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Your JEE Guide

MP Board Class XII · Higher Mathematics

Sample Question Paper 7 · Session 2026-27

Time allowed: 3 hours **Maximum marks: 80**

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This is an original practice paper written to the MPBSE 2027 sample question paper pattern; it is not issued by MPBSE.

General instructions:

1. All questions are compulsory.
2. Sub-questions of question numbers 1 to 5 carry 1 mark each.
3. Question numbers 6 to 15 carry 2 marks each.
4. Question numbers 16 to 19 carry 3 marks each.
5. Question numbers 20 to 23 carry 4 marks each.
6. Internal choices are provided for question numbers 16 to 23.
7. Draw neat and clean labelled diagrams wherever required.

1.	**(i)** *Choose and write the correct option:* If $f(x) = \frac{1}{x}$ for x ≠ 0, then (f ∘ f)(x) is: (a) x^2 (b) x (c) $\frac{1}{x}$ (d) 1	1
	(ii) The domain of $\cos^{-1}(x-1)$ is: (a) [–2, 0] (b) [–1, 1] (c) [1, 2] (d) [0, 2]	1
	(iii) If $A = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$, then A^{-1} is: (a) 2I (b) I (c) $\frac{1}{2}I$ (d) 4I	1
	(iv) $\frac{d}{dx}(2^x)$ equals: (a) $2^x \log 2$ (b) $x2^{x-1}$ (c) $\frac{2^x}{\log 2}$ (d) 2^x	1
	(v) $\int e^x \left(\log x + \frac{1}{x}\right) dx$ equals: (a) $e^x + \log x + C$ (b) $e^x\left(\log x - \frac{1}{x}\right) + C$ (c) $e^x \log x + C$ (d) $\frac{e^x}{x} + C$	1
	(vi) Two dice are thrown. The probability that the sum of the numbers is 7 is: (a) $\frac{7}{36}$ (b) $\frac{1}{6}$ (c) $\frac{5}{36}$ (d) $\frac{1}{12}$	1

2.	**(i)** *Fill in the blanks:* The function f(x) = x on a set is called the _____ function.	1
	(ii) The principal value branch of $\sec^{-1} x$ is $[0, \pi] - \{$ _____ $\}$.	1
	(iii) If A is a square matrix with $A^2 = I$, then A^{-1} = _____.	1
	(iv) $\frac{d}{dx}(\sin^{-1} x + \cos^{-1} x)$ = _____.	1
	(v) If f is an odd function, then $\int_{-a}^{a} f(x)\,dx$ = _____.	1
	(vi) If $\hat{a}$ is a unit vector, then $\lvert 3\hat{a} \rvert$ = _____.	1
3.	**(i)** *Write True or False:* The composition of two bijective functions is bijective.	1
	(ii) $\tan^{-1}\left(\tan \frac{2\pi}{3}\right) = \frac{2\pi}{3}$.	1
	(iii) Every diagonal matrix is symmetric.	1
	(iv) Every polynomial function is continuous.	1
	(v) $\int \log x\,dx = x \log x - x + C$.	1
	(vi) P(A ∪ B) = P(A) + P(B) for any two events A and B.	1
4.	Match column A with column B:	7

Column A	Column B
(i) $\frac{d}{dx}(x \log x)$	(a) $e^{\sin x} \cos x$
(ii) $\frac{d}{dx} e^{\sin x}$	(b) P(A) P(B)
(iii) $\int \frac{dx}{x^2}$	(c) 1
(iv) $\int_0^{\pi/2} \sin x\,dx$	(d) $-\frac{1}{x} + C$
(v) $\lvert \hat{i} - \hat{j} \rvert$	(e) $\sqrt{2}$
(vi) P(A ∩ B) for independent A and B	(f) I
(vii) I^{-1}, I the identity matrix	(g) 1 + log x

5.	**(i)** *Write the answer in one word or one sentence:* Write the number of relations on the set {1, 2, 3}.	1
	(ii) Write the value of $\tan\left(\cos^{-1} \frac{1}{2}\right)$.	1
	(iii) Write x if $\begin{vmatrix} x & 3 \\ 2 & x \end{vmatrix} = \begin{vmatrix} 4 & 3 \\ 2 & 4 \end{vmatrix}$.	1
	(iv) Write $\frac{d}{dx} \log(5x)$, x > 0.	1

