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MATHEMATICS (041)

SESSION 2025-26

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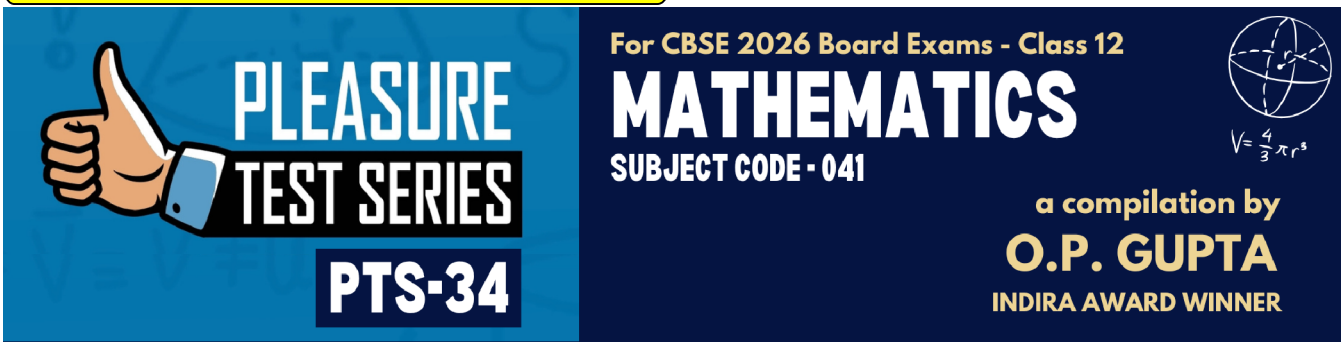


General Instructions : Same as given in PTS-01.

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. Let X be a symmetric matrix and Y be a skew-symmetric matrix such that $3X+2Y=\begin{bmatrix}2 & 1\\ 4 & 3\end{bmatrix}$.

Then the matrix $6X=$

(a) $\begin{bmatrix}\frac{2}{3} & \frac{5}{6}\\ \frac{5}{6} & 1\end{bmatrix}$ (b) $\begin{bmatrix}0 & -\frac{3}{4}\\ \frac{3}{4} & 0\end{bmatrix}$ (c) $\begin{bmatrix}4 & 5\\ 5 & 6\end{bmatrix}$ (d) $\begin{bmatrix}0 & 3\\ -3 & 0\end{bmatrix}$

02. Let us define a relation R in $\mathbb{R}$ as, aRb if $a \geq b$. Then the relation R is

(a) an equivalence relation
(b) reflexive, transitive but not symmetric
(c) symmetric, transitive but not reflexive
(d) neither transitive nor reflexive but symmetric

03. The function $f:[0,\infty)\to R$ given by $f(x)=\frac{x}{x+1}$ is

(a) both one-one and onto
(b) one-one but not onto
(c) neither one-one nor onto
(d) onto but not one-one

04. If $A=\begin{bmatrix}1 & 2 & -2\\ 2 & 1 & 2\\ -1 & 2 & 0\end{bmatrix}$, then $AA'=$

(a) $\begin{bmatrix}3 & 0 & 9\\ 0 & 9 & 0\\ 5 & 0 & 3\end{bmatrix}$ (b) $\begin{bmatrix}9 & 0 & 3\\ 0 & 9 & 0\\ 5 & 0 & 3\end{bmatrix}$ (c) $\begin{bmatrix}9 & 0 & 3\\ 0 & 0 & 9\\ 3 & 0 & 5\end{bmatrix}$ (d) $\begin{bmatrix}9 & 0 & 3\\ 0 & 9 & 0\\ 3 & 0 & 5\end{bmatrix}$

05. For what value of 'x', $\begin{vmatrix}5 & 3 & -1\\ -7 & x & 2\\ 9 & 6 & -2\end{vmatrix}=0$?

(a) 6 (b) 0 (c) -6 (d) 1

06. If A and B are square matrices of the same order n, such that $|A|=2$ and $AB=2I$, then the value of $|B|$ is

(a) 2^{n+1} (b) 2^{n-1} (c) 2^n (d) 2^{n-2}

07. If $y=a\sin mx+b\cos mx$, then $\frac{d^2y}{dx^2}$ is equal to

(a) m^2y (b) $-(m^2y)$ (c) $-(my)$ (d) my

08. If $y=\sqrt{\cos x+y}$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{\sin x}{1-2y}$ (b) $\frac{\cos x}{2y-1}$ (c) $\frac{\sin x}{1+2y}$ (d) $\frac{\sin x}{2y-1}$

