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Your JEE Guide

MP Board Class XII · Higher Mathematics

Sample Question Paper 3 · 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) = 4x – 7, then $f^{-1}(x)$ is: (a) $\frac{x+7}{4}$ (b) 4x + 7 (c) $\frac{x-7}{4}$ (d) $\frac{1}{4x-7}$	1
	(ii) The principal value of $\tan^{-1}(-1)$ is: (a) $\frac{\pi}{4}$ (b) $-\frac{\pi}{4}$ (c) $\frac{3\pi}{4}$ (d) $-\frac{3\pi}{4}$	1
	(iii) If A is a square matrix of order 2 with |A| = 3, then |4A| is: (a) 64 (b) 12 (c) 7 (d) 48	1
	(iv) $\frac{d}{dx}\log(\sin x)$ equals: (a) –cot x (b) $\frac{1}{\sin x}$ (c) cot x (d) tan x	1
	(v) $\int_1^e \frac{dx}{x}$ equals: (a) 0 (b) e – 1 (c) 1 (d) e	1
	(vi) If A and B are independent events with P(A) = 0.4 and P(B) = 0.5, then P(A ∩ B) is: (a) 0.2 (b) 0.45 (c) 0.9 (d) 0.1	1

2.	**(i)** *Fill in the blanks:* A function f: A → B is onto if its range is equal to _____.	1
	(ii) The principal value range of $\cos^{-1} x$ is _____.	1
	(iii) A square matrix A with A′ = –A is called a _____ matrix.	1
	(iv) $\frac{d}{dx}(\tan x)$ = _____.	1
	(v) $\int \frac{1}{x}\, dx$ = _____.	1
	(vi) If $\vec{a} \cdot \vec{b} = 0$ for two non-zero vectors, the vectors are _____ to each other.	1
3.	**(i)** *Write True or False:* Every function is invertible.	1
	(ii) $\cos^{-1}\left(\cos \frac{4\pi}{3}\right) = \frac{4\pi}{3}$.	1
	(iii) For matrices A and B, (AB)′ = B′A′.	1
	(iv) The function f(x) = 1/x is continuous at every point of its domain.	1
	(v) The degree of the differential equation $\left(\frac{dy}{dx}\right)^3 + y = 0$ is 3.	1
	(vi) In a linear programming problem with a bounded feasible region, the optimal value of the objective function occurs at a corner point.	1
4.	Match column A with column B:	7

Column A	Column B
(i) $\int \sec^2 x\, dx$	(a) $\frac{1}{\sqrt{1-x^2}}$
(ii) $\int \cos x\, dx$	(b) sin x + C
(iii) $\frac{d}{dx} \log x$	(c) 2 × 3
(iv) $\frac{d}{dx} \sin^{-1} x$	(d) tan x + C
(v) $\hat{i} \cdot \hat{i}$	(e) $\frac{1}{x}$
(vi) $\hat{i} \times \hat{j}$	(f) $\hat{k}$
(vii) Order of a matrix with 2 rows and 3 columns	(g) 1

5.	**(i)** *Write the answer in one word or one sentence:* How many one-one functions are there from {1, 2, 3} to itself?	1
	(ii) Write the principal value of $\sin^{-1} \frac{1}{2}$.	1
	(iii) If A is a 2 × 2 matrix with |A| = 5, write |adj A|.	1
	(iv) If $f(x) = x^2$, write the rate of change of f with respect to x at x = 3.	1

