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PTS-04

For CBSE 2026 Board Exams - Class 12

MATHEMATICS

SUBJECT CODE - 041

a compilation by
O.P. GUPTA
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General Instructions : Same as given in PTS-01.

SECTION A

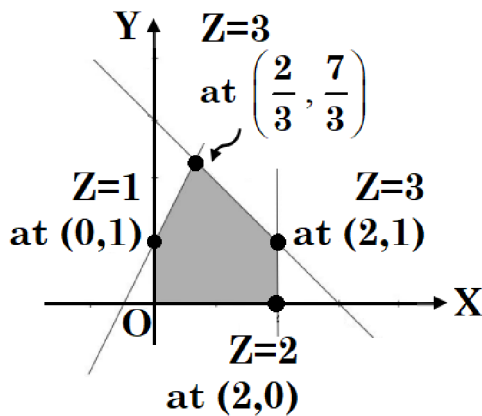
(Question numbers 01 to 20 carry **1 mark** each.)

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

01. For a square matrix P , if we have $P \cdot (\text{adj. } P) = \begin{bmatrix} -2025 & 0 & 0 \\ 0 & -2025 & 0 \\ 0 & 0 & -2025 \end{bmatrix}$, then $|P| + |\text{adj. } P| =$
- (a) $2025^2 \times 2024$ (b) -2024 (c) 2025×2024 (d) $(-2025)^2 + 2025$
02. X and Y are two matrices such that the transpose of $(X + Y)$ is $\begin{bmatrix} 2 & -1 \\ 7 & 6 \end{bmatrix}$. If $Y = \begin{bmatrix} 3 & -2 \\ 6 & 0 \end{bmatrix}$, then which of the following is correct?
- (a) $X = \begin{bmatrix} -1 & 1 \\ 1 & 6 \end{bmatrix}$ (b) $X = \begin{bmatrix} -1 & 9 \\ -7 & 6 \end{bmatrix}$ (c) $X = \begin{bmatrix} 1 & -9 \\ 7 & -6 \end{bmatrix}$ (d) $X = \begin{bmatrix} -4 & 4 \\ 0 & 7 \end{bmatrix}$
03. Function f defined by $f(x) = e^{-x}$ is strictly increasing when
- (a) $x \in \phi$ (b) $x \in (-\infty, 0)$ (c) $x \in [0, \infty)$ (d) $x \in (-\infty, \infty)$
04. If A , B and C are square matrices of order 3 and $\det(BC) = 2\det(A)$, then what is the value of $\det(2A^{-1}BC)$?
- (a) 1 (b) 2^2 (c) 2^3 (d) 2^4
05. The value of 'n', such that the differential equation given by $\frac{dy}{dx} = \frac{x^2 + y^2}{x^n}$; where $x, y \in \mathbb{R}^+$ is homogeneous, is
- (a) 0 (b) 1 (c) 2 (d) 3
06. If $\begin{vmatrix} 2 & -3 & 1 \\ k & -1 & 1 \\ 0 & 4 & 1 \end{vmatrix} = 0$, then
- (a) $7k = 10$ (b) $7k + 10 = 0$ (c) $10k + 7 = 0$ (d) $10k = 7$
07. If A is a square matrix of order n , then the number of minors in the determinant of A are
- (a) n (b) $n - 1$ (c) n^2 (d) n^n
08. Delhi Metro is highly popular mode of transport among the commuters. The Metro connects numerous stations across Delhi NCR. Among them are Dwarka and Hauz Khas. Wishi takes the Metro scheduled at 8:25 AM from Dwarka station to Hauz Khas station every morning. The probability that the Metro is late is $\frac{3}{4}$ and, the probability that Wishi gets a seat in the Metro is $\frac{1}{15}$. The probability that the Metro is on time and she gets a seat in it is

- (a) $\frac{1}{20}$ (b) $\frac{1}{4}$ (c) $\frac{1}{60}$ (d) $\frac{7}{10}$

09. There are two non-zero vectors $\vec{a}$ and $\vec{b}$ such that $\vec{a} \cdot \vec{b} = 0$. Then the projection of $\vec{a}$ on $\vec{b}$ is
 (a) 1 (b) 0 (c) 2 (d) can not be determined
10. Let $y = f(x)$ be a real function such that its first-order derivative is same as its second-order derivative. Then $f(x) =$
 (a) x (b) 2^x (c) e^x (d) no such function exists
11. Shown below is the feasible region of a linear programming problem (L.P.P.) whose objective function is : Maximize $Z = x + y$.



