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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 $A=\begin{bmatrix}1 & 2 & -2\\ 0 & -1 & 3\end{bmatrix}$ satisfies $A+X=O$, then $X=$

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

02. If A is a square matrix of order 3, $|A'|=2$, then $|A'A|=$

(a) 8 (b) 2 (c) 4 (d) 16

03. If ΔABC be a right angled triangle such that $\angle B=\frac{\pi}{2}$, then which of the following is true?

(a) $|\overrightarrow{AB}|=|\overrightarrow{BC}|+|\overrightarrow{CA}|$ (b) $|\overrightarrow{AB}|^2=|\overrightarrow{BC}|^2+|\overrightarrow{CA}|^2$

(c) $\overrightarrow{AC}.\overrightarrow{AB}=0$ (d) $\overrightarrow{BC}.\overrightarrow{BA}=0$

04. The value of '8k' for which the function $f(x)=\begin{cases}\frac{1-\cos 2x}{8x^2}, & \text{if } x\neq 0\\ 2k, & \text{if } x=0\end{cases}$ is continuous at $x=0$, is

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

05. If $f'(x)=1-\frac{1}{x}$ and $f(1)=0$, then $f(x)=$

(a) $x-\log|x|+1$ (b) $x+\log|x|-1$ (c) $x-\log|x|-1$ (d) $x+\log|x|+1$

06. Integration factor for $\frac{dx}{dy}-x=\sin^2 y$ is

(a) e^y (b) e^{-y} (c) e^x (d) e^{-x}

07. The solution set of the inequality $3x+5y\geq 4$ is

(a) an open half-plane not containing the origin

(b) an open half-plane containing the origin

(c) the whole XY-plane not containing the line $3x+5y=4$

(d) a closed half-plane containing the origin

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

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

09. The value of $\int_0^{\pi}|\cos x|\,dx$ is

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

10. If A and B are square matrices of the same order, then $(AB')' =$

(a) BA^{-1} (b) $A'B'$ (c) $B'A'$ (d) BA'

11. For the following LPP,

Maximum $Z = 3x + 4y$

Subject to constraints $x - y \geq 1,\ x \leq 3,\ x \geq 0,\ y \geq 0$.

The maximum value is

(a) 17 (b) 18 (c) 3 (d) 9

12. If $\begin{vmatrix} 2x & 2 \\ 1 & x \end{vmatrix} = \begin{vmatrix} 1 & 4 \\ 0 & 2 \end{vmatrix}$, then the possible value (s) of 'x' is/are

(a) $2, -2$ (b) $1, -1$ (c) $\sqrt{2}, -\sqrt{2}$ (d) $\pm 2\sqrt{2}$

13. If $A = \left[a_{ij}\right]_{3\times 3}$ and $|A| = 4$, then $|4A| =$

(a) 4^8 (b) 4^4 (c) 2^4 (d) 2^6

14. If $2P(A) = P(B) = \frac{5}{13}$ and A and B are independent events, then $P(A \cap B) =$

(a) $\frac{1}{26}$ (b) $\frac{5}{26}$ (c) $\frac{11}{13}$ (d) $\frac{25}{338}$

15. The general solution of the differential equation $\sqrt{1-y^2}\,dx - \sqrt{1-x^2}\,dy = 0$ is

(a) $\sin^{-1}x^2 - \sin^{-1}y^2 = C$ (b) $\tan^{-1}x - \tan^{-1}y = C$

(c) $\sin^{-1}x - \sin^{-1}y = C$ (d) $\sin^{-1}\sqrt{1-x^2} - \sin^{-1}\sqrt{1-y^2} = C$

16. If $y = \cos^{-1}x$ implies that $(1-x^2)y_2 + k\,x\,y_1 = 0$, then k is equal to

(a) 1 (b) -1 (c) 2 (d) any Real no.

17. Which of the following represents one of the vector components of vector $2\hat{i} - \hat{j} + 7\hat{k}$?

(a) 2 (b) -1 (c) 7 (d) $-\hat{j}$

18. For $\vec{r} = 2\hat{i} - \hat{j} + 7\hat{k} + \lambda(\sqrt{2}\hat{i} - \hat{j} + \hat{k})$, the direction angles are

(a) $\frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{3}$ (b) $\frac{\pi}{4}, \frac{2\pi}{3}, \frac{\pi}{3}$ (c) $\frac{3\pi}{4}, \frac{2\pi}{3}, \frac{\pi}{6}$ (d) $\frac{3\pi}{4}, \frac{\pi}{3}, \frac{2\pi}{3}$

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) :** Principal value of $\sec^{-1}\left(\sec\frac{4\pi}{3}\right) = \frac{2\pi}{3}$.

Reason (R) : For $y = \text{cosec}^{-1}x$, $-\pi \leq y \leq \pi$.

