

Sample Question Paper 5 · Session 2026-27

Time allowed: 3 hours (plus 15 minutes reading time) **Maximum marks: 80**

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This is an original practice paper written to the CISCE 2027 specimen paper format; it is not issued by CISCE.

General instructions:

1. You are allowed an additional fifteen minutes for only reading the question paper. You must NOT start writing during the reading time.
2. The paper consists of twenty questions and four sections: Sections A, B, C and D.
3. All questions are compulsory.
4. Section A consists of very short answer questions of 1 mark each. Section B consists of short answer questions of 2 marks each. Section C consists of moderately long answer questions of 3 marks each. Section D consists of long answer questions of 5 marks each.
5. Internal choices have been provided in three questions each in Sections B, C and D.
6. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
7. The intended marks for questions or parts of questions are given in brackets [ ].
8. All workings, including rough work, should be done on the same page as, and adjacent to, the rest of the answer.

Section A (20 marks)

1.	**(i)** The relation R on $\mathbb{N}$ defined by aRb if and only if a divides b is: (a) reflexive and transitive but not symmetric (b) an equivalence relation (c) reflexive and symmetric but not transitive (d) symmetric but not reflexive	1
	(ii) The function f: $\mathbb{R} \to \mathbb{R}$, f(x) = sin x is: (a) one-one but not onto (b) one-one and onto (c) onto but not one-one (d) neither one-one nor onto	1
	(iii) The value of $\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{3}$ is: (a) $\frac{\pi}{2}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{6}$	1
	(iv) The range of the principal value branch of $\cos^{-1} x$ is: (a) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ (b) [0, π] (c) (0, π) (d) $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$	1

	(v) If A is a square matrix of order 3 with |A| = –4, then $\lvert AA' \rvert$ equals: (a) 64 (b) –64 (c) 16 (d) –16	1
	(vi) In a 2 × 3 matrix with entries $a_{ij} = i + j$, the entry a_{23} is: (a) 5 (b) 3 (c) 4 (d) 6	1
	(vii) Statement I: The derivative of a differentiable even function is an odd function. **Statement II:** $\frac{d}{dx}\cos x = \sin x$. (a) Both the statements are true. (b) Both the statements are false. (c) Statement I is false and Statement II is true. (d) Statement I is true and Statement II is false.	1
	(viii) If $y = x^x$, then $\frac{dy}{dx}$ at x = 1 is: (a) e (b) 1 (c) 0 (d) 2	1
	(ix) The function f(x) = cos x is strictly decreasing on: (a) (π, 2π) (b) (0, π) (c) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ (d) (0, 2π)	1
	(x) $\int \frac{\log x}{x}\, dx$ equals: (a) $\log(\log x) + C$ (b) $(\log x)^2 + C$ (c) $\frac{(\log x)^2}{2} + C$ (d) $\frac{1}{x} + C$	1
	(xi) $\int_0^{\pi} \sin^2 x\, dx$ equals: (a) 0 (b) $\frac{\pi}{4}$ (c) π (d) $\frac{\pi}{2}$	1
	(xii) The solution of $\frac{dy}{dx} = 3x^2$ with y = 2 when x = 0 is: (a) $y = x^3 + 2$ (b) $y = 6x + 2$ (c) $y = x^3 - 2$ (d) $y = 2x^3$	1
	(xiii) The vectors $2\hat{i} + \hat{j}$ and $\hat{i} - 2\hat{j}$ are: (a) equal in direction (b) inclined at 60° (c) parallel (d) perpendicular	1
	(xiv) The direction ratios of the line $\frac{x-2}{3} = \frac{1-y}{2} = \frac{z}{5}$ are: (a) –3, 2, 5 (b) 3, 2, 5 (c) 3, –2, 5 (d) 2, 1, 0	1

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	(xv) For events A and B, $P(A) = \frac{1}{2}$, $P(B) = \frac{1}{3}$ and $P(A \cup B) = \frac{2}{3}$. Then A and B are: (a) mutually exclusive (b) independent (c) complementary (d) exhaustive	1
	(xvi) Assertion: $f(x) = x^3$ is one-one on $\mathbb{R}$. **Reason:** f is strictly increasing on $\mathbb{R}$. (a) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. (c) Assertion is true and Reason is false. (d) Assertion is false and Reason is true.	1
	(xvii) Assertion: If |A| = 0 for a square matrix A, then A^{-1} does not exist. **Reason:** |AB| = |A||B| for square matrices of the same order. (a) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. (c) Assertion is true and Reason is false. (d) Assertion is false and Reason is true.	1
	(xviii) Find x if $\begin{vmatrix} 2 & 3 \\ x & 5 \end{vmatrix} = 1$.	1
	(xix) Find the maximum value of $f(x) = -(x-1)^2 + 10$.	1
	(xx) Find a unit vector in the direction of $\vec{a} + \vec{b}$, where $\vec{a} = 2\hat{i} + 2\hat{j} - 5\hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} + 3\hat{k}$.	1

