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MATHEMATICS (041)

SESSION 2025-26

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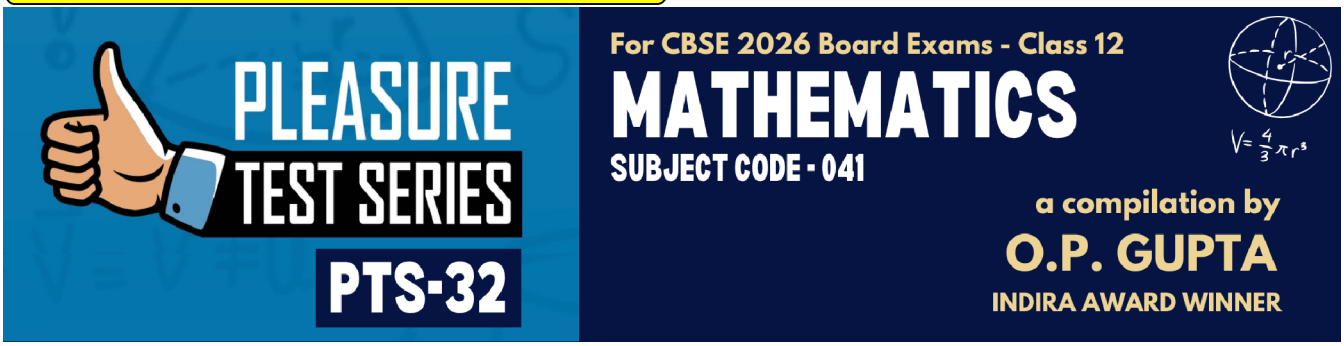


General Instructions : Same as given in PTS-01.

SECTION A

*(Question numbers 01 to 20 carry **1 mark** each.)*

*Followings are **multiple choice questions**. Select the correct option in each one of them.*

01. If $y = 5\cos x - 3\sin x$, then $\frac{d^2y}{dx^2}$ is equal to

(a) y (b) $-y$ (c) $25y$ (d) $9y$

02. For matrix $A = \begin{bmatrix} 2 & 5 \\ -11 & 7 \end{bmatrix}$, $(\text{adj.}A)'$ is equal to

(a) $\begin{bmatrix} -2 & -5 \\ 11 & -7 \end{bmatrix}$ (b) $\begin{bmatrix} 7 & 11 \\ -5 & 2 \end{bmatrix}$ (c) $\begin{bmatrix} 7 & 5 \\ 11 & 2 \end{bmatrix}$ (d) $\begin{bmatrix} 7 & -5 \\ 11 & 2 \end{bmatrix}$

03. If $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$, then $(\vec{r} \times \hat{i}).(\vec{r} \times \hat{j}) + xy =$

(a) 1 (b) -1 (c) 2 (d) 0

04. Given that matrices A and B are of order $3 \times n$ and $m \times 5$ respectively, then the order of matrix $C = 5A + 3B$ is

(a) 3×5 and $m = n$ (b) 5×5 (c) 3×3 (d) 3×5

05. Let $\int \frac{\sin 2x}{\sqrt{9 - \cos^4 x}} dx = f(x) + C$. Then $f(x)$ equals

(a) $\sin^{-1}\left(\frac{\cos^2 x}{3}\right)$ (b) $-\sin^{-1}\left(\frac{\cos^2 x}{3}\right)$ (c) $-\sin^{-1}\left(\frac{\cos x}{3}\right)$ (d) $\sin^{-1}\left(\frac{\cos x}{3}\right)$

06. Sum of the order and the degree of the differential equation $\frac{d}{dx}\left(\frac{dy}{dx}\right) = 5$, is

(a) 1 (b) 2 (c) 3 (d) 4

07. For an objective function $Z = ax + by$, where $a, b > 0$; the corner points of the feasible region determined by a set of constraints (linear inequalities) are (0, 20), (10, 10), (30, 30) and (0, 40). The condition on a and b, such that the maximum value of Z occurs at both the points (30, 30) and (0, 40) is