09. The function $f(x)=|2x-1|$ is differentiable, when $x \in$

(a) $(-\infty, \infty)$ (b) $(-\infty, \infty)-\left\{\frac{1}{2}\right\}$ (c) $(0,\infty)$ (d) $(-\infty, 0)$

10. The surface area (A, in square units) of a sphere, when the volume (V) is increasing at the same rate as the radius (r), is

(a) 1 (b) $\frac{1}{2\pi}$ (c) 4π (d) $\frac{4\pi}{3}$

11. $f(x)=x^x,\ x>0$ decreases strictly, in the interval

(a) $(0, e)$ (b) $(0, \infty)$ (c) $(0, 1)$ (d) $\left(0, \frac{1}{e}\right)$

12. $\int \frac{\cos 2x}{(\cos x+\sin x)^2}dx =$

(a) $-\frac{1}{\sin x+\cos x}+C$ (b) $\log|\sin x+\cos x|+C$

(c) $\log|\sin x-\cos x|+C$ (d) $\frac{1}{(\sin x+\cos x)^2}+C$

13. $\int e^x\left(\frac{1-\sin x}{1-\cos x}\right)dx =$

(a) $e^x \cot\frac{x}{2}+C$ (b) $-e^x \cot\frac{x}{2}+C$ (c) $-e^x \tan\frac{x}{2}+C$ (d) $e^x \tan\frac{x}{2}+C$

14. $\int \frac{dx}{x(x^2+1)}$ equals

(a) $\log|x|+\frac{1}{2}\log|x^2+1|+C$ (b) $\frac{1}{2}\log\left|\frac{x^2}{x^2+1}\right|+C$

(c) $-\log|x|+\frac{1}{2}\log|x^2+1|+C$ (d) $-\frac{1}{2}\log|x|+\log|x^2+1|+C$

15. The value of $\int_0^{\frac{\pi}{2}} \frac{\sin x-\cos x}{1+\sin x\cos x}dx$ is

(a) $\frac{\pi}{2}$ (b) π (c) 1 (d) 0

16. Sum of the order and degree of the differential equation $\left(\frac{d^3y}{dx^2}\right)^2-3\left(\frac{d^2y}{dx^2}\right)+2x=0$ is

(a) 3, 2 (b) 3 (c) 2 (d) 5

17. If the lines $\frac{x-1}{\lambda}=\frac{y-2}{2}=\frac{z-3}{1}$ and $\frac{x-2}{3}=\frac{y-3}{\lambda}=\frac{z-1}{5}$ intersect at right angle, then the value of λ is

(a) -5 (b) 1 (c) 5 (d) -1

18. If $P(A)=\frac{3}{8}$, $P(B)=\frac{1}{3}$ and $P(A\,|\,B)=\frac{3}{4}$, then $P(A'\cap B')$ is

(a) $\frac{11}{24}$ (b) $\frac{13}{24}$ (c) $\frac{1}{4}$ (d) $\frac{13}{8}$

*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 principal value of $\sec^{-1}(-2) = \frac{2\pi}{3}$.

Reason (R) : For $y = \sec^{-1} x$, we always have $y \in [0, \pi] - \left\{\frac{\pi}{2}\right\}$.

20. **Assertion (A) :** The side BC of a parallelogram ABCD, whose one of the side AB and a diagonal AC are respectively given by the vectors $2\hat{i}+\hat{j}+\hat{k}$ and $4\hat{i}+3\hat{k}$ is, $2\hat{i}-\hat{j}+2\hat{k}$.

Reason (R) : For a parallelogram ABCD, its area is given by $\left|\overrightarrow{AB}\times\overrightarrow{AD}\right|$ (in Square units).

SECTION B

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

21. Prove that : $\tan^{-1}\left(\frac{\sqrt{1+\sin x}+\sqrt{1-\sin x}}{\sqrt{1+\sin x}-\sqrt{1-\sin x}}\right) = \frac{\pi}{2} - \frac{x}{2}$, where $0 < x < \frac{\pi}{2}$.

22. Show that the function $f(x) = \begin{cases} x-1, \text{ if } x < 2 \\ 2x-3, \text{ if } x \geq 2 \end{cases}$ is not differentiable at $x = 2$.

23. If $\vec{a} = \hat{i}+2\hat{j}+\hat{k}$, $\vec{b} = 2\hat{i}+\hat{j}$ and $\vec{c} = 3\hat{i}-4\hat{j}-5\hat{k}$, then find the unit vector (s) perpendicular to both vectors $(\vec{a}-\vec{b})$ and $(\vec{c}-\vec{b})$.