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	(v) Write the value of $\int_0^{\pi/4} \sec^2 x \, dx$.	1
	(vi) Write the value of $\hat{i} \cdot (\hat{j} \times \hat{k})$.	1
	(vii) Write the scalar projection of $2\hat{i} + 3\hat{j}$ on the x-axis.	1
6.	Show that the relation R = {(1, 1), (2, 2), (3, 3), (1, 2), (2, 3)} on {1, 2, 3} is reflexive but not transitive.	2
7.	Find the value of $\tan^{-1}\sqrt{3} - \sec^{-1}(-2)$.	2
8.	If $A = \begin{bmatrix} 1 & 5 \\ -2 & 3 \end{bmatrix}$, show that A – A′ is a skew-symmetric matrix.	2
9.	Evaluate $\begin{vmatrix} 2 & -1 & 3 \\ 0 & 4 & 1 \\ 1 & 0 & 2 \end{vmatrix}$.	2
10.	Find $\frac{dy}{dx}$ if $xy + y^2 = \tan x + y$.	2
11.	Find the rate of change of the area of a circle with respect to its radius when r = 4 cm.	2
12.	Find $\int x e^x \, dx$.	2
13.	Evaluate $\int_0^1 \frac{x}{1 + x^2} \, dx$.	2
14.	Find a unit vector perpendicular to both $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$.	2
15.	If P(A) = 0.6, P(B) = 0.3 and P(A ∩ B) = 0.2, find P(A | B) and P(A ∪ B).	2
16.	Prove that $\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{3} = \frac{\pi}{4}$. **OR** Show that f: $\mathbb{N} \to \mathbb{N}$, f(x) = 2x is one-one but not onto.	3
17.	Show that $f(x) = \begin{cases} x^2, & x \le 1 \\ 2x - 1, & x > 1 \end{cases}$ is continuous and differentiable at x = 1. **OR** If $x = a(\theta - \sin\theta)$ and $y = a(1 - \cos\theta)$, find $\frac{dy}{dx}$.	3
18.	Find $\int \frac{dx}{x^2 + 4x + 8}$. **OR** Evaluate $\int_0^{\pi} \frac{x \sin x}{1 + \cos^2 x} \, dx$.	3

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19.	In a college, 60% of the students live in the hostel and 40% are day scholars. 30% of the hostellers and 20% of the day scholars get an A grade. A student chosen at random has an A grade. Find the probability that the student is a hosteller. **OR** A die is thrown twice. Find the probability distribution of the number of sixes and its mean.	3
20.	Solve by the matrix method: x + y + z = 2, 2x − y + 3z = 8, x − 2y − z = 3. **OR** If $A = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$, show that $A^2 - 4A + 3I = O$. Hence find A^{-1}.	4
21.	The sum of two positive numbers is 24. Find the numbers if the product of one of them and the square of the other is the greatest. **OR** Find the intervals in which $f(x) = x^3 - 6x^2 + 9x + 7$ is increasing or decreasing.	4
22.	Using integration, find the area of the region bounded by the parabola $y^2 = 9x$ and the line x = 4. **OR** Find $\int \dfrac{dx}{x(x^2+1)}$.	4
23.	Solve the differential equation $\frac{dy}{dx} + y\tan x = \sec x$. **OR** Solve graphically: Maximise Z = 2x + 3y subject to 3x + y ≤ 12, x + 2y ≤ 14, 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) **(a)** $\frac{x+7}{4}$. *Working:* y = 4x − 7 gives x = (y + 7)/4.

(ii) **(b)** $-\frac{\pi}{4}$. *Working:* The principal range of $\tan^{-1}$ is $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

(iii) **(d)** 48. *Working:* $|kA| = k^2|A| = 16 \times 3$.

(iv) **(c)** cot x. *Working:* $\frac{\cos x}{\sin x}$.

(v) **(c)** 1. *Working:* $[\log x]_1^e = 1 - 0$.

(vi) **(a)** 0.2. *Working:* P(A)P(B) = 0.2.

Question 2

(i) B, its co-domain.

(ii) [0, π].

(iii) skew-symmetric.

(iv) $\sec^2 x$.

(v) log |x| + C.

(vi) perpendicular.

Question 3

(i) False: only one-one and onto functions are invertible.

(ii) False: it is $\frac{2\pi}{3}$, since $\frac{4\pi}{3}$ is outside [0, π].

(iii) True.

(iv) True: its domain does not include x = 0.

(v) True.

(vi) True.