(a) $b - 3a = 0$ (b) $a = 3b$ (c) $a + 2b = 0$ (d) $2a - b = 0$

08. If $\hat{a}$ and $\hat{b}$ are unit vectors, and θ is the angle between, then $|\hat{a} + \hat{b}| =$

(a) $2\cos\theta$ (b) $\cos\left(\frac{\theta}{2}\right)$ (c) $2\sin\left(\frac{\theta}{2}\right)$ (d) $2\cos\left(\frac{\theta}{2}\right)$

09. The value of $\int_0^6 \sqrt{36 - x^2} dx$ is

(a) 9π (b) $\frac{9\pi}{2}$ (c) $\frac{\pi}{9}$ (d) $\frac{\pi}{2}$

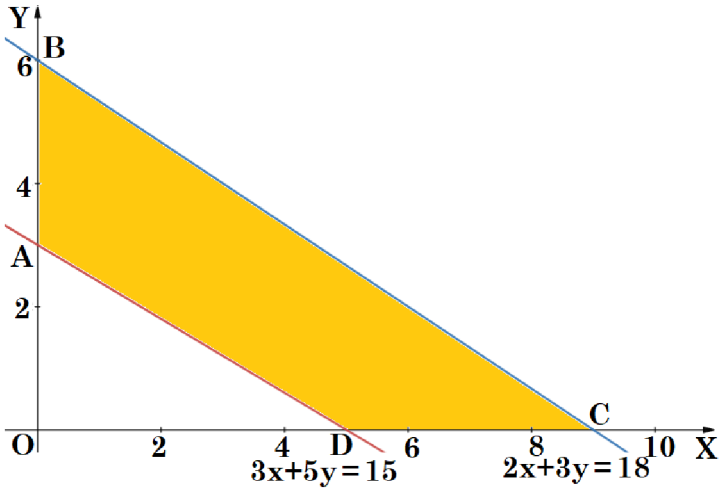
10. Let $A=\begin{bmatrix} 1 & \sin\alpha & 1 \\ -\sin\alpha & 1 & \sin\alpha \\ -1 & -\sin\alpha & 1 \end{bmatrix}$, where $0\le\alpha\le 2\pi$, then

(a) $|A|=0$ (b) $|A|\in(2,\infty)$ (c) $|A|\in(2,4)$ (d) $|A|\in[2,4]$

11. Consider the graph shown below corresponding to the linear programming problem. Minimize $Z=30x+50y$ subject to constraints, $3x+5y\ge 15$, $2x+3y\le 18$, $x\ge 0$, $y\ge 0$.

In the feasible region, the minimum value of Z occurs at

(a) a unique point
(b) no point
(c) infinitely many points
(d) two points only



12. It is given that $A=[a_{ij}]$ is a square matrix of order 3×3 and $|A|=-7$, then the value of $\sum_{i=1}^{3} a_{i2}A_{i2}$, where A_{ij} denotes the cofactor of element a_{ij} is

(a) 7 (b) –7 (c) 0 (d) 49

13. Given that A is a non-singular matrix of order 3 such that $A^2=2A$, then value of $|2A|$ is

(a) 4 (b) 8 (c) 64 (d) 16

14. Two cards are drawn at random from a pack of 52 cards one by one without replacement. What is the probability of getting first card red and second card Jack?

(a) $\frac{1}{26}$ (b) $\frac{1}{52}$ (c) $\frac{26}{51}$ (d) $\frac{1}{51}$

15. For what value of n, $\frac{dy}{dx}=\frac{x^3-y^n}{x^2y+xy^2}$ is a homogeneous differential equation?

(a) 0 (b) 1 (c) 2 (d) 3

16. The point (s), at which the function f given by $f(x)=\begin{cases}\frac{x}{|x|}, & x<0\\ -1, & x\ge 0\end{cases}$ is continuous, is/are

(a) $x\in R-\{0\}$ (b) $x=0$ (c) $x\in R$ (d) $x=-1$ and 1

17. X and Y are two points with position vectors $3\vec{a}+\vec{b}$ and $\vec{a}-3\vec{b}$ respectively. Then the position vector of a point Z which divides the line segment XY in the ratio 2:1 externally, is given by

(a) $\vec{a}-7\vec{b}$ (b) $\vec{a}+7\vec{b}$ (c) $-\vec{a}-7\vec{b}$ (d) $7\vec{b}-\vec{a}$

18. One of the point on the line $\frac{x-1}{3}=\frac{3y-6}{2}$, $z=-4$ is

(a) (1, 2, – 4) (b) (–1, 2, – 4) (c) (–1, 2, 4) (d) (1, – 2, 4)

Followings are ***Assertion-Reason based questions.***

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

19. **Assertion (A) :** The value of $\sin\left[\frac{\pi}{3}-\sin^{-1}\left(-\frac{1}{2}\right)\right]=1$.