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	(v) Write the value of $\int_{-2}^{2} \lvert x \rvert \, dx$.	1
	(vi) Write the scalar projection of $\hat{i} + \hat{j} + \hat{k}$ on $\hat{j}$.	1
	(vii) If A and B are independent with P(A) = 0.5 and P(B) = 0.4, write P(A′ ∩ B′).	1
6.	Show that f: $\mathbb{R} \to \mathbb{R}$, $f(x) = x^3 + 1$ is one-one.	2
7.	Find the value of $\sin^{-1}\left(\sin \frac{3\pi}{5}\right)$.	2
8.	Find x and y if $\begin{bmatrix} x+y & 2 \\ 5 & x-y \end{bmatrix} = \begin{bmatrix} 6 & 2 \\ 5 & 2 \end{bmatrix}$.	2
9.	If A is a square matrix of order 3 with |A| = 3, find |adj A| and |2A|.	2
10.	Find $\frac{dy}{dx}$ if $y = \sin^3(2x)$.	2
11.	Show that $f(x) = e^x + x$ is strictly increasing on $\mathbb{R}$.	2
12.	Find $\int \sin 3x \cos 2x \, dx$.	2
13.	Evaluate $\int_0^1 \frac{dx}{\sqrt{1-x^2}}$.	2
14.	Find the unit vector in the direction of $\vec{a} + \vec{b}$, where $\vec{a} = 3\hat{i} - \hat{j} + 2\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$.	2
15.	If P(A) = 1/2, P(B) = 1/3 and P(A ∩ B) = 1/6, are A and B independent? Justify.	2
16.	For the relation R = {(1, 2), (2, 1)} on the set {1, 2, 3}, check whether R is reflexive, symmetric and transitive. **OR** Solve $\tan^{-1}(x+1) + \tan^{-1}(x-1) = \tan^{-1}\frac{8}{31}$.	3
17.	If $y = \frac{\sin^{-1} x}{\sqrt{1-x^2}}$, show that $(1-x^2)\frac{dy}{dx} - xy = 1$. **OR** Find $\frac{dy}{dx}$ if $y = (\sin x)^{\tan x}$, 0 < x < π/2.	3
18.	Find $\int \frac{x}{(x+1)(x+3)} \, dx$. **OR** Evaluate $\int_{-1}^{1} (x^5 + 3x^3 + 2) \, dx$.	3

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19.	Urn A has 2 white and 4 black balls; urn B has 5 white and 3 black balls. A coin is tossed: on a head a ball is drawn from A, on a tail from B. The ball drawn is white. Find the probability that it came from urn A. **OR** A random variable X takes the values 1, 2 and 3 with probabilities 0.2, 0.5 and 0.3. Find its mean and variance.	3
20.	Solve by the matrix method: 3x + y + z = 4, x + 2y − z = −3, 2x − y + 3z = 9. **OR** Find the inverse of $A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ using the adjoint.	4
21.	Find two numbers whose sum is 16 and the sum of whose cubes is the least. **OR** Find the absolute maximum and minimum values of f(x) = x + 2 cos x on [0, π].	4
22.	Using integration, find the area of the smaller region cut off from the circle $x^2 + y^2 = 16$ by the line x = 2. **OR** Find $\int \sqrt{x^2 + 6x + 13}\, dx$.	4
23.	Solve the differential equation $\frac{dy}{dx} = \frac{y}{x} + \frac{x}{y}$, x > 0. **OR** Solve graphically: Maximise Z = 2x + 5y subject to x + y ≤ 7, x + 3y ≤ 15, x ≥ 0, y ≥ 0.	4

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Answers and Marking Scheme

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

Question 1

(i) **(b)** x. *Working:* $f\left(\frac{1}{x}\right) = x$.

(ii) **(d)** [0, 2]. *Working:* −1 ≤ x − 1 ≤ 1.

(iii) **(c)** $\frac{1}{2}I$. *Working:* A = 2I.

(iv) **(a)** $2^x \log 2$. *Working:* $\frac{d}{dx}a^x = a^x \log a$.

(v) **(c)** $e^x \log x + C$. *Working:* It is $\int e^x[f(x) + f'(x)]dx$ with f(x) = log x.

(vi) **(b)** $\frac{1}{6}$. *Working:* 6 of the 36 outcomes.

Question 2

(i) identity.

(ii) $\frac{\pi}{2}$.

(iii) A.

(iv) 0.

(v) 0.

(vi) 3.

Question 3

(i) True.

(ii) False: it is $-\frac{\pi}{3}$, since the principal range is $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

(iii) True.

(iv) True.

(v) True.

(vi) False: this holds only when A and B are mutually exclusive.