A student Drishti claimed that there exists **no optimal solution** for the L.P.P. as there is no unique maximum value at the corner points of its feasible region. Based on her statement, choose most appropriate option.

(a) Her claim is correct, as there are two corner points of its feasible region at which maximum value of Z occurs.

(b) Her claim is false, as there are exactly two corner points i.e., $\left(\frac{2}{3}, \frac{7}{3}\right)$ and $(2, 1)$ at which the maximum value of Z occurs, which is 3.

(c) Her claim is false, as every point on the line joining $\left(\frac{2}{3}, \frac{7}{3}\right)$ and $(2, 1)$ gives the maximum value of Z , which is 3.

(d) Her claim is false, as the maximum value of Z occurs at $(2, 0)$, which is 2.

12. If $f(x)$ is continuous for all real values of x , then $\int_{\frac{a}{4}}^{\frac{b}{4}} f(4x) dx$ equals

- (a) $4 \int_a^b f(x) dx$ (b) $\frac{1}{4} \int_{4a}^{4b} f(x) dx$ (c) $\frac{1}{4} \int_a^b f(x) dx$ (d) $4 \int_{4a}^{4b} f(x) dx$

13. For the function $y = \sin^{-1} \{|x| - 1\}$

- (a) Domain = $x \in [-1, 1]$, Range = $y \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$
 (b) Domain = $x \in (-2, 2)$, Range = $y \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$
 (c) Domain = $x \in (-1, 1)$, Range = $y \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$
 (d) Domain = $x \in [-2, 2]$, Range = $y \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

14. A differential equation has an order of 3 and a degree of 2. Which of the following could this differential equation be?

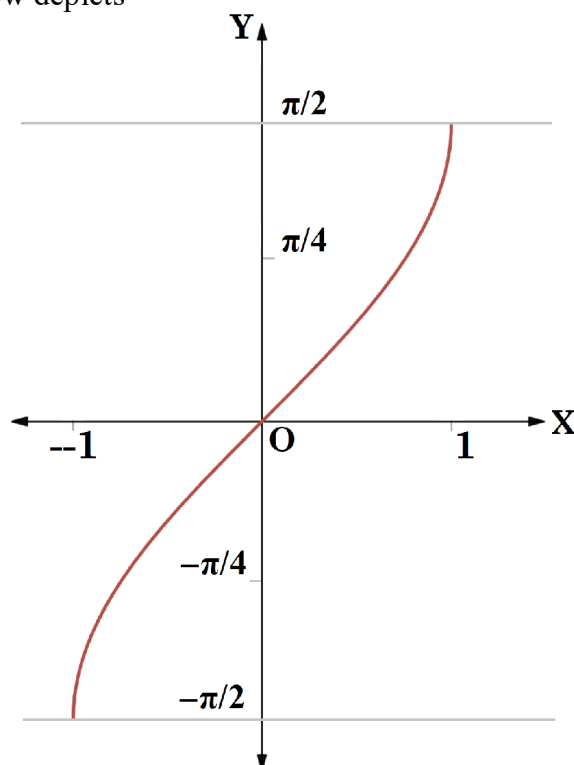
$$(a) \frac{d^3y}{dx^3} - \left(\frac{d^2y}{dx^2} \right)^2 = 0$$

$$(b) \tan \left(\frac{d^2y}{dx^2} \right) + \left(\frac{d^3y}{dx^3} \right)^2 = 0$$

$$(c) \left(\frac{d^3y}{dx^3} \right)^2 + \frac{d^2y}{dx^2} - \left(\frac{dy}{dx} \right)^3 = 0$$

$$(d) \left(\frac{d^3y}{dx^3} \right)^3 + \left(\frac{dy}{dx} \right)^2 = 0$$

15. The graph drawn below depicts



- (a) $y = \cos^{-1} x$ (b) $y = \operatorname{cosec}^{-1} x$ (c) $y = \sin^{-1} x$ (d) $y = \cot^{-1} x$

16. $f(x) = |\sin x|$ is non-differentiable at

- (a) $x = n\pi, n \in \mathbb{Z}$ (b) $x = (2n+1)\pi, n \in \mathbb{Z}$
 (c) $x = (2n+1)\frac{\pi}{2}, n \in \mathbb{Z}$ (d) $x = \mathbb{R} - \left\{ (2n+1)\frac{\pi}{2} \right\}, n \in \mathbb{Z}$

17. If $[.]$ denotes the greatest integer function, then $f(x) = [x]$ is discontinuous at

- (a) infinite points, in $2 < x < 5$ (b) only two points, in $2 < x < 5$
 (c) only three points, in $2 < x < 5$ (d) no point, in $2 < x < 5$

18. The area under the curve $x^2 = y$ between the line $x = 0$ and $x = k$ is 9 square units. Which of the following could be the correct value of k ?