Reason (R) : If $y=\tan^{-1}x$, then $-\frac{\pi}{2}<y<\frac{\pi}{2}$.

20. **Assertion (A) :** The line $\vec{r}=\hat{i}-\hat{j}+2\hat{k}+\lambda(\hat{i}-\hat{j}+\hat{k})$ in the Cartesian form is $\frac{x-1}{1}=\frac{y+1}{-1}=\frac{z-2}{1}$.

Reason (R) : For the parallel lines $\vec{r}=\vec{a}_1+\lambda\vec{b}$ and $\vec{r}=\vec{a}_2+\mu\vec{b}$, the shortest distance between them is $d=\frac{\left|\vec{b}.(\vec{a}_2-\vec{a}_1)\right|}{\left|\vec{b}\right|}$ units.

SECTION B

(Question numbers 21 to 25 carry ***2 marks*** *each.)*

21. Find the simplest form of $\tan^{-1}\left(\frac{\sqrt{1+\cos x}+\sqrt{1-\cos x}}{\sqrt{1+\cos x}-\sqrt{1-\cos x}}\right)$, $\pi<x<\frac{3\pi}{2}$.

OR

Check if the function $f:\mathbb{R}\to\mathbb{R}$ defined as $f(x)=x^3$ is one-one and onto.

22. The volume of a cube is rising at constant rate. Prove that the increase in surface area varies inversely as the length of edge of the cube.

23. Show that $A(2\hat{i}-\hat{j}+\hat{k})$, $B(\hat{i}-3\hat{j}-5\hat{k})$ and $C(3\hat{i}-4\hat{j}-4\hat{k})$ respectively, form the vertices of a right angled triangle.

OR

Find the value of p, for which the following lines are perpendicular :

$$\frac{1-x}{3}=\frac{2y-14}{2p}=\frac{z-3}{2};\ \frac{1-x}{3p}=\frac{y-5}{1}=\frac{6-z}{5}.$$

24. If $y=(\cot^{-1}x)^2$, show that $(x^2+1)^2\frac{d^2y}{dx^2}+2x(x^2+1)\frac{dy}{dx}=2$.

25. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}|=1$, $|\vec{b}|=2$ and $|\vec{c}|=3$. If the projection of $\vec{b}$ along $\vec{a}$ is equal to the projection of $\vec{c}$ along $\vec{a}$; and $\vec{b}$, $\vec{c}$ are perpendicular to each other, then find $|3\vec{a}-2\vec{b}+2\vec{c}|$.

SECTION C

(Question numbers 26 to 31 carry ***3 marks*** *each.)*

26. Find : $\int_1^5\left(|x-1|+|x-2|+|x-4|\right)dx$.

27. If a machine is correctly set up, it produces 90% acceptable items. If the machine is incorrectly set up, it produces only 40% acceptable items. Past experience shows that 80% of the set ups are correctly done. If after a certain set up, the machine produces 2 acceptable items, then find the probability that the machine is correctly setup.

OR

A delivery company in Delhi is analyzing delays in its service due to rain. With the available data, they observe the following probabilities on a given day.

- The probability that it rains in the city = 0.3
- The probability that a delivery van breaks down = 0.1

The company finds that these two events are independent (rain does not affect van breakdowns). What is the probability that neither it rains nor a van breaks down?

28. Evaluate : $\int\left(\sqrt{\tan x}-\sqrt{\cot x}\right)dx$.

OR

Evaluate : $\int\frac{x+1}{x(x^2+1)}dx$.

29. Find the particular solution of the differential equation : $ye^y dx=(y^3+2xe^y)dy,\ y(0)=1$.

OR

Find the general solution of the differential equation : $x\frac{dy}{dx}=y-x\sin\left(\frac{y}{x}\right)$.

