SECOND YEAR HIGHER SECONDARY
SECOND TERMINAL EXAMINATION, DECEMBER-2025

Part – III

Time : 2 Hours

MATHEMATICS (SCIENCE)   Cool-off time : 15 Minutes

Maximum : 60 scores

General Instructions to Candidates :

- There is a 'Cool-off time' of 15 minutes in addition to the writing time.
- Use the 'Cool-off time' to get familiar with questions and to plan your answers.
- Read questions carefully before answering.
- Read the instructions carefully.
- Calculations, figures and graphs should be shown in the answer sheet itself.
- Malayalam version of the questions is also provided.
- Give equations wherever necessary.
- Electronic devices except non-programmable calculators are not allowed in the Examination Hall.

വിദ്യാർത്ഥികൾക്കുള്ള പൊതുനിർദ്ദേശങ്ങൾ :

- നിർദ്ദിഷ്ട സമയത്തിന് പുറമേ 15 മിനിറ്റ് 'കൂൾ ഓഫ്ടൈം' ഉണ്ടായിരിക്കും.
- 'കൂൾ ഓഫ് ടൈം' ചോദ്യങ്ങൾ പരിചയപ്പെടാനും ഉത്തരങ്ങൾ ആസൂത്രണം ചെയ്യാനും ഉപയോഗിക്കുക.
- ഉത്തരങ്ങൾ എഴുതുന്നതിന് മുമ്പ് ചോദ്യങ്ങൾ ശ്രദ്ധാപൂർവ്വം വായിക്കണം.
- നിർദ്ദേശങ്ങൾ മുഴുവനും ശ്രദ്ധാപൂർവ്വം വായിക്കണം.
- കണക്ക് കൂട്ടലുകൾ, ചിത്രങ്ങൾ, ഗ്രാഫുകൾ, എന്നിവ ഉത്തരപേപ്പറിൽ തന്നെ ഉണ്ടായിരിക്കണം.
- ചോദ്യങ്ങൾ മലയാളത്തിലും നല്ലിയിട്ടുണ്ട്.
- ആവശ്യമുള്ള സ്ഥലത്ത് സമവാക്യങ്ങൾ കൊടുക്കണം.
- പ്രോഗ്രാമുകൾ ചെയ്യാനാകാത്ത കാൽക്കുലേറ്ററുകൾ ഒഴികെയുള്ള ഒരു ഇലക്ട്രോണിക് ഉപകരണവും പരീക്ഷാഹാളിൽ ഉപയോഗിക്കുവാൻ പാടില്ല.

Answer any 6 questions from 1 to 8. Each carries 3 scores. $(6 \times 3 = 18)$

1. (i) Let R be a relation defined on $A = \{1, 2, 3\}$ by

   $R = \{(1, 1), (2, 2), (3, 3), (1, 3)\}$. Then R is

   (a) reflexive only

   (b) transitive only

   (c) reflexive but not transitive

   (d) reflexive and transitive   **(1)**

   (ii) Make the relation R Equivalence by adding minimum number of ordered pair.   **(1)**

   (iii) Write the equivalence class [1]   **(1)**

2. (i) $\sin^{-1}x : [-1, 1] \to A$

   Write an example of A other than principal value branch.   **(1)**

   (ii) Simplify :

   $$\tan^{-1}\left(\frac{\cos x}{1-\sin x}\right), \frac{-\pi}{2} < x < \frac{3\pi}{2}$$ **(2)**

3. (i) $A = \begin{bmatrix} a & c & 0 \\ b & d & 0 \\ 0 & 0 & b \end{bmatrix}$ is a scalar matrix. Find the value of $a + 2b + 3c + d$.   **(1)**

   (ii) $A = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$, $B = [-2 \quad -1 \quad -4]$

   Find $B^T A^T$.   **(2)**

4. Solve the system of equations using matrix method :

   $2x + 3y = 4$; $4x + 5y = 6$ **(3)**

5. (i) The set of all points of discontinuity of $f(x) = \dfrac{1}{x - [x]}$ is _____.

