

Indian Maritime University
(A Central University, Govt of India)
End Semester Examinations – December 2025
Programme Name: B Tech (ME)
Semester: First
Subject Code: UG11T5102
Subject Name: Engineering Mathematics I

Date: 09.12.2025

Max Marks: 70

Duration: 03 Hrs

Pass Marks: 35

General Instructions

- (i) All Sections (A, B & C) are to be attempted.
- (ii) Options, if any, are specified in respective section.

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable. 10x1=10

1. If A is 6 x 9 matrix and Rank of A is 4, then the Nullity of A is

- a) 6 b) 9 c) 3 d) 5

2. For an orthogonal matrix A the valid equality is

- a) $A^T = A^{-1}$ b) $A = A^{-1}$ c) $A^T = A$ d) $\det(A) = 0$

3. If $x = r \cos \theta$, $y = r \sin \theta$, then $\frac{\partial(r, \theta)}{\partial(x, y)}$ is

- a) r b) 0 c) $\frac{1}{r}$ d) r^2

4. If $f(x) = |x|$, then it is

- a) Continuous and differentiable b) not continuous and differentiable
c) Continuous and not differentiable d) not continuous and not differentiable

5. The degree of homogeneous function $u = \frac{x+y}{\sqrt{x+y}}$

- a) 1 b) $\frac{3}{2}$ c) $\frac{1}{2}$ d) 2

6. Which integrating factor f(x) depending only on x can make a non-exact

M dx + N dy = 0 exact?

a) $f(x) = e^{\int \frac{\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}}{M} dy}$ b) $f(x) = e^{\int \frac{\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}}{N} dx}$ c) $f(x) = e^{\int M dx}$ d) $f(x) = N(x, y)$

7. The Value of $\int_0^a \int_0^b \int_0^c xyz \, dz \, dy \, dx$ is

a) $\frac{abc}{8}$ b) $\frac{a^2b^2c^2}{2}$ c) $\frac{a^2+b^2+c^2}{2}$ d) $\frac{(abc)^2}{8}$

8. $\int_0^2 \int_0^{x^2} e^{\frac{y}{x}} \, dy \, dx$ is equal to

a) $e^2 + 1$ b) $e^2 - 1$ c) e^2 d) e^{-2}

9. If $\vec{F} = xz^3\vec{i} - 2xyz\vec{j} + xz\vec{k}$ then $\text{div } \vec{F}$ at $(1, 2, 0)$ is

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

10. If $\phi = x^2 - y^2 + z^2 - a^2$ then $\nabla\phi$ is

a) $2x\vec{i} - 2y\vec{j} - 2z\vec{k}$ b) $2x\vec{i} + 2y\vec{j} + 2z\vec{k}$ c) $2x\vec{i} - 2y\vec{j} + 2z\vec{k}$ d) $2x\vec{i} - 2y\vec{j} + 2z\vec{k} - 2a$

Section B

Five Questions of 02 Marks each

5x2=10

11. Using Cayley Hamilton theorem find the inverse of $\begin{bmatrix} 5 & 3 \\ 3 & 2 \end{bmatrix}$.

12. Check whether the function is continuous or not at $x = 2$ if $f(x) = 3x^2 + 2x - 1$

13. Obtain the complementary function of $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = e^{3x}$

14. Solve $(1+y^2) + (x - e^{-\tan^{-1}y})\frac{dy}{dx} = 0$

15. Find the curl of \vec{F} if $\vec{F} = (x+y)\vec{i} + (2x-z)\vec{j} + (y+z)\vec{k}$

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

5x10 = 50

16. a) Find the Eigen Values and Eigen Vectors of $\begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$ (5 marks)

16. b) Solve $x + y + z = 6$; $x - y + 2z = 5$; $2x + 3y + z = 11$ using Gauss Elimination

Method

(5 marks)

17. a) Reduce the following matrix into its normal form and hence find the rank.

$$A = \begin{bmatrix} 2 & 3 & -1 & -1 \\ 1 & -1 & -2 & -4 \\ 3 & 1 & 3 & -2 \\ 6 & 3 & 0 & -7 \end{bmatrix} \quad (5 \text{ marks})$$

17. b) Find the Maximum and Minimum values of the function

$$f(x, y) = x^3 + y^3 - 3x - 12y + 20 \quad (5 \text{ marks})$$

18. a) If $y = e^{a \sin^{-1} x}$ then prove that $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} - (n^2 + a^2)y_n = 0$

Hence find the value of y_n when $x=0$ (5 marks)

18. b) Solve $\cos^2 x \frac{dy}{dx} + y = \tan x$ (5 marks)

19. a) A rectangular box open at the top is said to have volume of 32 cubic ft.

Find the dimensions of the box requiring least material for its construction. (5 marks)

19. b) Expand $e^x \cos y$ about $(0, \frac{\pi}{2})$ up to the third term using Taylor's series.

(5 marks)

20. a) Solve $(3x^2y^4 + 2xy)dx + (2x^3y^3 - x^2)dy = 0$. (5 marks)

20. b) Find the volume of the tetrahedron bounded by the planes $x = 0, y = 0,$

$$z = 0 \text{ and } \frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1 \quad (5 \text{ marks})$$

21. a) Change the order of integration in $I = \int_{y=0}^1 \int_{x=y}^1 e^{x^2} dx dy$ and hence evaluate the same. (5 marks)

21. b) Evaluate $\int_0^{\log 2} \int_0^x \int_0^{x+y} e^{x+y+z} dz dy dx$ (5 marks)

22. a) Verify Green's Theorem in a plane for $\int_C [(3x^2 - 8y^2)dx + (4y - 6xy)dy]$ where

C is the boundary of the region defined by the lines $x = 0, y = 0$ and $x + y = 1$ (5 marks)

22. b) A vector field is given by $\vec{A} = (x^2 + xy^2)\vec{i} + (y^2 - x^2y)\vec{j}$. Show that the field irrotational and find its scalar potential. (5 marks)

