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MATHEMATICS (041)

SESSION 2025-26

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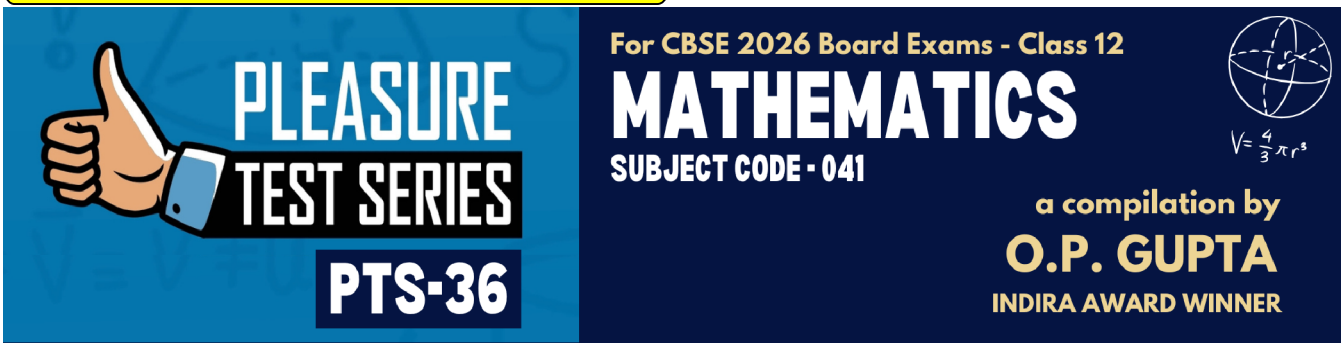


General Instructions : Same as given in PTS-01.

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 $A=\begin{pmatrix}1&0&0\\0&1&0\\0&0&1\end{pmatrix}$, then A^2 is equal to

(a) 2A (b) 3A (c) $-I$ (d) A

02. If A is a matrix of order 2×3, then each row of A contains

(a) 6 elements (b) 2 elements (c) 3 elements (d) 12 elements

03. If the vectors $a\hat{i}+a\hat{j}+c\hat{k}$, $\hat{i}+\hat{k}$ and $c\hat{i}+c\hat{j}+b\hat{k}$ are coplanar, then

(a) $c=ab$ (b) $a^2=bc$ (c) $c^2=ab$ (d) $b^2=ca$

04. The value of k, for which the function f defined as $f(x)=\begin{cases}\dfrac{\sqrt{1+kx}-\sqrt{1-kx}}{x}, & \text{if } x<0\\ \dfrac{2x+1}{x-1}, & \text{if } x\geq 0\end{cases}$ is

continuous at $x=0$, is

(a) 1 (b) -1 (c) 0 (d) ±1

05. $\int\dfrac{e^x(1+x)\,dx}{\cos^2(x\,e^x)}$ is equal to

(a) $\tan[e^x(1+x)]+C$ (b) $\cot[e^x(1+x)]+C$ (c) $\cot(x\,e^x)+C$ (d) $\tan(x\,e^x)+C$

06. If m and n respectively, are the order and degree of the differential equation

$y\left(\dfrac{dy}{dx}\right)^4-x^3\left(\dfrac{d^2y}{dx^2}\right)^2+xy=\sin x$, then $(m^2-n^2)=$

(a) 0 (b) 8 (c) 2 (d) 4

07. Area of the triangle formed by the vertices O, A, B where $\overrightarrow{OA}=\hat{i}+2\hat{j}+3\hat{k}$, $\overrightarrow{OB}=-3\hat{i}-2\hat{j}+\hat{k}$ is

(a) $2\sqrt{5}$ Sq. units (b) $5\sqrt{5}$ Sq. units (c) $\sqrt{5}$ Sq. units (d) $3\sqrt{5}$ Sq. units

08. The value of $\int_0^{\frac{\pi}{4}}\tan x\,dx$ is

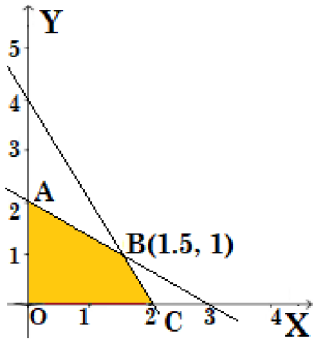
(a) $\log 2$ (b) $\dfrac{1}{2}\log 2$ (c) $-\dfrac{1}{2}\log 2$ (d) $-\log 2$