Section B (14 marks)

2.	If $f(x) = 8x^3$ and $g(x) = x^{1/3}$, find g ∘ f and f ∘ g.	2
3.	Show that $\sin^{-1}\frac{3}{5} - \sin^{-1}\frac{8}{17} = \cos^{-1}\frac{84}{85}$.	2
4.	If $y = e^x \sin x$, show that $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$. **OR** If $x = a\cos^3\theta$ and $y = a\sin^3\theta$, find $\frac{dy}{dx}$.	2
5.	Find the slope of the tangent to the curve $y = \frac{x-1}{x-2}$ at x = 10.	2
6.	Find $\int \frac{dx}{x^2 + 8x + 20}$. **OR** Find $\int \frac{e^{2x} - 1}{e^{2x} + 1}\,dx$.	2

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7.	Show that the lines $\frac{x-1}{2} = \frac{y+3}{-1} = \frac{z-2}{3}$ and $\frac{x+2}{1} = \frac{y-4}{5} = \frac{z}{1}$ are perpendicular. **OR** Find the vector equation of the plane through the point (1, 0, –2) with normal $\hat{i} + \hat{j} - \hat{k}$.	2
8.	A die is thrown. E is the event “the number is a multiple of 3” and F is the event “the number is even”. Are E and F independent?	2

Section C (21 marks)

9.	Find the inverse of $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix}$. **OR** Using properties of determinants, prove that $\begin{vmatrix} 1 & 1 & 1 \\ a & b & c \\ a^3 & b^3 & c^3 \end{vmatrix} = (a-b)(b-c)(c-a)(a+b+c)$.	3
10.	Show that f(x) = |x – 1| + |x – 2| is continuous at every real number but is not differentiable at x = 1 and x = 2.	3
11.	(a) Find $\frac{dy}{dx}$ if $y = \tan^{-1}\left(\frac{3x-x^3}{1-3x^2}\right)$, $-\frac{1}{\sqrt{3}} < x < \frac{1}{\sqrt{3}}$. *[1½]* (b) Differentiate $\sin^{-1}\left(\frac{2x}{1+x^2}\right)$ with respect to $\tan^{-1} x$, for –1 < x < 1. *[1½]*	3
12.	Find the absolute maximum and minimum values of $f(x) = 4x - \frac{x^2}{2}$ on [–2, 4.5]. **OR** Show that the tangents to the curve $y = 7x^3 + 11$ at x = 2 and x = –2 are parallel, and find their equations.	3
13.	Find $\int \frac{x^3 + 2x + 3}{x^2 - 4}\, dx$.	3
14.	Evaluate $\int_0^1 x(1-x)^5\, dx$. **OR** Evaluate $\int_0^{\pi/2} \frac{\cos x}{1 + \sin^2 x}\, dx$.	3
15.	Form the differential equation of the family of curves $y = ae^{3x} + be^{-2x}$, where a and b are arbitrary constants.	3

Section D (25 marks)

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16.	Use the matrix method to solve: x + y + 2z = 9, 2x + y + z = 7, x + 2y + z = 8.	5
17.	Find the point on the parabola $y^2 = 4x$ nearest to the point (2, 1), and the least distance. **OR** A right circular cylinder is inscribed in a right circular cone of height 12 cm and base radius 6 cm, with its base on the base of the cone. Find the height and radius of the cylinder of greatest volume, and that volume.	5
18.	Using integration, find the area of the smaller region bounded by the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ and the line $\frac{x}{3} + \frac{y}{2} = 1$. **OR** Using integration, find the area enclosed between the curves y = sin x and y = cos x from x = 0 to $x = \frac{\pi}{2}$.	5
19.	(a) Solve the differential equation $(x^2 + 1)\frac{dy}{dx} + 2xy = \frac{1}{x^2+1}$, given that y = 0 when x = 0. *[4]* (b) Hence find the value of y when x = 1. *[1]*	5
20.	A machine is correctly adjusted 90% of the time. When it is correctly adjusted, 95% of its items are good; otherwise only 60% are good. (a) Find the probability that an item chosen at random is good. *[2]* (b) An item is found to be good. Find the probability that the machine was correctly adjusted. *[2]* (c) An item is found to be defective. Find the probability that the machine was not correctly adjusted. *[1]* **OR** (a) Show that the lines $\vec{r} = (\hat{i} + \hat{j}) + \lambda(\hat{i} + 2\hat{j} + 2\hat{k})$ and $\vec{r} = (2\hat{i} + 3\hat{j} + \hat{k}) + \mu(\hat{i} + 2\hat{j} + 2\hat{k})$ are parallel, and find the distance between them. *[3]* (b) Find the equation of the plane containing both lines. *[2]*	5