   (a) [0, 1]   (b) (0, 1)

   (c) R   (d) Z   (1)

   (ii) Examine the continuity of the function $f(x) = \begin{cases} \dfrac{\sin 2x}{\sin 3x} & , \quad x \neq 0 \\ 2 & , \quad x = 0 \end{cases}$ at $x = 0$ (2)

6. The surface area of a cube increases at the rate of 72 cm²/sec. Find the rate of change of its volume, when the edge of the cube is 3 cm.   (3)

7. (i) Evaluate $\displaystyle\int \dfrac{x^2 \tan^{-1}(x^3)}{1 + x^6}\, dx$ (1½)

   (ii) If $\displaystyle\int_0^a \dfrac{1}{4 + x^2}\, dx = \dfrac{\pi}{6}$, then find the value of a.   (1½)

8. If the vector $8i + aj$ is of magnitude 10 in the direction of the vector $4i - 3j$, find the value of a.   (3)

Answer any 6 questions from 9 to 16. Each carries 4 scores. (6 × 4 = 24)

9. (i) The function $f(x) = |x| + |x + 2|$ is

   (a) continuous, but not differentiable at $x = 0$ and $x = 2$

   (b) differentiable but not continuous at $x = 0$ and $x = 2$

   (c) continuous, but not differentiable at $x = 0$ and $x = -2$

   (d) differentiable but not continuous at $x = 0$ and $x = -2$ (1)

   (ii) If $y^x = x^y$, find $\dfrac{dy}{dx}$.   (3)

10. (i) $f(x) = (x-1) e^x + 1$ is an increasing function, then which of the following is correct ?

   (a) $x > 0$ (b) $x \geq 0$

   (c) $x < 0$ (d) $x \leq 0$ (1)

   (ii) Find the intervals in which the function $f(x) = \sin x + \cos x$; $0 \leq x \leq 2\pi$ is increasing and decreasing.   (3)

11. Show that of among all rectangles inscribed in a given circle, the square has maximum area.   (4)

12. (i) Draw a rough sketch of the curve $y^2 = 16 - x^2$.   (1)

   (ii) Hence find the area bounded by the curve $y^2 = 16 - x^2$ in the IIIrd quadrant using integration.   (3)

13. Evaluate $\displaystyle\int_{0}^{a} \frac{\sqrt{x}}{\sqrt{x} + \sqrt{a-x}} \, dx$ (4)

14. (i) Find the order and degree of the differential equation :

$$\frac{d^3y}{dx^3} + x\left(\frac{dy}{dx}\right)^5 = 4 \log\left(\frac{d^4y}{dx^4}\right)$$ (1)

   (ii) In a bank, principal increases continuously at the rate of 5% per year. In how many years ₹ 1,000 double itself ? (Find using differential equation)   (3)

15. A, B, C are three points having position vectors $2i + 3j + 4k$, $7i + 5j + 8k$ and $-3i + 7j + 11k$ respectively.

    (i) How far is the point A from point B ?   (1)

    (ii) Find the measure of $\angle CAB$.   (2)

    (iii) Find the projection of $\overrightarrow{AC}$ on $\overrightarrow{AB}$.   (1)

16. (i) The lines $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ and $\frac{x-1}{-2} = \frac{y-2}{-4} = \frac{z-3}{-6}$ are

        (a) parallel   (b) intersecting

        (c) skew lines   (d) perpendicular   (1)

    (ii) Find the vector equation of a line passing through $(2, -1, 3)$ and equally inclined to the axes.   (3)

Answer any 3 questions from 17 to 20. Each carries 6 scores. $(3 \times 6 = 18)$

17. Integrate the following w.r.t. x :

    (i) $\dfrac{5x + 3}{\sqrt{x^2 + 4x + 10}}$ (3)

    (ii) $\sin^{-1} x$ (3)

18. (i) Find the solution of the differential equation

        $(1 + x^2)\, dy + 2xy\, dx = \cot x\, dx$ (3)

    (ii) Solve the differential equation

        $\dfrac{dy}{dx} = xy + x + y + 1$ (3)

19. (i) The angle between the vectors $\vec{a} \times \vec{b}$ and $\vec{b} \times \vec{a}$ is _____ (1)

   (ii) Let $\vec{a} = i - j$, $\vec{b} = 3j - k$ and $\vec{c} = 7i - k$. Find a vector $\vec{d}$ which is perpendicular to both $\vec{a}$ and $\vec{b}$, and $\vec{c} \cdot \vec{d} = 1$. (2½)

   (iii) Find the area of the triangle with vertices A (1, 1, 2), B(2, 3, 5), C(1, 5, 5) (2½)

20. (i) Find the angle between the lines $\dfrac{x+3}{3} = \dfrac{y-1}{5} = \dfrac{z+3}{4}$ and $\dfrac{x+1}{1} = \dfrac{y-4}{1} = \dfrac{z-5}{2}$. (2)

   (ii) Find the shortest distance between the lines $\vec{r} = i + 2j + k + \lambda\,(i - j + k)$ and $\vec{r} = 2i - j - k + \mu\,(2i + j + 2k)$ (4)

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