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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 is a symmetric matrix of order 3, then which of the following is not symmetric matrix?

(a) $A + A^T$ (b) $A.A^T$ (c) $A - A^T$ (d) $\frac{1}{2}(A + A^T)$

02. Let $P = ACB$. If $A = \begin{pmatrix} 2 & 3 \\ 3 & 2 \end{pmatrix}$, $B = \begin{pmatrix} 2 \\ 1 \\ 5 \end{pmatrix}$ and $C = \begin{pmatrix} 0 & 0 & 4 \\ 5 & 1 & -1 \end{pmatrix}$, then the order of matrix P is

(a) 1×2 (b) 2×3 (c) 2×2 (d) 2×1

03. If $\vec{a} = \hat{i} + \hat{j} - 2\hat{k}$ and, $\vec{b} = -\hat{i} + 2\hat{j} + 2\hat{k}$ are two vectors, then $\vec{a} + \vec{b}$ equals

(a) -1 (b) $2\hat{i} - \hat{j} - 4\hat{k}$ (c) $3\hat{j}$ (d) $-2\hat{i} + \hat{j} + 4\hat{k}$

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

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

05. $\int \frac{\sec^2 x}{\tan x - 1} dx$ equals

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

06. The solution of D.E. $\frac{dy}{dx} = \frac{y}{x^2}$, $y > 0$ is

(a) $y = k e^{-\frac{1}{x}}$ (b) $y = k e^{\frac{1}{x}}$ (c) $y = k e^{-x}$ (d) $y = k e^{x}$

07. The maximum value of $Z = 4x + 3y$ subject to constraint $x + y \leq 8$; $x, y \geq 0$ is

(a) 56 (b) 32 (c) 65 (d) 24

08. The scalar projection of the vector $3\hat{i} - x\hat{k}$ on the vector $\hat{i} + \sqrt{2}\hat{j} + \hat{k}$ is $\frac{1}{2}$, then $x =$

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

09. The shortest distance between the lines $\vec{r} = \vec{a}_1 + \lambda\vec{b}$ and $\vec{r} = \vec{a}_2 + \mu\vec{b}$ is given by

(a) $\left|\frac{\vec{b} \times (\vec{a}_2 - \vec{a}_1)}{\vec{b}}\right|$ (b) $\frac{|\vec{b} \times (\vec{a}_2 - \vec{a}_1)|}{|\vec{a}_2 - \vec{a}_1|}$ (c) $\frac{|\vec{b}.(\vec{a}_2 - \vec{a}_1)|}{|\vec{b}|}$ (d) $\frac{|\vec{b} \times (\vec{a}_2 - \vec{a}_1)|}{|\vec{b}|}$

10. If $\Delta = \begin{vmatrix} 1 & 3 & -2 \\ 4 & -5 & 6 \\ 3 & 5 & 2 \end{vmatrix}$, then the cofactor of a_{32} (the element of third row and second column) is

(a) 14 (b) –14 (c) 3 (d) 2

11. If a linear programming problem has same optimal value at two points, then it has

(a) infinite solutions (b) two solutions (c) unique solution (d) three solutions

12. If a non-singular matrix A satisfying $2A^2 + A - I = O$ then, $A^{-1} =$

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

13. If A is square matrix of order 3×3 such that $|\text{adj.}A| = 16$, such that $|2A|^2 = 2^x$, then $x =$

(a) 1 (b) 2 (c) 8 (d) 10

14. Which of the following may represent priori probability of the hypothesis E_i, when Bayes' theorem is applied?

(a) $P(A)$ (b) $P(E_i)$ (c) $P(E_i \mid A)$ (d) $P(\overline{A})$

15. The general solution of the differential equation $\frac{dy}{dx} = \frac{x}{y}$ is

(a) $y^2 = x^2 + C$ (b) $x - y = C$ (c) $xy = C$ (d) $x - y^2 = C$

16. If $y^{\frac{1}{x}} = a$, $(a > 0)$, then $\frac{dy}{dx} =$

(a) y (b) ay (c) a^x (d) $y(\log_e a)$

17. Let $A = \{m, a, t, h\}$. If a relation R in the set A is given by $R = \{(m, m), (a, t), (t, a), (h, t), (t, h)\}$, then R is

(a) only reflexive (b) only symmetric (c) only transitive (d) equivalence

18. Vector equation of line passing through (1, 0, –2) and parallel to y-axis, is

(a) $\vec{r} = \hat{j} + \lambda(\hat{i} - 2\hat{k})$ (b) $\vec{r} = \hat{i} - 2\hat{k} + \lambda(\hat{i})$ (c) $\vec{r} = \hat{i} - 2\hat{j} + \lambda(\hat{j})$ (d) $\vec{r} = \hat{i} - 2\hat{k} + \lambda(\hat{j})$

*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) :** Unit vector along $\hat{i} + 2\hat{j} - \hat{k}$ is $\pm\left(\frac{\hat{i} + 2\hat{j} - \hat{k}}{\sqrt{6}}\right)$.