09. If A is a square matrix such that $A^2=I$, then $(A+I)^3+(A-I)^3$ is

(a) $8A$ (b) $5A$ (c) A (d) $I+A$

10. The corner points of the shaded bounded feasible region of an LPP are (0, 2), (1.5, 1) and (2, 0) as shown in the figure below. The maximum value of the objective function $F=2x+y$ occurs at

(a) (1.5, 1) only
(b) (2, 0) only
(c) (1.5, 1) and (2, 0) only
(d) at all the points of the line-segment joining (1.5, 1) and (2, 0)



11. The corner points of the feasible region determined by a set of constraints (linear inequalities) are P(0, 5), Q(3, 5), R(5, 0) and S(4, 1) and the objective function is $Z = ax + 2by$ where $a, b > 0$. The condition on a and b such that the maximum Z occurs at Q and S is

(a) $a - 2b = 0$ (b) $a - 3b = 0$ (c) $a - 5b = 0$ (d) $a - 8b = 0$

12. If $\begin{vmatrix} x+1 & x-1 \\ x-3 & x+2 \end{vmatrix} = \begin{vmatrix} 4 & -1 \\ 1 & 3 \end{vmatrix}$, then the possible value(s) of 'x' is/are

(a) $\pm\sqrt{3}$ (b) -2 (c) $\sqrt{3}$ (d) 2

13. If $A = \left[a_{ij}\right]_{3\times 3}$ is a square matrix and $|A| = 6$, then $|A\,(\text{adj.}\,A)| =$

(a) 36 (b) 216 (c) 1296 (d) 6

14. A box of oranges is inspected by examining three randomly selected oranges drawn without replacement. If all the three oranges are good, the box is approved for sale, otherwise, it is not approved. The probability that a box containing 15 oranges out of which 12 are good and 3 are bad ones will be approved for sale, is given by

(a) $\frac{47}{91}$ (b) $\frac{74}{91}$ (c) $\frac{44}{91}$ (d) $\frac{34}{91}$

15. For what value of λ, the vectors $2\hat{i} - \lambda\hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} + 8\hat{k}$ are orthogonal?

(a) 0 (b) 5 (c) -5 (d) 1

16. If $x = \sqrt{1+t^2}$, $y = \sqrt{1-t^2}$, then $\frac{dy}{dx}$ (in terms of x and y) is equal to

(a) $-\frac{y}{x}$ (b) $\frac{y}{x}$ (c) $-\frac{x}{y}$ (d) $\frac{x}{y}$

17. The general solution of the differential equation $\cos^2(x-2y) = \left(1 - 2\frac{dy}{dx}\right)$ is

(a) $y = \tan(x-2y) + C$ (b) $x = -\tan(x-2y) + C$
(c) $x = \tan(x-2y) + C$ (d) $x = \cot(x-2y) + C$

18. A is a point on the line joining the points (0, 5, –2) and (3, –1, 2). If the x-coordinate of A is 3, then

(a) A(3, 0, 0) (b) A(3, –1, –2) (c) A(3, 1, 2) (d) A(3, –1, 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) :** $\sin^{-1}\left(\sin\frac{2\pi}{3}\right)=\frac{2\pi}{3}$.

Reason (R) : $\sin^{-1}(\sin x)=x$, if $x\in\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$.

20. **Assertion (A) :** Cartesian equation of a line passing through the points (0, 0, 1) and (2, 4, 3) is $\frac{x}{1}=\frac{y}{2}=\frac{z-1}{1}$.

Reason (R) : The line passing through the points (x_1, y_1, z_1) and (x_2, y_2, z_2) is given by $\vec{r}=x_1\hat{i}+y_1\hat{j}+z_1\hat{k}+\lambda(x_2\hat{i}+y_2\hat{j}+z_2\hat{k})$.

SECTION B

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

21. Find the value of $\tan^{-1}\left[\tan\left(\frac{33\pi}{5}\right)\right]$.

OR

Prove that the function f is one-one, where $f:\mathbb{R}_+\to[4,\infty)$ given by $f(x)=x^2+4$.