- (a) $\frac{3}{2}$ (b) 9 (c) 3 (d) $\frac{9}{2}$

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) :** All the points in the feasible region of an L.P.P. (linear programming problem) are optimal solutions to the problem.
Reason (R) : Every point in the feasible region satisfies all the constraints of an L.P.P. (linear programming problem).
20. **Assertion (A) :** If the angle between $\vec{p}$ and $\vec{q}$ is obtuse, then $\vec{p} \cdot \vec{q} < 0$.
Reason (R) : Value of $\cos \theta$ lies in $(-1, 0)$, when $90^\circ < \theta < 180^\circ$.

SECTION B

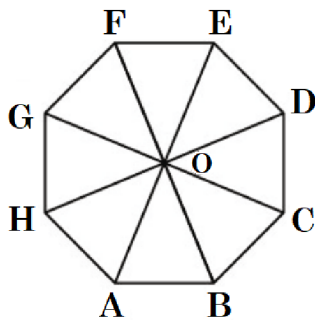
(Question numbers 21 to 25 carry 2 marks each.)

21. If $4x + \frac{1}{x} = 4$, then find $\cos^{-1} x - \sin^{-1} 2x$.
22. The total cost (in ₹) of manufacturing 'n' earphone sets per day in a Karnataka based start-up Maxier Electronics Limited is given by $C(n) = 0.0001n^2 + 4n + 400$. Find $C(n = 100)$. Also, find the marginal cost of manufacturing 10000 earphone sets.
23. If $y = ax^{\frac{n+2}{n+1}} + \frac{b}{x^{\frac{n+1}{n+1}}}$, where $n \in \mathbb{N}$ and $a, b \in \mathbb{R}$, then prove that $x^2 \frac{d^2y}{dx^2} = (n+1)(n+2)y$.

OR

Differentiate the function $y = \cos^{-1} \left(\frac{1-3^{2x}}{1+3^{2x}} \right)$ with respect to x .

24. A bird is sitting on an electric wire (assuming that the wire has no slack). If the equation of wire is given by $\frac{x+1}{-3} = y-2 = z$ and the position of bird is at a point P such that the distance between P and $Q(-1, 2, 0)$ is $6\sqrt{11}$ units, then find the position of bird (coordinates of point P).
25. Shown below is a regular octagon ABCDEFGH, with centre O.



Show that $\vec{AE} + \vec{FB} + \vec{CG} + \vec{HD} = 2(\vec{AD} - \vec{BC})$.

OR

A parallelogram ABCD is constructed such that its adjacent sides, AB and AD, are $3\vec{a} - 5\vec{b}$ and $\vec{a} - 2\vec{b}$ respectively. If $|\vec{a}| = \sqrt{2}$, $|\vec{b}| = \sqrt{8}$ and the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{3}$, find the length of diagonal BD.

SECTION C

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

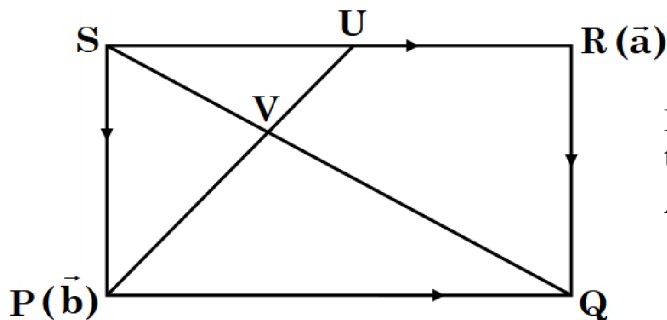
26. A cylindrical disk of radius R and height H is pressed by a hydraulic press. During the process, the radius and the height of the disk change such that the cylindrical shape is retained and the volume (V) of the disk remains constant. What is the ratio of the rate of change of height to the rate of change of radius in terms of R?