20. **Assertion (A) :** A unit vector in the direction of $\hat{i} - 2\hat{j} + 2\hat{k}$ is $\frac{\hat{i} - 2\hat{j} + 2\hat{k}}{3}$.

Reason (R) : For the vector $\vec{r} = x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$, the unit vector in the direction of $\vec{r}$ is given by $\frac{x_1\hat{i} + y_1\hat{j} + z_1\hat{k}}{\sqrt{x_1^2 + y_1^2 + z_1^2}}$.

SECTION B

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

21. Simplify : $\sin^{-1}\left[2x\sqrt{1-x^2}\right], \frac{1}{\sqrt{2}} \le x \le 1$.

OR

Consider $f : \mathbb{R} \to \mathbb{R}$, given by $f(x) = 4x + 3$. Show that f is one-one and onto both.

22. The surface area (A) of a cube is increasing at the rate of $3.6\ cm^2/s$. How fast is the volume (V) increasing, when the edge length of cube is $a = 10\ cm$?

23. If the sum of two unit vectors $\hat{a}$ and $\hat{b}$ is also a unit vector, then show that the magnitude of their difference is $\sqrt{3}$.

OR

Write the direction ratios of the line $\frac{x+3}{2} = \frac{5-y}{3}, z = -2$.

Hence, find the vector equation of above line.

24. If $\sin^2 y + \cos(xy) = \pi$, then find $\frac{dy}{dx}$.

25. Find the direction cosines of $\overrightarrow{AB}$, if it is given that $A(\hat{j} - 2\hat{k})$ and $B(\hat{i} + 3\hat{j} + \hat{k})$.

SECTION C

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

26. Find : $\int \sqrt{\frac{1-x}{1+x}}\, dx$.

OR

Find : $\int \frac{\cos x\ dx}{\sqrt{\sin^2 x - 2\sin x - 3}}$.

27. Meteorological Department conducted a study on weather predictions for October, 2025 in Delhi NCR. The study revealed the following information.

- Probability that it was predicted to rain on a given day = 0.4
- Probability that it was not predicted to rain = 0.6
- Probability that it actually rained when rain was predicted = 0.7
- Probability that it actually rained even though no rain was predicted = 0.2

A random day in October, 2025 is chosen. Find the probability that it actually rained on that day.

OR

A card is lost from a pack of 52 playing cards. Two cards are drawn from the remaining cards. What is the probability that they both are diamonds?

28. Evaluate : $\int_{-5}^{5} \frac{x^2\ dx}{1+2^x}$.

29. Solve the differential equation : $e^x\, dy + (y e^x + 2x)\, dx = 0$.

OR

Solve the differential equation : $(x+1)\frac{dy}{dx} = 2e^{-y} - 1,\ y(0) = 0$.

30. Solve the following Linear Programming Problem graphically.

Maximize $Z = 10500x + 9000y$ subject to $x + y \le 50,\ 2x + y \le 80,\ x \ge 0,\ y \ge 0$.

Mention the point at which maximum value of Z is obtained.

31. Find : $\int \frac{\sqrt{\cos 2x}}{\cos x} dx$.

SECTION D

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

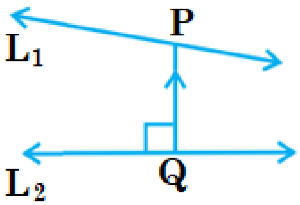
32. Find the area of the region bounded by the curve $y = x^2$ and the line $y = 4$.

33. Let N be the set of all natural numbers and R be a relation on $N \times N$ defined by $(a, b) R (c, d) \Leftrightarrow ad = bc$ for all $(a, b), (c, d) \in N \times N$.
Show that R is an equivalence relation on $N \times N$.

OR

Show that $f : [-1, 1] \to \mathbb{R}$, given by $f(x) = \frac{x}{x+2}$ is one-one.
Is the function, $f : [-1, 1] \to \mathbb{R}$ an onto function?

34. Given two lines, $L_1 : \vec{r} = \hat{i} + 2\hat{j} + \hat{k} + \lambda(\hat{i} - \hat{j} + \hat{k})$ and $L_2 : \vec{r} = 2\hat{i} - \hat{j} - \hat{k} + \mu(2\hat{i} + \hat{j} + 2\hat{k})$.



Write the equation of line PQ, as seen in the diagram above, if it is given that the line PQ is perpendicular to both the lines L_1 and L_2.

OR

Let ABCD is a parallelogram. The position vectors of the points A, B and C are respectively given as $4\hat{i} + 5\hat{j} - 10\hat{k}$, $2\hat{i} - 3\hat{j} + 4\hat{k}$ and $2\hat{j} - \hat{i} - \hat{k}$. Find the vector equation of the diagonal BD.

35. If $A = \begin{pmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$, find adj.A and verify that $A(\text{adj.}A) = (\text{adj.}A)A = |A| I_3$.