22. Find a point on the curve $y^2=8x$, at which the abscissa and ordinate are changing at the same rate.

23. If $\vec{a}=\hat{i}+\hat{j}+\hat{k}$, $\vec{b}=2\hat{i}-\hat{j}+3\hat{k}$ and, $\vec{c}=\hat{i}-2\hat{j}+\hat{k}$, then find a unit vector which is parallel to the vector $2\vec{a}-\vec{b}+3\vec{c}$.

OR

The two vectors $\hat{j}+\hat{k}$ and $3\hat{i}-\hat{j}+4\hat{k}$ represent the two sides $\overrightarrow{AB}$ and $\overrightarrow{AC}$ respectively of triangle ABC. Find the length of the median through A.

24. If $y=\left(x+\frac{1}{x}\right)^x$, then find $\frac{dy}{dx}$.

25. Find the value of 'k' for which the following lines are perpendicular :

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

Hence, write the vector equations of both lines.

SECTION C

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

26. Find : $\int\frac{\sin 5x\,dx}{\sin 2x\sin 3x}$.

27. A company delivers electronic gadgets through two independent delivery partners, BlueFast and QuickShip. From past records, it is known that the probability that a parcel delivered by BlueFast reaches on time is 0.8 and the probability that a parcel delivered by QuickShip reaches on time is 0.9. Both companies operate independently of each other. Each morning, the company sends two separate parcels - one through BlueFast and another through QuickShip.

(i) What is the probability that both parcels reach on time?

(ii) What is the probability that at least one parcel is late?

(iii) If both parcels are sent, what is the probability that exactly one reaches on time?

(iv) If the parcel from QuickShip reaches on time, what is the probability that the parcel from BlueFast also reaches on time?

OR

A letter is known to have come either from TATANAGAR or from CALCUTTA.
On the envelope, just two consecutive letters TA are visible. What is the probability that the letters came from TATANAGAR?

28. Evaluate : $\int_1^3 |x^2 - 2x|\,dx$.

OR

Evaluate : $\int_0^{\pi} \frac{x \sin x}{4 + \cos^2 x}\,dx$. Use properties of definite integrals.

29. Solve the differential equation : $(x\,dy - y\,dx)\,y \sin\left(\frac{y}{x}\right) = (y\,dx + x\,dy)\,x \cos\left(\frac{y}{x}\right)$.

OR

Solve : $(\tan^{-1} y - x)dy = (1 + y^2)dx$.

30. Solve the following linear programming graphically.
To minimize : $Z = 3x + 7y$
Subject to constraints :

$x \geq 0$,

$y \geq 0$,

$x + y \leq 9$,

$x + y \geq 2$.

What will be the maximum value of Z?

31. Find : $\int \frac{(3 \sin x - 2)\cos x}{13 - \cos^2 x - 7 \sin x}\,dx$.

SECTION D

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

32. Sketch the curves $x - |y| = 0$ and $x - 2 = 0$.

Hence, determine the area of the bounded region, using integration.

33. Let R be relation defined on the set of natural number N as follows :
$R = \{(x, y) : 2x + y = 41;\ x, y \in N\}$. Check if the relation R is reflexive, symmetric and transitive. Is R an equivalence relation? Justify your answer.

OR

Let a relation R on set of natural numbers N be defined as
$(x, y) \in R \Leftrightarrow x^2 - 4xy + 3y^2 = 0\ \forall\ x, y \in N$.
Verify that R is reflexive but not symmetric and transitive.

34. Find the equations of the two lines through origin (0, 0, 0) such that each line is intersecting the line $\frac{x-3}{2} = \frac{y-3}{1} = \frac{z}{1}$ at an angle of $\frac{\pi}{3}$.

35. Using matrices, solve the following system of equations :
$3x + \frac{4}{y} + 7xz = 14,\ 2x - \frac{1}{y} + 3xz = 4,\ x + \frac{2}{y} - 3xz = 0$.

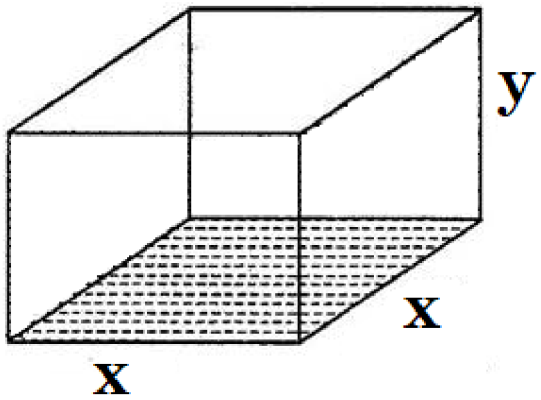
OR

Let $\Delta = \begin{vmatrix} 1+a & 1 & 1 \\ 1 & 1+b & 1 \\ 1 & 1 & 1+c \end{vmatrix}$. Then, prove that $\Delta = abc\left(1 + \frac{1}{a} + \frac{1}{b} + \frac{1}{c}\right) = abc + bc + ca + ab$.