4. (i) – (g) 1 + log x; (ii) – (a) $e^{\sin x}\cos x$; (iii) – (d) $-\frac{1}{x} + C$; (iv) – (c) 1; (v) – (e) $\sqrt{2}$; (vi) – (b) P(A) P(B); (vii) – (f) I

Question 5

(i) $2^9 = 512$.

(ii) $\sqrt{3}$.

(iii) $x^2 - 6 = 10$, so $x = \pm 4$.

(iv) $\frac{1}{x}$.

(v) 4.

(vi) 1.

(vii) 0.5 × 0.6 = 0.3.

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6. f(a) = f(b) ⇒ $a^3 + 1 = b^3 + 1 \Rightarrow a^3 = b^3$ (1) ⇒ a = b, so f is one-one (1).

7. $\frac{3\pi}{5}$ is not in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$; $\sin\frac{3\pi}{5} = \sin\left(\pi - \frac{3\pi}{5}\right) = \sin\frac{2\pi}{5}$ (1). Value $= \frac{2\pi}{5}$ (1).

8. x + y = 6 and x – y = 2 (1), so x = 4, y = 2 (1).

9. $|\operatorname{adj} A| = |A|^2 = 9$ (1). $|2A| = 2^3|A| = 24$ (1).

10. $\frac{dy}{dx} = 3\sin^2(2x)\cdot\cos(2x)\cdot 2$ (1) $= 6\sin^2(2x)\cos(2x)$ (1).

11. $f'(x) = e^x + 1$ (1), which is positive for every real x (1).

12. $\sin 3x\cos 2x = \frac{1}{2}(\sin 5x + \sin x)$ (1). Integral $= -\frac{\cos 5x}{10} - \frac{\cos x}{2} + C$ (1).

13. $[\sin^{-1} x]_0^1$ (1) $= \frac{\pi}{2}$ (1).

14. $\vec{a} + \vec{b} = 4\hat{i} + \hat{j} + 3\hat{k}$, magnitude $\sqrt{26}$ (1). Unit vector $= \frac{1}{\sqrt{26}}(4\hat{i} + \hat{j} + 3\hat{k})$ (1).

15. P(A)P(B) = 1/2 × 1/3 = 1/6 (1), which equals P(A ∩ B), so A and B are independent (1).

16. (1, 1) ∉ R, so R is not reflexive (1). For each (a, b) in R, (b, a) is in R, so R is symmetric (1). (1, 2) and (2, 1) are in R but (1, 1) is not, so R is not transitive (1).

OR $\tan^{-1}\frac{2x}{1-(x^2-1)} = \tan^{-1}\frac{8}{31}$, so $\frac{2x}{2-x^2} = \frac{8}{31}$ (1). This gives $4x^2 + 31x - 8 = 0$, i.e. (4x – 1)(x + 8) = 0 (1). x = –8 makes the left side negative, so $x = \frac{1}{4}$ (1).

17. $y\sqrt{1-x^2} = \sin^{-1} x$ (1). Differentiating: $\sqrt{1-x^2}\frac{dy}{dx} - \frac{xy}{\sqrt{1-x^2}} = \frac{1}{\sqrt{1-x^2}}$ (1). Multiplying by $\sqrt{1-x^2}$ gives the result (1).

OR log y = tan x · log sin x (1). $\frac{1}{y}\frac{dy}{dx} = \sec^2 x\log\sin x + \tan x\cdot\frac{\cos x}{\sin x} = \sec^2 x\log\sin x + 1$ (1). $\frac{dy}{dx} = (\sin x)^{\tan x}(1 + \sec^2 x\log\sin x)$ (1).

18. $\frac{x}{(x+1)(x+3)} = \frac{A}{x+1} + \frac{B}{x+3}$: x = –1 gives $A = -\frac{1}{2}$, x = –3 gives $B = \frac{3}{2}$ (1½). Integral $= -\frac{1}{2}\log|x+1| + \frac{3}{2}\log|x+3| + C$ (1½).

OR $x^5 + 3x^3$ is an odd function, so its integral over [–1, 1] is 0 (1½). $\int_{-1}^{1} 2\,dx = 4$, so the value is 4 (1½).

19. P(A) = P(B) = ½, P(W | A) = 2/6 = 1/3, P(W | B) = 5/8 (1). P(A | W) $= \frac{\frac{1}{2}\cdot\frac{1}{3}}{\frac{1}{2}\cdot\frac{1}{3} + \frac{1}{2}\cdot\frac{5}{8}}$ (1) $= \frac{8/24}{23/24} = \frac{8}{23}$ (1).