4. (i) – (d) tan x + C; (ii) – (b) sin x + C; (iii) – (e) $\frac{1}{x}$; (iv) – (a) $\frac{1}{\sqrt{1-x^2}}$; (v) – (g) 1; (vi) – (f) $\hat{k}$; (vii) – (c) 2 × 3

Question 5

(i) 6.

(ii) $\frac{\pi}{6}$.

(iii) 5, since $|\operatorname{adj} A| = |A|^{n-1}$.

(iv) 6.

(v) 1.

(vi) 1.

(vii) 2.

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6. (1, 1), (2, 2), (3, 3) ∈ R, so R is reflexive (1). (1, 2) and (2, 3) ∈ R but (1, 3) ∉ R, so R is not transitive (1).

7. $\tan^{-1}\sqrt{3} = \frac{\pi}{3}$ and $\sec^{-1}(-2) = \pi - \frac{\pi}{3} = \frac{2\pi}{3}$ (1). Value $= -\frac{\pi}{3}$ (1).

8. $A - A' = \begin{bmatrix} 0 & 7 \\ -7 & 0 \end{bmatrix}$ (1). Its transpose is $\begin{bmatrix} 0 & -7 \\ 7 & 0 \end{bmatrix} = -(A - A')$, so it is skew-symmetric (1).

9. Expanding along the first row: 2(8 – 0) + 1(0 – 1) + 3(0 – 4) (1) = 16 – 1 – 12 = 3 (1).

10. $y + x\frac{dy}{dx} + 2y\frac{dy}{dx} = \sec^2 x + \frac{dy}{dx}$ (1), so $\frac{dy}{dx} = \frac{\sec^2 x - y}{x + 2y - 1}$ (1).

11. $A = \pi r^2$, $\frac{dA}{dr} = 2\pi r$ (1). At r = 4: 8π cm² per cm (1).

12. By parts with u = x: $xe^x - \int e^x\,dx$ (1) $= xe^x - e^x + C$ (1).

13. Put $t = 1 + x^2$: $\frac{1}{2}\int_1^2 \frac{dt}{t}$ (1) $= \frac{1}{2}\log 2$ (1).

14. $\vec{a} \times \vec{b} = \hat{i} - \hat{j} + \hat{k}$ (1). Unit vector $= \frac{1}{\sqrt{3}}(\hat{i} - \hat{j} + \hat{k})$ (1).

15. P(A | B) = 0.2/0.3 = 2/3 (1). P(A ∪ B) = 0.6 + 0.3 – 0.2 = 0.7 (1).

16. Since $\frac{1}{2}\cdot\frac{1}{3} < 1$, the sum is $\tan^{-1}\frac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{6}}$ (1) $= \tan^{-1}\frac{5/6}{5/6}$ (1) $= \tan^{-1} 1 = \frac{\pi}{4}$ (1).

OR f(a) = f(b) ⇒ 2a = 2b ⇒ a = b, so f is one-one (1½). 1 ∈ ℕ has no pre-image, since 2x = 1 gives x = ½ ∉ ℕ, so f is not onto (1½).

17. Left limit = 1, right limit = 2 – 1 = 1 and f(1) = 1, so f is continuous at 1 (1½). Left derivative = 2x = 2 at x = 1; right derivative = 2, so f is differentiable at 1 (1½).

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

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

OR Using $x \to \pi - x$ and adding: $2I = \pi\int_0^\pi \frac{\sin x}{1+\cos^2 x}\,dx$ (1). Put t = cos x: $I = \frac{\pi}{2}\int_{-1}^{1}\frac{dt}{1+t^2}$ (1) $= \frac{\pi}{2}\cdot\frac{\pi}{2} = \frac{\pi^2}{4}$ (1).

19. P(H) = 0.6, P(D) = 0.4, P(A | H) = 0.3, P(A | D) = 0.2 (1). By Bayes' theorem, P(H | A) $= \frac{0.6\times0.3}{0.6\times0.3 + 0.4\times0.2}$ (1) $= \frac{0.18}{0.26} = \frac{9}{13}$ (1).

