SY-4027

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 ഓഫ് ടൈം' 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 നല്കിയിട്ടുണ്ട്.
- 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 × 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) $A = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}, B = \begin{bmatrix} -2 & -1 & -4 \end{bmatrix}$

   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 $f(x) = \frac{1}{x-[x]}$ is ________.

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

(c) R (d) Z **(1)**

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

6. The surface area of a cube increases at the rate of 72 cm^2/sec. Find the rate of change of its volume, when the edge of the cube is 3 cm. **(3)**

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

(ii) If $\int_0^a \frac{1}{4 + x^2} dx = \frac{\pi}{6}$, 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 $\frac{dy}{dx}$. **(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 III[rd] quadrant using integration. **(3)**

13. Evaluate $\int_0^a \frac{\sqrt{x}}{\sqrt{x} + \sqrt{a-x}}\, dx$ **(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 $\vec{AC}$ on $\vec{AB}$. **(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 × 6 = 18)**

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

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

$\frac{dy}{dx} = xy + x + y + 1$ **(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 $\frac{x+3}{3} = \frac{y-1}{5} = \frac{z+3}{4}$ and $\frac{x+1}{1} = \frac{y-4}{1} = \frac{z-5}{2}$. **(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)**