OR Mean = 0.2 + 1.0 + 0.9 = 2.1 (1). $E(X^2)$ = 0.2 + 2.0 + 2.7 = 4.9 (1). Variance = 4.9 – 2.1^2 = 4.9 – 4.41 = 0.49 (1).

20. $A = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 2 & -1 \\ 2 & -1 & 3 \end{bmatrix}$, |A| = 3(6 – 1) – 1(3 + 2) + 1(–1 – 4) = 5 (1). $\operatorname{adj} A = \begin{bmatrix} 5 & -4 & -3 \\ -5 & 7 & 4 \\ -5 & 5 & 5 \end{bmatrix}$ (1½). $X = \frac{1}{5}\begin{bmatrix} 5 \\ -5 \\ 10 \end{bmatrix}$ (1), so x = 1, y = –1, z = 2 (½).

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OR |A| = 2(4 − 1) + 1(−2 + 1) + 1(1 − 2) = 4 (1). $\operatorname{adj} A = \begin{bmatrix} 3 & 1 & -1 \\ 1 & 3 & 1 \\ -1 & 1 & 3 \end{bmatrix}$ (2). $A^{-1} = \frac{1}{4}\begin{bmatrix} 3 & 1 & -1 \\ 1 & 3 & 1 \\ -1 & 1 & 3 \end{bmatrix}$ (1).

21. Let the numbers be x and 16 − x; $S = x^3 + (16 - x)^3$ (1). $\frac{dS}{dx} = 3x^2 - 3(16 - x)^2 = 0$ gives x = 8 (1). $\frac{d^2S}{dx^2} = 6x + 6(16 - x) = 96 > 0$, a minimum (1). The numbers are 8 and 8 (1).

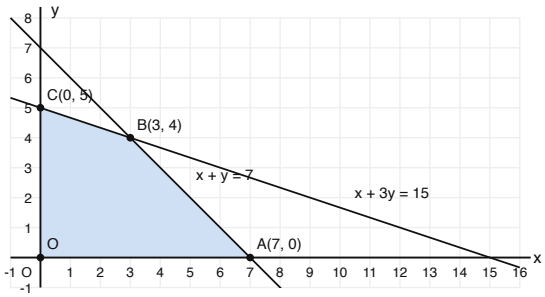
OR f′(x) = 1 − 2 sin x = 0 gives $x = \frac{\pi}{6}, \frac{5\pi}{6}$ (1). f(0) = 2, $f\left(\frac{\pi}{6}\right) = \frac{\pi}{6} + \sqrt{3} \approx 2.26$, $f\left(\frac{5\pi}{6}\right) = \frac{5\pi}{6} - \sqrt{3} \approx 0.89$, f(π) = π − 2 ≈ 1.14 (2). Absolute maximum $\frac{\pi}{6} + \sqrt{3}$ at $x = \frac{\pi}{6}$; absolute minimum $\frac{5\pi}{6} - \sqrt{3}$ at $x = \frac{5\pi}{6}$ (1).

22. Area $= 2\int_2^4 \sqrt{16 - x^2}\,dx$ (1) $= 2\left[\frac{x}{2}\sqrt{16 - x^2} + 8\sin^{-1}\frac{x}{4}\right]_2^4$ (1) $= 2\left[4\pi - \left(2\sqrt{3} + \frac{4\pi}{3}\right)\right]$ (1) $= \frac{16\pi}{3} - 4\sqrt{3}$ square units (1).

OR $x^2 + 6x + 13 = (x + 3)^2 + 2^2$ (1). Using $\int \sqrt{t^2 + a^2}\,dt = \frac{t}{2}\sqrt{t^2 + a^2} + \frac{a^2}{2}\log\left|t + \sqrt{t^2 + a^2}\right|$ (1), the integral is $\frac{x+3}{2}\sqrt{x^2 + 6x + 13} + 2\log\left|x + 3 + \sqrt{x^2 + 6x + 13}\right| + C$ (2).

23. Homogeneous; put y = vx (1). $v + x\frac{dv}{dx} = v + \frac{1}{v}$, so $v\,dv = \frac{dx}{x}$ (1). $\frac{v^2}{2} = \log x + C$ (1), i.e. $y^2 = 2x^2\log x + 2Cx^2$ (1).

OR Feasible region (1½):



Corners O(0, 0), A(7, 0), B(3, 4), C(0, 5): Z = 0, 14, 26, 25 (1½). Maximum Z = 26 at x = 3, y = 4 (1).

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