OR P(X = 0) = 25/36, P(X = 1) = 10/36, P(X = 2) = 1/36 (2). Mean = 10/36 + 2/36 = 1/3 (1).

20. $A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & -1 & 3 \\ 1 & -2 & -1 \end{bmatrix}$, |A| = 1(1 + 6) – 1(–2 – 3) + 1(–4 + 1) = 9 (1). $\operatorname{adj} A = \begin{bmatrix} 7 & -1 & 4 \\ 5 & -2 & -1 \\ -3 & 3 & -3 \end{bmatrix}$ (1½). $X = \frac{1}{9}\begin{bmatrix} 7 & -1 & 4 \\ 5 & -2 & -1 \\ -3 & 3 & -3 \end{bmatrix}\begin{bmatrix} 2 \\ 8 \\ 3 \end{bmatrix} = \frac{1}{9}\begin{bmatrix} 18 \\ -9 \\ 9 \end{bmatrix}$ (1), so x = 2, y = –1, z = 1 (½).

OR $A^2 = \begin{bmatrix} 5 & -4 \\ -4 & 5 \end{bmatrix}$ (1). $A^2 - 4A + 3I = \begin{bmatrix} 5-8+3 & -4+4 \\ -4+4 & 5-8+3 \end{bmatrix} = O$ (1). Multiplying by A^{-1}: A – 4I + 3A^{-1} = O (1), so $A^{-1} = \frac{1}{3}(4I - A) = \frac{1}{3}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ (1).

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21. Let the numbers be x and 24 – x, and P = (24 – x)x² (1). $\frac{dP}{dx} = 48x - 3x^2 = 3x(16 - x) = 0$ gives x = 16 (1). $\frac{d^2P}{dx^2} = 48 - 6x = -48 < 0$ at x = 16, a maximum (1). The numbers are 16 and 8; the greatest product is 8 × 16² = 2048 (1).

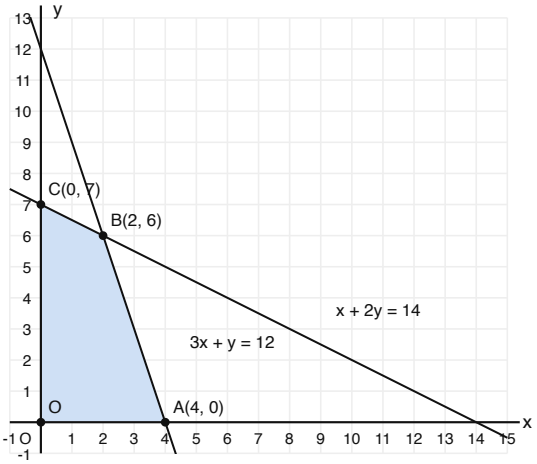
OR $f'(x) = 3x^2 - 12x + 9 = 3(x - 1)(x - 3)$ (1). f′(x) = 0 at x = 1, 3 (1). f′ > 0 on (–∞, 1) and (3, ∞), so f is increasing there (1); f′ < 0 on (1, 3), so f is decreasing there (1).

22. The region is symmetric about the x-axis, so area $= 2\int_0^4 3\sqrt{x}\,dx$ (1) $= 6\left[\frac{2}{3}x^{3/2}\right]_0^4$ (1) $= 4 \times 8$ (1) $= 32$ square units (1).

OR $\frac{1}{x(x^2+1)} = \frac{A}{x} + \frac{Bx+C}{x^2+1}$ gives A = 1, B = –1, C = 0 (2). Integral $= \log|x| - \frac{1}{2}\log(x^2+1) + C$ (2).

23. Linear equation with P = tan x, Q = sec x (1). IF $= e^{\int \tan x\,dx} = \sec x$ (1). $y\sec x = \int \sec^2 x\,dx = \tan x + C$ (1), so $y = \sin x + C\cos x$ (1).

OR Feasible region (1½):



Corners O(0, 0), A(4, 0), B(2, 6), C(0, 7): Z = 0, 8, 22, 21 (1½). Maximum Z = 22 at x = 2, y = 6 (1).

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