Reason (R) : For two non-zero vectors $\vec{a}$ and $\vec{b}$, $\vec{a}.\vec{b} = 0$ implies $\vec{a} \perp \vec{b}$.

20. **Assertion (A) :** $\int_{-\pi}^{\pi} (x + \sin x)\,dx = 0$.

Reason (R) : $\int_{-a}^{a} f(x)\,dx = \begin{cases} 2\int_0^a f(x)\,dx, & \text{if } f(-x) = f(x) \\ 0, & \text{if } f(-x) = -f(x) \end{cases}$.

SECTION B

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

21. A relation R in the set of real numbers $\mathbb{R}$ is given by $R = \{(a, b) : a > b, \text{ such that } a, b \in \mathbb{R}\}$. Check the transitivity of relation R. Is it symmetric?

OR

Find the value of $\text{cosec}^{-1}\left[\text{cosec}\left(\frac{3\pi}{5}\right)\right]$.

22. Find the interval in which $f(x) = \cos 3x,\ x \in \left[0, \frac{\pi}{2}\right]$ is increasing and/or decreasing.

23. Write the unit vectors which are perpendicular to both the vectors $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$.

OR

The equations of two perpendicular lines are $x = ay + b,\ z = cy + d$ and $x = ty + u,\ z = vy + w$. Write the value of $(a\,t + c\,v)$.

24. If $\cos y = x\cos(a + y)$, then prove that $\frac{dy}{dx} = \frac{\cos^2(a+y)}{\sin a}$.

25. If $|\vec{a}| = 4$ and $-3 \le \lambda \le 2$, then find the range of $|\lambda\vec{a}|$.

SECTION C

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

26. Find : $\int \frac{\cos x}{\cos 3x}\,dx$.

27. Two integers are selected at random from the integers one to eleven. If their sum is even, find the probability that both the numbers are odd.

OR

A bag contains 5 red and 4 black balls, a second bag contains 3 red and 6 black balls. One of the two bags is selected at random and two balls are drawn at random (without replacement). What is the probability that both the balls drawn are red?

28. Evaluate : $\int_{-\pi}^{\pi} \frac{\cos^2 x}{1 + e^x}\,dx$.

OR

Evaluate : $\int_{0}^{\frac{3}{2}} |x\cos(\pi x)|\,dx$.

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

OR

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

30. Solve the following Linear Programming Problem graphically :

Minimize $Z = 5x + 8y$

subject to constraints $x + y \le 5, x \le 4, y \ge 2, x \ge 0,\ y \ge 0$.

Also, write the coordinate of point at which Z_{min} is obtained.

31. Find : $\int \frac{e^x\,dx}{e^{2x} + 4e^x + 3}$.

SECTION D

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

32. Find the area enclosed by the parabola $4y = 3x^2$ and the line $2y = 3x + 12$.

33. Find the value of 'λ' for which the following lines are perpendicular to each other :

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

Hence, find whether the lines intersect or not (use the concept of shortest distance).

OR

Find the foot of perpendicular drawn from the point (2, 3,–8) to the line $\frac{4-x}{2}=\frac{y}{6}=\frac{1-z}{3}$.

Also, find the perpendicular distance from the given point to the line.

34. Determine whether the relation R defined on the set R of all real numbers as $R=\{(a,b):a,b\in R \text{ and } a-b+\sqrt{3}\in S$, where S is the set of all irrational numbers$\}$, is reflexive, symmetric and transitive.

OR

Consider $f:\mathbb{R}-\left\{-\frac{4}{3}\right\}\to\mathbb{R}-\left\{\frac{4}{3}\right\}$ given by $f(x)=\frac{4x+3}{3x+4}$.

Show that f is one-one and onto.

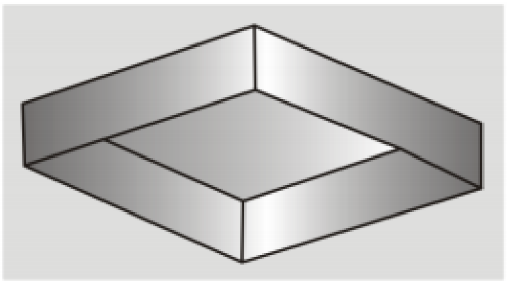
35. Using matrices, solve the following system of equations :

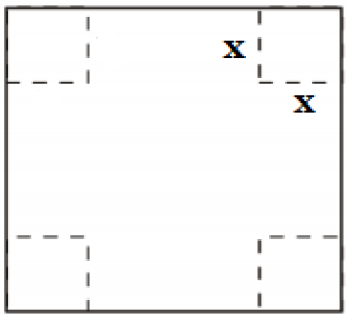
$3x+4y+5z=18,\ 2x-y+8z=13,$ and $5x-2y+7z=20$.