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Section A (20 marks)

Question 1

(i) **(a)** reflexive and transitive but not symmetric. *Working:* a divides a; a | b and b | c give a | c; but 2 | 4 while 4 does not divide 2.

(ii) **(d)** neither one-one nor onto. *Working:* sin 0 = sin π, so not one-one; the range is [–1, 1], so not onto $\mathbb{R}$.

(iii) **(c)** $\frac{\pi}{4}$. *Working:* $\tan^{-1}\frac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{6}} = \tan^{-1}1$.

(iv) **(b)** [0, π]. *Working:* By definition.

(v) **(c)** 16. *Working:* $|AA'| = |A||A'| = (-4)(-4)$.

(vi) **(a)** 5. *Working:* 2 + 3 = 5.

(vii) **(d)** Statement I is true and Statement II is false. *Working:* If f(–x) = f(x), then –f′(–x) = f′(x), so f′ is odd. The derivative of cos x is –sin x, so Statement II is false.

(viii) **(b)** 1. *Working:* $\frac{dy}{dx} = x^x(1+\log x) = 1$ at x = 1.

(ix) **(b)** (0, π). *Working:* f′(x) = –sin x < 0 on (0, π).

(x) **(c)** $\frac{(\log x)^2}{2} + C$. *Working:* Put t = log x.

(xi) **(d)** $\frac{\pi}{2}$. *Working:* $\int_0^{\pi}\frac{1-\cos 2x}{2}dx = \frac{\pi}{2}$.

(xii) **(a)** $y = x^3 + 2$. *Working:* $y = x^3 + C$ and y(0) = 2.

(xiii) **(d)** perpendicular. *Working:* Their dot product is 2 – 2 = 0.

(xiv) **(c)** 3, –2, 5. *Working:* $\frac{1-y}{2} = \frac{y-1}{-2}$.

(xv) **(b)** independent. *Working:* $P(A\cap B) = \frac{1}{2}+\frac{1}{3}-\frac{2}{3} = \frac{1}{6} = P(A)P(B)$.

(xvi) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. *Working:* A strictly increasing function never takes the same value twice, so the Reason explains the Assertion.

(xvii) **(b)** Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. *Working:* Both are true. The Assertion follows from $A^{-1} = \frac{\operatorname{adj}A}{|A|}$, which needs |A| ≠ 0; the product rule for determinants is a different fact.

(xviii) 10 – 3x = 1 (½), so x = 3 (½).

(xix) $-(x-1)^2 \le 0$ (½), so the maximum is 10, at x = 1 (½).

(xx) $\vec{a}+\vec{b} = 4\hat{i}+3\hat{j}-2\hat{k}$, magnitude $\sqrt{29}$ (½). Unit vector $\frac{1}{\sqrt{29}}(4\hat{i}+3\hat{j}-2\hat{k})$ (½).

Section B (14 marks)

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2. (g ∘ f)(x) $= (8x^3)^{1/3} = 2x$ (1). (f ∘ g)(x) $= 8(x^{1/3})^3 = 8x$ (1).

3. Let $\sin A = \frac{3}{5}$, $\sin B = \frac{8}{17}$; then $\cos A = \frac{4}{5}$, $\cos B = \frac{15}{17}$ (½). $\cos(A - B) = \frac{4}{5} \cdot \frac{15}{17} + \frac{3}{5} \cdot \frac{8}{17} = \frac{84}{85}$ (1). As A – B lies in [0, π], $A - B = \cos^{-1} \frac{84}{85}$ (½).

4. $y' = e^x(\sin x + \cos x)$ and $y'' = 2e^x \cos x$ (1). Then $2e^x \cos x - 2e^x(\sin x + \cos x) + 2e^x \sin x = 0$ (1).

OR $\frac{dx}{d\theta} = -3a\cos^2\theta \sin\theta$, $\frac{dy}{d\theta} = 3a \sin^2\theta \cos\theta$ (1). $\frac{dy}{dx} = -\tan\theta$ (1).