30. Solve the following Linear Programming Problem graphically.

Maximize $Z=(100x+120y)$

Subject to constraints $x\geq 0,\ y\geq 0,\ 5x+8y\leq 200,\ 10x+8y\leq 240$.

Also, write the point at which Z_{max} is obtained.

31. Find : $\int\cos 2x\cos 4x\cos 6x\,dx$.

SECTION D

*(Question numbers 32 to 35 carry **5 marks** each.)*

32. Using integration, find the area of the region : $\left\{(x,\ y):0\leq y\leq\sqrt{3}x,\ x^2+y^2\leq 9\right\}$.

OR

Find the area bounded by $x^2=4y,\ x=4y-2$ and $y=0$. Use integrals.

33. Let $A=\{1, 2, 3, ..., 9\}$ and R be the relation in $A\times A$ defined by

(a, b) R (c, d) if $a+d=b+c$ for (a, b), (c, d) in $A\times A$.

Prove that R is an equivalence relation.

Also obtain the equivalence class [(2, 5)].

34. Find the intervals in which the function $f(x)=(x-1)^3(x+2)^2$ is strictly increasing or strictly decreasing. Also find the points of local maximum and local minimum, if any.

35. If $A=\begin{bmatrix}1 & 1 & 1\\ 0 & 1 & 3\\ 1 & -2 & 1\end{bmatrix}$, find A^{-1}.

Hence, solve the following system of equations : $x+y+z=6,\ y+3z=11$ and, $x-2y+z=0$.

OR

If $A=\begin{pmatrix}1 & 0 & 2\\ 0 & 2 & 1\\ 2 & 0 & 3\end{pmatrix}$, prove that $A^3-6A^2+7A+2I=O$. Hence find A^{-1}.

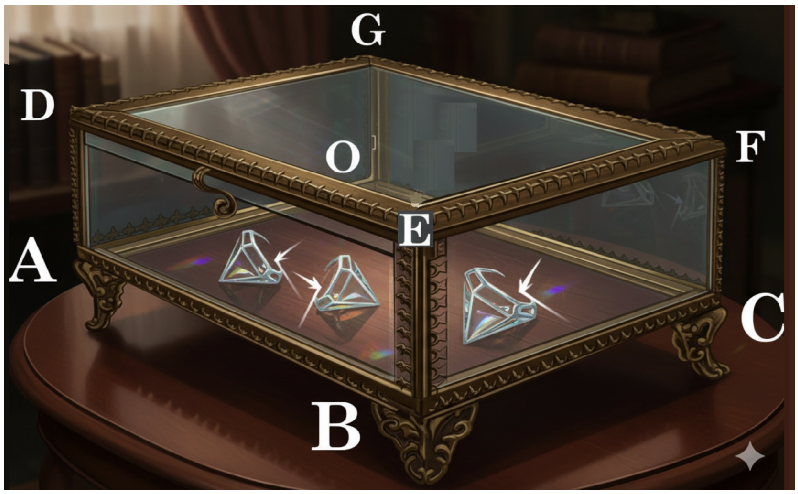
SECTION E

*(Question numbers 36 to 38 carry **4 marks** each.)*
*This section contains **three Case-study / Passage based questions**.*
*First two questions have **three sub-parts** (i), (ii) and (iii) of **marks 1, 1 and 2** respectively.*
*Third question has **two sub-parts** of **2 marks** each.*

36. **CASE STUDY I :** Read the following passage and then answer the questions given below.

In a diamond exhibition organized by a Jewellery outlet, the diamonds are covered in a glass box with laser lights set up for the security.

The coordinates of the glass box are given by
O(0, 0, 0), A(1, 0, 0), B(1, 2, 0), C(0, 2, 0), D(0, 0, 3), E(1, 0, 3), F(1, 2, 3) and G(0, 2, 3).