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 the answer the questions given below.





A factory makes an open cardboard box for a jewellery shop from a square sheet of side 18 cm by cutting off squares from each corner and folding up the flaps.
Assume that x is the side-length of each square cut from the corners.

(i) Write the volume (V) of the open box as a function of x, where 'x' is the side-length of each square to be cut-off from the corners.

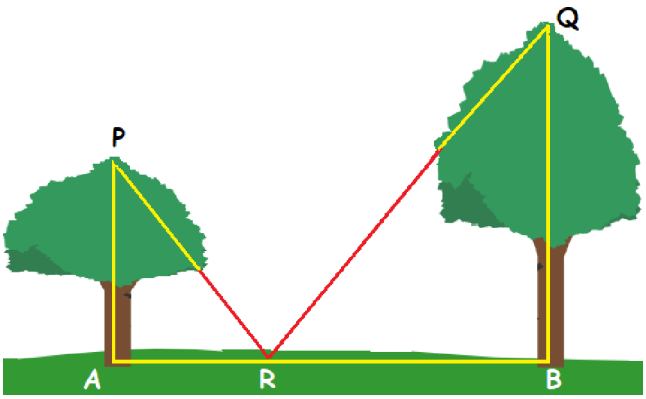
(ii) Write the conditions on $\frac{dV}{dx}$ and $\frac{d^2V}{dx^2}$, so that the volume (V) is maximum.

(iii) Find the maximum volume (V) of the open box. Also find the total area of the removed squares.

OR

(iii) What should be the side of square to be cut off so that the volume (V) is maximum?

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



Reeta goes for walk in a Community Park daily.
She notices two trees in a line (as seen in the figure above), whose heights are $AP = 16$ m and $BQ = 22$ m respectively, are 20 m apart from each other.

(i) Reeta stands at a point (*say*, R) in between these trees such that $AR = x$ m.
Obtain an expression for $RP^2 + RQ^2$, in terms of x.

(ii) Let $f(x) = RP^2 + RQ^2$. Then, find $f'(x)$.

(iii) Is the function $f(x)$ differentiable in $x \in (0, 20)$? Find the intervals in which, $f(x)$ is strictly increasing / decreasing.

OR

(iii) At what value of x, $f'(x) = 0$? Can we say that $f(x)$ is minimum?
Also write the minimum value of $f(x)$. Use second derivative test.

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

In an office canteen, there are two automatic coffee machines, A and B. Both machines work independently of each other.

- Probability that Machine A gives a perfect cup of coffee = 0.9
- Probability that Machine B gives a perfect cup of coffee = 0.8

(i) Find the probability that both machines give perfect coffee on a given morning.
(ii) Find the probability that at least one machine gives perfect coffee.

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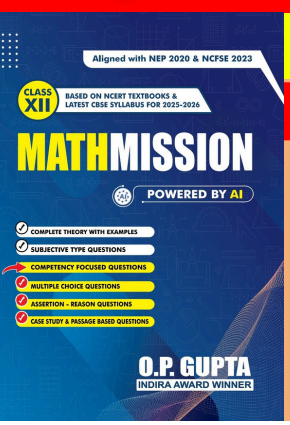

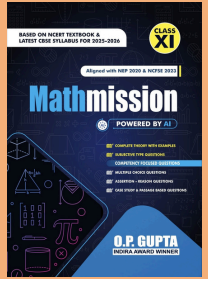

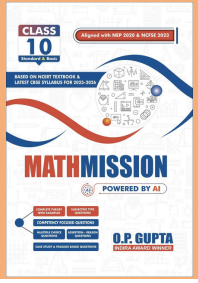

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ABOUT THE AUTHOR

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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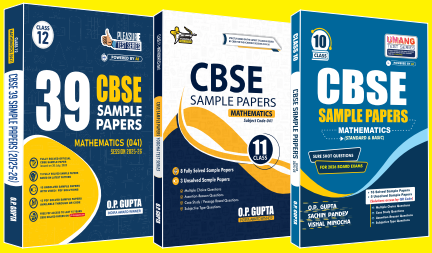

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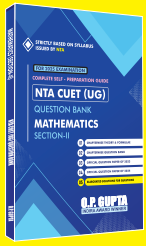

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