5. $\frac{dy}{dx} = \frac{(x-2)-(x-1)}{(x-2)^2} = -\frac{1}{(x-2)^2}$ (1). At x = 10 the slope is $-\frac{1}{64}$ (1).

6. $x^2 + 8x + 20 = (x+4)^2 + 2^2$ (1). Integral $= \frac{1}{2}\tan^{-1}\frac{x+4}{2} + C$ (1).

OR Dividing by e^x: $\int \frac{e^x - e^{-x}}{e^x + e^{-x}} dx$ (1) $= \log(e^x + e^{-x}) + C$ (1).

7. Direction ratios 2, –1, 3 and 1, 5, 1 (1). 2(1) + (–1)(5) + 3(1) = 0, so the lines are perpendicular (1).

OR $(\vec{r} - \vec{a}) \cdot \vec{n} = 0$ (1): $\vec{r} \cdot (\hat{i} + \hat{j} - \hat{k}) = 1 + 0 + 2 = 3$ (1).

8. P(E) = 1/3, P(F) = 1/2, and E ∩ F = {6}, so P(E ∩ F) = 1/6 (1). Since P(E ∩ F) = P(E) P(F), they are independent (1).

Section C (21 marks)

9. |A| = 1 (½). $\operatorname{adj} A = \begin{bmatrix} 1 & -2 & 5 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}$ (2). $A^{-1} = \operatorname{adj} A$ (½).

OR $C_2 \to C_2 - C_1$, $C_3 \to C_3 - C_1$ and taking out (b – a)(c – a): $\begin{vmatrix} 1 & 1 \\ b^2 + ab + a^2 & c^2 + ca + a^2 \end{vmatrix}$ (1½). This equals $(c - b)(a + b + c)$ (1). Collecting the factors gives the result (½).

10. f is a sum of continuous functions, so continuous (1). For x < 1, f = 3 – 2x; for 1 < x < 2, f = 1; for x > 2, f = 2x – 3 (1). At x = 1 the one-sided derivatives are –2 and 0; at x = 2 they are 0 and 2, so f is not differentiable at either point (1).

11. (a) With x = tan θ, $y = \tan^{-1}(\tan 3\theta) = 3\tan^{-1} x$ (1), so $\frac{dy}{dx} = \frac{3}{1+x^2}$ (½). (b) With x = tan θ, $\sin^{-1}(\sin 2\theta) = 2\tan^{-1} x$ (1), so the derivative with respect to $\tan^{-1} x$ is 2 (½).

12. f′(x) = 4 – x = 0 at x = 4 (1). f(–2) = –10, f(4) = 8, f(4.5) = 7.875 (1). Absolute maximum 8 at x = 4; absolute minimum –10 at x = –2 (1).

OR $\frac{dy}{dx} = 21x^2 = 84$ at both points, so the tangents are parallel (1). At (2, 67): y = 84x – 101 (1). At (–2, –45): y = 84x + 123 (1).

13. $\frac{x^3 + 2x + 3}{x^2 - 4} = x + \frac{6x+3}{x^2-4}$ (1). $\frac{6x+3}{(x-2)(x+2)} = \frac{15/4}{x-2} + \frac{9/4}{x+2}$ (1). Integral $= \frac{x^2}{2} + \frac{15}{4}\log|x-2| + \frac{9}{4}\log|x+2| + C$ (1).

14. Using $\int_0^a f(x)dx = \int_0^a f(a-x)dx$: $\int_0^1 (1-x)x^5\,dx$ (1) $= \left[\frac{x^6}{6} - \frac{x^7}{7}\right]_0^1$ (1) $= \frac{1}{42}$ (1).

OR Put t = sin x, dt = cos x dx; t goes from 0 to 1 (1). $\int_0^1 \frac{dt}{1+t^2} = [\tan^{-1} t]_0^1$ (1) $= \frac{\pi}{4}$ (1).

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15. $y' = 3ae^{3x} - 2be^{-2x}$, $y'' = 9ae^{3x} + 4be^{-2x}$ (1). Then $y'' - y' = 6ae^{3x} + 6be^{-2x} = 6y$ (1½). The equation is $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 6y = 0$ (½).