27. Sumathi bought a luxury car for ₹ y . The price $P(t)$ of the car depreciates as $\frac{dP(t)}{dt} = -a(T-t)$, after ' t ' years; where ' T ' is the total life of the car (in years) and ' a ' is an arbitrary constant. Find the value of the car when the car has been used for ' T ' years, in terms of ' y '.

OR

The first derivative of a function y with respect to x is given by $-\frac{1}{x^2(1+x^2)}$. Find the function, if it is given that $y = \frac{\pi}{4}$, when $x = 1$.

28. In the rectangle PQRS below, S is at the origin and the position vectors of the points R and P are $\vec{a}$ and $\vec{b}$ respectively.



Point U bisects SR. Use vectors to prove that V divides PU and QS in the same ratio. Also find the ratio in which V divides QS.

29. Evaluate : $\int \sqrt{\sqrt{x^2+4}+x} dx$.

OR

Evaluate : $\int e^x \left\{ \frac{x^3+x+1}{(x^2+1)^{3/2}} \right\} dx$.

30. Consider the following Linear Programming Problem.

Maximize $Z = x + 2y$

Subject to $2x + 3y \geq 6$, $4x + y \geq 4$; $x, y \geq 0$.

Show graphically that the maximum value of Z will not occur.

31. A company conducts a mandatory health check-up for all the newly hired employees, to check for infections that could affect other employees. A blood infection affects roughly 5% of the population. The probability of a false positive report on the test for this infection is 4%, while the probability of a false negative report on the test is 3%. If a person tests positive for the infection, what is the probability that he is actually infected?

OR

Bag I contains 4 white and 5 black balls. Bag II contains 6 white and 7 black balls. A ball drawn randomly from bag I is transferred to bag II and then a ball is drawn randomly from bag II. Find the probability that the ball drawn is white.

SECTION D

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

32. Draw the rough sketch of the curve $y = \sin 2x$; where $\frac{\pi}{12} \leq x \leq \frac{\pi}{6}$.

Using integration, find the area of the region bounded by the curve $y = \sin 2x$ from the ordinates

$x = \frac{\pi}{12}$ to $x = \frac{\pi}{6}$ and the x-axis.

33. The curve $y = ax^2 + bx + c$; (where $a, b, c \in \mathbb{R}$ and $a \neq 0$) passes through the points $(-1, 0)$, $(2, 12)$ and $(3, 20)$. Use matrix method to determine the values of a , b and c by solving the system of linear equations in a , b and c . Find the equation of the curve. If $y = ax^2 + bx + c = 0$, then write the real roots of quadratic equation (if possible).
34. The vertices of a $\triangle ABC$ are $A(1, 1, 0)$, $B(1, 2, 1)$ and $C(-2, 2, -1)$. Find the equations of the medians through A and B . Use the equations so obtained to find the coordinates of the centroid.

OR

Find the Cartesian equation of a line L_2 which is the mirror image of the line L_1 with respect to line $L : \frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3}$, given that line L_1 passes through the point $P(1, 6, 3)$ and parallel to line L .

35. Discuss the continuity of $f(x) = \begin{cases} x e^{-\left(\frac{1}{|x|} + \frac{1}{x}\right)}, & \text{if } x \neq 0 \\ 0, & \text{if } x = 0 \end{cases}$ at $x = 0$.

Is it differentiable at the same point? Justify your answer.

OR

If $\sqrt{1+x^2} + \sqrt{1+y^2} = a(x-y)$, then show that $\frac{dy}{dx} = \sqrt{\frac{1+y^2}{1+x^2}}$.

SECTION E

(Question numbers 36 to 38 carry 4 marks each.)

This section contains **three Case-study / Passage based questions**.