OR

If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three vectors such that $\left|\vec{a}+\vec{b}+\vec{c}\right| = 1$, $\vec{c} = \lambda(\vec{a}\times\vec{b})$; $|\vec{a}| = \frac{1}{\sqrt{2}}$, $|\vec{b}| = \frac{1}{\sqrt{3}}$ and $|\vec{c}| = \frac{1}{\sqrt{6}}$, then find the angle between $\vec{a}$ and $\vec{b}$.

24. Find matrix A, such that $\begin{bmatrix} 2 & -1 \\ 1 & 0 \\ -3 & 4 \end{bmatrix} A = \begin{bmatrix} -1 & -8 \\ 1 & -2 \\ 9 & 22 \end{bmatrix}$.

25. If a line L passes through the point $A(-2, 5, -3)$ and $B(-4, 15, -12)$, then write the vector and Cartesian equation of L.

SECTION C

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

26. Show that the relation R on the set $\mathbb{R}$ of real numbers, defined as $R = \{(a,b) : a \leq b^2\}$ is neither reflexive nor symmetric nor transitive.

OR

Show that the relation R in the set $N \times N$ defined by $(a,b)\,R\,(c,d)$, iff $a^2+d^2 = b^2+c^2$ $\forall$ a, b, c $d \in N$, is an equivalence relation.

27. Let $x = \cos t + \log \tan \frac{t}{2}$ and, $y = \sin t$.

Then, find the value of $\frac{d^2y}{dt^2}$ and $\frac{d^2y}{dx^2}$ at $t = \frac{\pi}{4}$.

28. Solve the differentiable equation : $xdy - ydx = \sqrt{y^2 - x^2}\, dx$, given that $y = 1$ when $x = 1$.

OR

Find the particular solution of the D.E. : $x\frac{dy}{dx} + 2y = x^2$, $x \neq 0$ if it is given that $y(2) = 1$.

29. Find the angle between the lines $2x = 3y = -z$ and $6x = -y = -4z$.

30. In a school, 20% of the students failed in Physics, 15% of the students failed in Mathematics, and 25% of the students failed either in Physics or in Mathematics. A student is selected at random. If the selected student is a failure in Physics then, what is the probability that he is failure in Mathematics as well?

31. Evaluate : $\int \frac{x^3 + x}{x^4 - 9} dx$.

OR

Evaluate : $\int_2^5 \left[|x-2| + |x-3| + |x-5|\right] dx$.

SECTION D

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

32. Find the area of the smaller part of circle $x^2 + y^2 = a^2$ cut off by the line $x = \frac{a}{\sqrt{2}}$.

33. Find the vector and Cartesian equations of the line passing through the point $(2, -1, 3)$ and perpendicular to the lines $\frac{x-1}{1} = \frac{y-2}{2} = \frac{z-3}{3}$ and $\frac{x}{-3} = \frac{y}{2} = \frac{z}{5}$.

OR

Find the foot of the perpendicular from $P(1, 2, 3)$ on the line $\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}$.

Also, obtain the equation and the length of perpendicular.

34. Solve the following linear programming problem graphically.

Maximize $Z = x + 2y$

Subject to the constraints

$x + 2y \geq 100$,

$2x - y \leq 0$,

$2x + y \leq 200$;

$x, y \geq 0$.

Also, write the point at which maximum value of Z is obtained.

Further, write $Z_{max} - Z_{min}$.

35. Show that of all the rectangles of given area, the square has the smallest perimeter.

OR

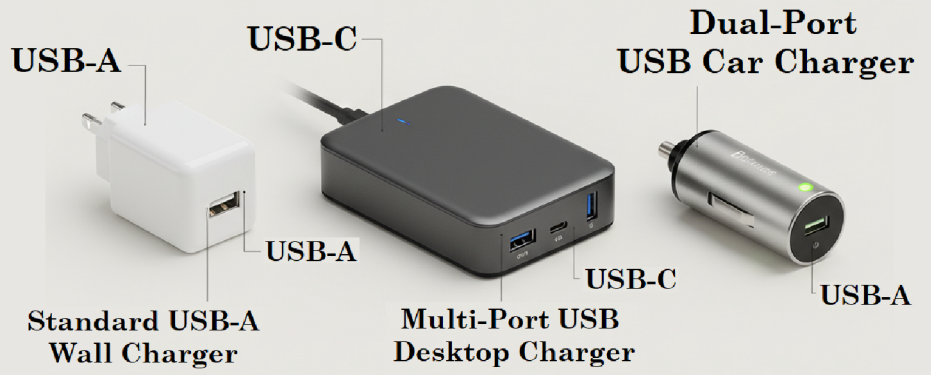
An airforce plane is ascending vertically at the rate of 100 km/hr. Assuming that the radius of earth is 'R' km, how fast is the area of the earth visible from the airforce plane, increasing at 3 minutes after it started ascending?