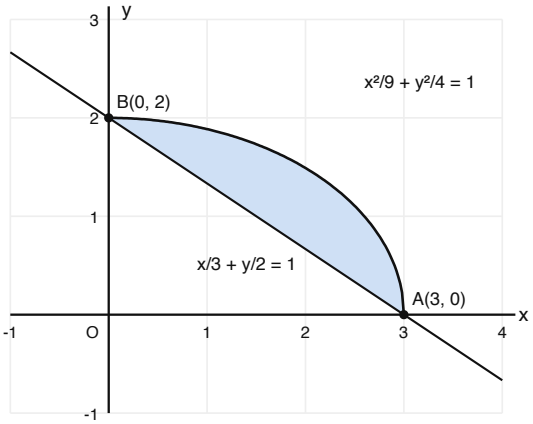
Section D (25 marks)

16. $A = \begin{bmatrix} 1 & 1 & 2 \\ 2 & 1 & 1 \\ 1 & 2 & 1 \end{bmatrix}$, |A| = 1(−1) − 1(1) + 2(3) = 4 (1). $\operatorname{adj} A = \begin{bmatrix} -1 & 3 & -1 \\ -1 & -1 & 3 \\ 3 & -1 & -1 \end{bmatrix}$ (2). $X = \frac{1}{4}\begin{bmatrix} -1 & 3 & -1 \\ -1 & -1 & 3 \\ 3 & -1 & -1 \end{bmatrix}\begin{bmatrix} 9 \\ 7 \\ 8 \end{bmatrix} = \frac{1}{4}\begin{bmatrix} 4 \\ 8 \\ 12 \end{bmatrix}$ (1), so x = 1, y = 2, z = 3 (1).

17. A point of the parabola is $(t^2, 2t)$; $D = (t^2 - 2)^2 + (2t - 1)^2$ is the squared distance (1). $\frac{dD}{dt} = 4t(t^2 - 2) + 4(2t - 1) = 4t^3 - 4$ (1½). t = 1, and D changes from decreasing to increasing there (1). The point is (1, 2) (½); least distance $= \sqrt{1 + 1} = \sqrt{2}$ units (1).

OR By similar triangles, the radius is $r = 6 - \frac{h}{2}$ (1). $V = \pi\left(6 - \frac{h}{2}\right)^2 h$ (1). $\frac{dV}{dh} = \pi\left(6 - \frac{h}{2}\right)\left(6 - \frac{3h}{2}\right) = 0$ gives h = 4 (h = 12 gives no cylinder) (1½). V changes from increasing to decreasing at h = 4 (½). r = 4 cm, h = 4 cm, V = 64π cm³ (1).

18. Sketch (1):



Area $= \int_0^3 \frac{2}{3}\sqrt{9 - x^2}\,dx - \int_0^3 \left(2 - \frac{2x}{3}\right)dx$ (1). The first integral is $\frac{2}{3} \cdot \frac{9\pi}{4} = \frac{3\pi}{2}$ (1½); the second is 3 (1). Area $= \frac{3\pi}{2} - 3 = \frac{3}{2}(\pi - 2)$ square units (½).

OR The curves cross at $x = \frac{\pi}{4}$ (1). Area $= \int_0^{\pi/4}(\cos x - \sin x)dx + \int_{\pi/4}^{\pi/2}(\sin x - \cos x)dx$ (1) $= (\sqrt{2} - 1) + (\sqrt{2} - 1)$ (2) $= 2\sqrt{2} - 2$ square units (1).

19. (a) The left side is $\frac{d}{dx}\left[(x^2 + 1)y\right]$ (1½). So $(x^2 + 1)y = \int \frac{dx}{1 + x^2} = \tan^{-1} x + C$ (1½). y(0) = 0 gives C = 0: $y = \frac{\tan^{-1} x}{1 + x^2}$ (1). (b) $y(1) = \frac{\pi/4}{2} = \frac{\pi}{8}$ (1).

20. (a) P(G) = 0.9 × 0.95 + 0.1 × 0.6 = 0.855 + 0.06 = 0.915 (2). (b) $\frac{0.855}{0.915} = \frac{57}{61}$ (2). (c) P(D) = 0.085, so $\frac{0.1 \times 0.4}{0.085} = \frac{8}{17}$ (1).

OR (a) They have the same direction $\vec{b} = (1, 2, 2)$ (½). $\vec{a}_2 - \vec{a}_1 = (1, 2, 1)$; $\vec{b} \times (\vec{a}_2 - \vec{a}_1) = (-2, 1, 0)$ (1). Distance $= \frac{\sqrt{5}}{3}$ units (1½). (b) Normal (–2, 1, 0) through (1, 1, 0) (1): –2(x – 1) + (y – 1) = 0, i.e. 2x – y = 1 (1).

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