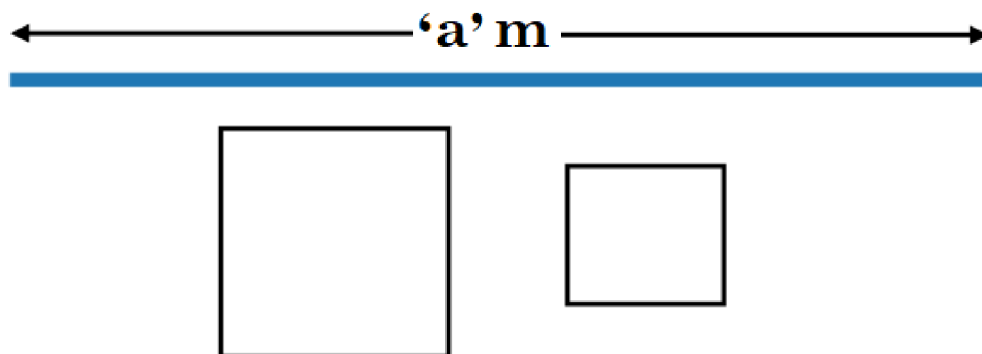
First two questions have **three sub-parts (i), (ii) and (iii) of marks 1, 1 and 2 respectively**.

Third question has **two sub-parts (i) and (ii) of 2 marks each**.

36. CASE STUDY I :

Sumaiya cuts a metallic wire of length 'a' m into two pieces. She uses both pieces to create two squares of different side lengths.

Assume that the wire of length 'x' m is used to make the first square.



Based on the above information, answer the following questions.

- Express the side lengths of both squares in terms of 'a' and 'x' only.
- Find an expression for the Combined area (A) of both squares in terms of 'x'.
- Determine the side lengths of both the squares (in terms of 'a') for which the Combined area (A) will be minimum. Use derivatives.

OR

- Using derivatives, find the minimum value of Combined area (A) of both squares in terms of 'a'.

37. CASE STUDY II :

Pratibha Vikas is an innovative program by the Government of Delhi, where cultural and literacy competitions are held between schools at cluster, block, district and state levels.

One of those competitions - Yogasana, is conducted under two categories : Middle school and High school. From South Delhi district, three students from middle school and two students from high school were selected for the state level.

Let $M = \{m_1, m_2, m_3\}$ and $H = \{h_1, h_2\}$, represent the set of students from middle school and high school respectively who got selected for the state level from that district.

A relation $R : M \rightarrow M$ is defined by $R = \{(x, y) : x \text{ and } y \text{ are students from the same category}\}$.

On the basis of the above information, answer the following questions.

(i) Check if the relation R is reflexive. Justify your answer.

(ii) Check if the relation R is symmetric. Justify your answer.

(iii) Check if the relation R is transitive. Is R an equivalence relation? Justify your answer.

OR

(iii) Let a function $f : M \rightarrow H$ is defined as $f = \{(m_1, h_1), (m_2, h_2), (m_3, h_2)\}$. Check whether the function f is one-one and onto. Justify your answer.

38. CASE STUDY III :

Based upon the results of regular medical check-ups in a hospital, it was found that out of 1000 people, 700 were very healthy, 200 maintained average health and 100 had a poor health record.

Let A_1 : People with good health, A_2 : People with average health, and A_3 : People with poor health.

During a pandemic, the data expressed that the chances of people contracting the disease from category A_1 , A_2 and A_3 are 25%, 35% and 50% respectively.

Using the information given above, answer the following questions.

(i) A person was tested randomly. What is the probability that he/she has contracted the disease?

(ii) Given that the person has not contracted the disease, what is the probability that the person is from category A_2 ?

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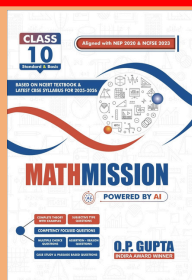
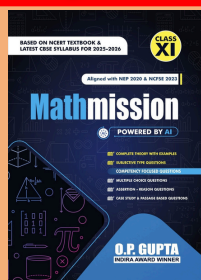
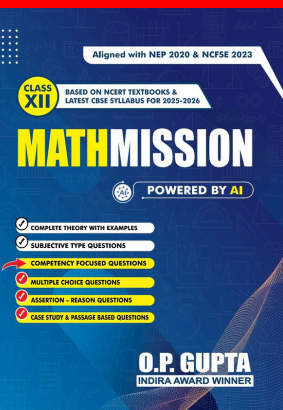
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ABOUT THE AUTHOR

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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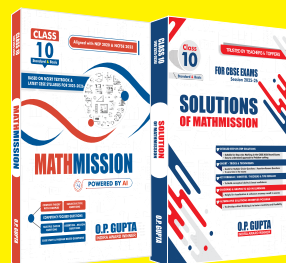
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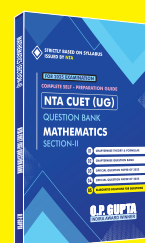
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