Visible area $A = \dfrac{2\pi R^2 h}{R+h}$, where 'h' is the height of the airforce plane above the earth.

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.



A retail shop sources USB chargers for its stores from three suppliers.

- Supplier A supplies 50% of the chargers. Defect rate from A = 2%.
- Supplier B supplies 30% of the chargers. Defect rate from B = 5%.
- Supplier C supplies 20% of the chargers. Defect rate from C = 10%.

Let A, B and C be the events that charger came from supplier A, B and C respectively.
Also let D be the event that charger is defective.

(i) Find $P(A)+P(B)+P(C)$.

(ii) What is the probability that a randomly chosen charger is defective?

(iii) If a randomly chosen charger is found to be defective, then what is the probability it came from Supplier B?

OR

(iii) If a randomly chosen charger is found to be defective, then what is the probability it came from either Supplier A or C?

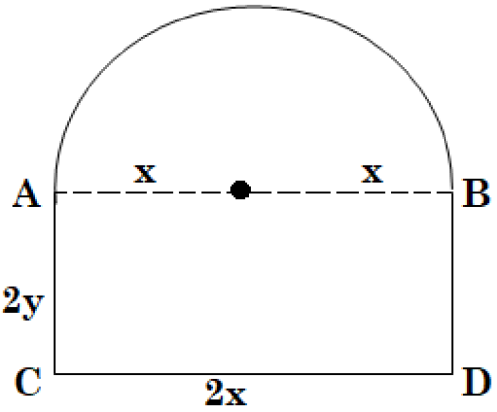
37. CASE STUDY II : Read the following passage and then answer the questions given below.

Mr Shashi, who is an architect, designs a building for a small company.

The design of window on the ground floor is proposed to be different than other floors.

The window is in the shape of a rectangle which is surmounted by a semi-circular opening.

This window is having a perimeter of 10 m.



(i) If 2x and 2y represents the length and breadth of the rectangular portion of the windows, then find the value of y, in terms of x.

(ii) Express the combined area (A) of the rectangular region and semi-circular region of the window, as a function of x.

(iii) Find the maximum value of area A, of the whole window using derivatives.

OR

(iii) The owner of this small company is interested in maximizing the area of the whole window so that maximum light input is possible. To fulfill this purpose, what should be the length and breadth of rectangular portion of the window? Also find the radius of semi-circular opening of the window. Use derivatives.

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

The management of two schools APS and KVS, decided to award prizes to their students for the three games hockey (x), cricket (y) and football (z).

The management of first school APS decided to award a total of ₹11000 for the three games to 5, 4 and 3 students respectively.

The management of second school KVS decided to award a total of ₹10700 for the three games to 4, 3 and 5 students respectively.

Also, the three prizes together amount to ₹2700.

(i) Represent the above situation using matrix equation.

(ii) Find out the prize amount for hockey, cricket and football, using matrices and determinants.

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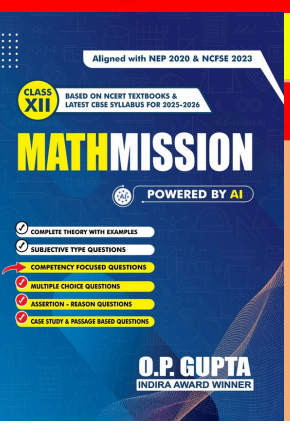

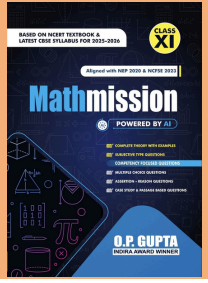

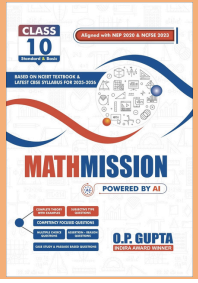

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ABOUT THE AUTHOR

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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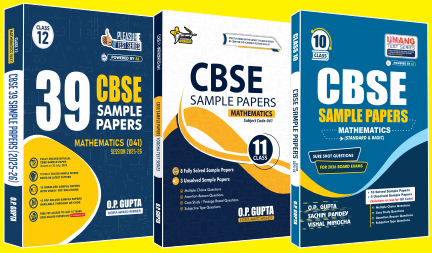

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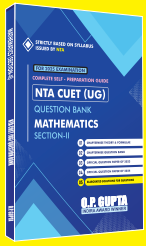

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