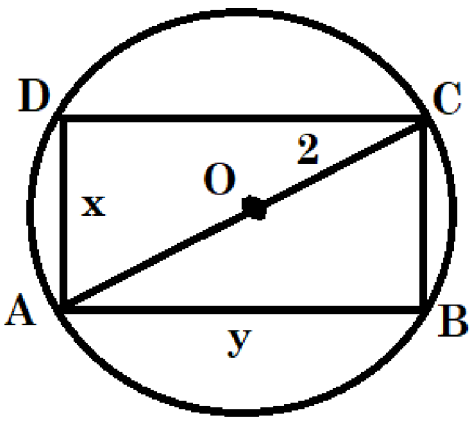
(i) Find the Cartesian equation of line joining the points E and F.
(ii) Find the vector equation of line EF obtained in **(i)**.
(iii) Write the shortest distance between the line EF and BC.

OR

(iii) Write the acute angle between the line EF and BE.

37. **CASE STUDY II :** Read the following passage and then answer the questions given below.

Ram Bhagat is a gardener. He wants to construct a rectangular bed of flowers in a circular patch of land, in the middle of a community park.
He takes the maximum perimeter of the rectangular region as possible.



Refer the diagram shown above for the dimensions.

(i) If length and breadth of the rectangular portion be y and x (in m) respectively, then find the area $A(y)$ of rectangular portion (in terms of y).

Take radius of the circular patch of land as 2 m.

(ii) What will be the expression for perimeter of rectangular portion (in terms of y), taking same dimensions as given in **(i)**?

(iii) What will be the length y (in m) of rectangular portion, if $A'(y) = 0$? What is the sign of $A''(y)$, when $A'(y) = 0$? What does it signify?

OR

(iii) Using second derivative test, find the value of maximum area of the rectangular portion. Also write the value of perimeter (in m) of rectangular portion, when its area is maximum?

38. CASE STUDY III : Read the following passage and then answer the questions given below.

A coach Mr Raj Nath is training 3 players.

He observes that

- the player A can hit a target 4 times in 5 shots,
- the player B can hit 3 times in 4 shots, and
- the player C can hit 2 times in 3 shots.

(i) Find the probability that A, B and, C all will hit the target.

(ii) What is the probability that 'any two of A, B and C will hit'?

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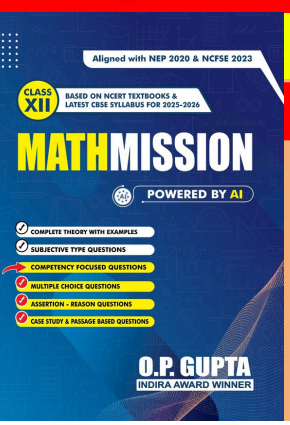

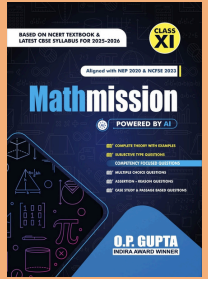

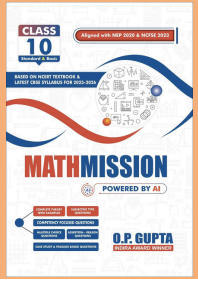

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ABOUT THE AUTHOR

O.P. GUPTA having taught math passionately over a decade, has devoted himself to this subject. Every book, study material or practice sheets, tests he has written, tries to teach serious math in a way that allows the students to learn math without being afraid. Undoubtedly his mathematics books are best sellers on Amazon and Flipkart. His resources have helped students and teachers for a long time across the country. He has contributed in CBSE Question Bank (issued in April 2021). Mr Gupta has been invited by many educational institutions for hosting sessions for the students of senior classes. Being qualified as an electronics & communications engineer, he has pursued his graduation later on with mathematics from University of Delhi due to his passion towards mathematics. He has been honored with the prestigious INDIRA AWARD by the Govt. of Delhi for excellence in education.

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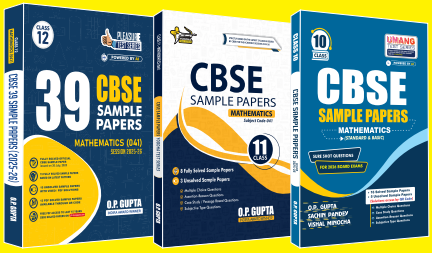

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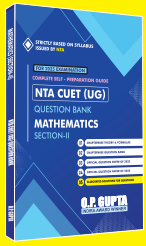

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