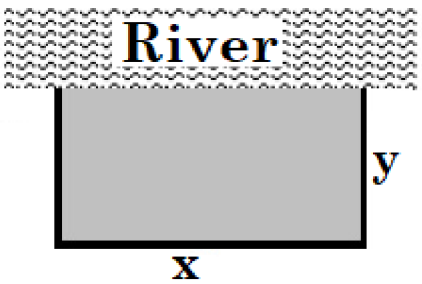
SECTION E

*(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 farmer Ram Kishan wishes to fence off his rectangular field of given area ($A = 100$ units^2).

The length of the field lies along a straight river.



(i) Assuming that along the river, no fencing is needed for the field, what should be the length (L) of fencing around the field, in terms of x and y? Here x and y denote the length and breadth of the field, respectively (see the diagram given above).

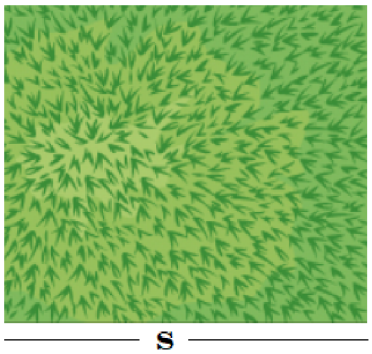
(ii) Find the length of fencing (L) in terms of x alone.

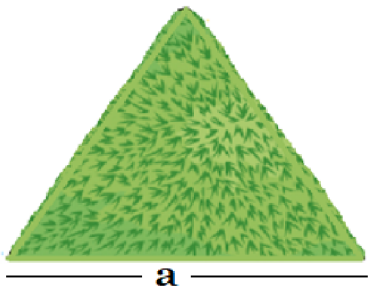
(iii) For what value of x, the length of fencing (L) will be least? Use derivatives.

OR

(iii) What is the value of y, if the length of fencing (L) is least?
Also write the minimum value of L.

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





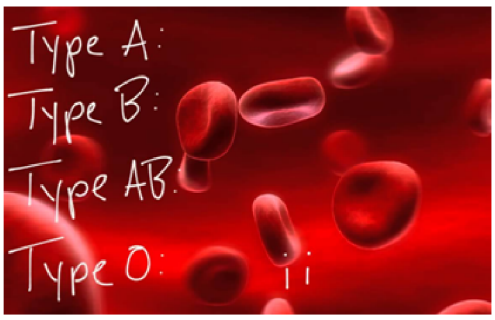
A farmer Nikhil Jha has two small pieces of agricultural land - one is in the shape of square and, the other is in the shape of an equilateral triangle.
To save his crops from stray animals, he decides to fence his fields.
For this purpose, he has a wire of length 40 m. This wire has to be cut into two pieces to fence around the fields.
The first piece of wire of length x m, is used for fencing around the triangular field and the other piece is used for the square field.

(i) Obtain the area of triangular field in terms of x.
(ii) Obtain the area of square field in terms of x.
(iii) For what value of x, the combined area (A) of triangular and square field is minimum?
What is the length of wire used for fencing the square field? Use derivatives.

OR

(iii) Using second derivatives, write the minimum value of combined area (A) of triangular and square field.

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



Suppose that 6% of the people with blood group O are left handed and 10% of those with other blood groups are left handed. It is known that 30% of the people have blood group O.

(i) What is the probability that the person selected is a left handed person? Write your answer in percentage.
(ii) If a left handed person is selected at random, what is the probability that he/she will have blood group O?

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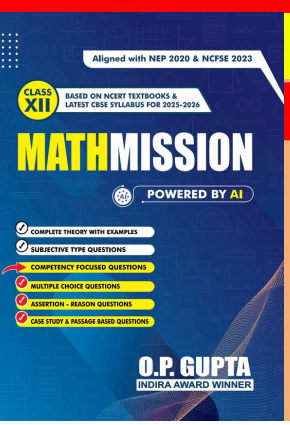

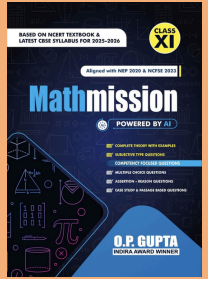

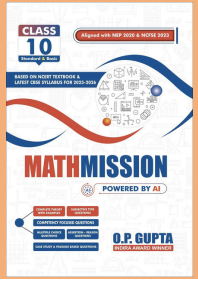

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ABOUT THE AUTHOR

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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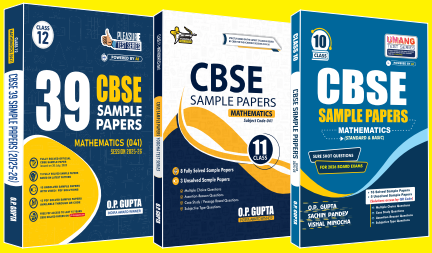

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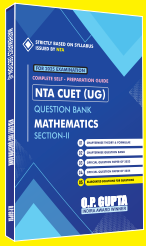

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