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.



Some children of a residential society were inspired by their teachers to start a composting to ensure that biodegradable waste is recycled.
For this purpose, instead of each child doing it for only his/her house, children convinced the Resident Welfare Association (RWA) to do it as a society initiative. The president of welfare identified a square area in the local park.
Local authorities charged amount of ₹ 50 per sq. meter for the space so that there is no misuse of the space and Resident Welfare Association takes it seriously.
Association hired a local worker for digging out $250\ m^3$ and he charged ₹ $400 \times (\text{depth})^2$.

(i) Let side of square plot is 'x' and its depth is 'y' (both in meters), then write an expression for 'y' in terms of 'x'.
(ii) Express the total cost incurred, $C(y)$ for the construction of this pit in terms of 'y'.
(iii) Find the value of y (in m) for which $C'(y) = 0$. Also find $C''(y)$.
Hence, write minimum value of cost $C(y)$, (in ₹).

OR

(iii) If $C(y)$ is minimum, then what is the corresponding value of x (in m)?
Find the amount charged by worker (in ₹), if total cost $C(y)$ is minimum. Use derivatives.

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

The relation between the height of the plant (y in cm) with respect to exposure to sunlight is governed by the equation $y = 4x - \frac{1}{2}x^2$, where 'x' is the number of days exposed to sunlight.

(i) Find the rate of growth of the plant with respect to sunlight.
(ii) What is the number of days, it will take for the plant to grow to the maximum height?
(iii) What is the maximum height of the plant? What will be the height of the plant after 2 days?

OR

(iii) If the height of the plant is $\frac{7}{2}$ cm, then find the number of days it has been exposed to the sunlight ($x > 1$).

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

The reliability of a HIV test is specified as follows :
Of people having HIV, 90% of the test detects the disease but 10% goes undetected.
Of people free of HIV, 99% of the tests are judged as HIV negative but 1% are diagnosed as showing HIV positive. From a large population of which only 0.1% have HIV, one person is selected at random, given the HIV test, and the pathologist reports him/her HIV positive.

Let E_1 : Person actually having HIV and, E_2 : Person actually not having HIV.

Also let A: Person tested as positive.

(i) What is the probability that the person is actually not having HIV given that he is tested as HIV positive?

(ii) What is the probability that the person selected will be diagnosed as HIV positive?

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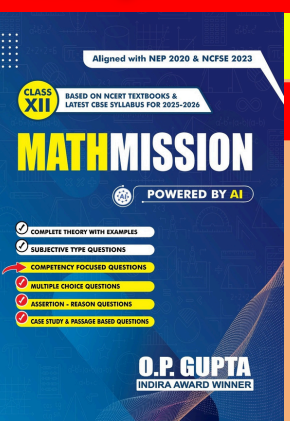

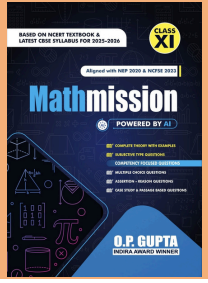

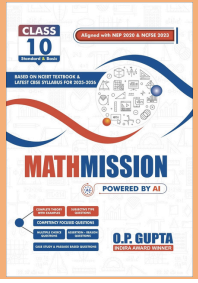

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ABOUT THE AUTHOR

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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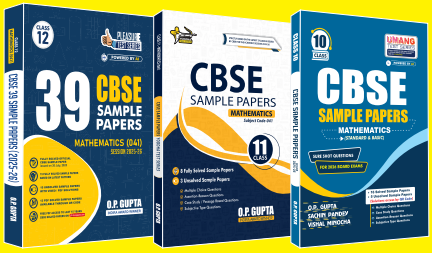

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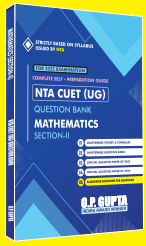

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