
Indian Maritime University
(A Central University, Govt of India)
End Semester Examinations – June 2026
Programme Name: B Sc (NS)
Semester: II
Subject Code: UG21T6201
Subject Name: NAUTICAL MATHEMATICS

Date: 01.06.2026

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 the respective section.
- (iii) Non-Programmable Scientific calculators are permissible for use.

Section A

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

1. The point on a sphere that is exactly 90° away from every point on the circumference of a given great circle is called its
- A) Centre B) Pole C) Equator D) Vertex

2. The angle of a polar triangle is _____ to the corresponding side of its primitive triangle.

3. In Spearman's rank correlation coefficient, when ties are present, the correction term involves $\sum(m^3 - m)/12$. What does m represent?
- A) The total number of tied observations in the entire dataset
- B) The number of times a particular rank is repeated
- C) The difference between two consecutive ranks
- D) The number of distinct ranks after adjusting for ties
4. A normal distribution converts into a standard normal distribution when.
- A) Its mean is 1 and standard deviation is 0
- B) Its mean is 0 and standard deviation is 1
- C) Its mean is equal to its median
- D) Its standard deviation is equal to its range
5. If all entries above or below the principal diagonal are zero then the value of the determinant is equal to the _____ of the entries on the principal diagonal.
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6. For any $m \times n$ matrix A , which of the following statements is always true?

- A) $\text{rank}(A) = \min(m, n)$
B) $\text{rank}(A) \geq \max(m, n)$
C) $0 \leq \text{rank}(A) \leq \min(m, n)$
D) $\text{Rank}(A) = m + n$

7. Determine whether the conditional statement is true or false. In propositional logic, consider the statement "If $2 \times 2 = 5$, then $\sqrt{4} = -2$."

8. Which of the following best describes fuzzy logic?

- (A) Every statement is either completely true or completely false.
(B) Statements can be partially true or partially false.
(C) Only statements about vague concepts are allowed.
(D) It is a branch of logic that deals with infinite truth values.

9. In a linear programming problem, the set of all points that satisfy all constraints (including non-negativity) is called the _____ region.

10. Which of the following methods is used to find the optimal solution in a transportation problem?

- (a) North-West Corner Rule (b) Vogel's Approximation Method
(c) Hungarian Method (d) MODI Method

Section B

Five Questions of 02 Marks each.

11. In a spherical triangle ABC, $a = 49^\circ 8'$, $b = 58^\circ 23'$ and $C = 71^\circ 20'$.

Calculate B using the four-part formula.

[2 Mark]

12. A marine academy accepts applications for its offshore navigation course.

Historically, only 5% of applicants ($p = 0.05$) meet the stringent physical and academic requirements. If 15 applicants are randomly selected $n = 15$, what is the probability that exactly 3 of them meet the requirements?

[2 Mark]

13. Solve the following system of linear equations using the matrix inverse method.

[2 Mark]

$$x + 2y = 5$$

$$3x + 4y = 11$$

14. Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ be the universal set. Let $A = \{1, 2, 3, 4, 5\}$ and $B = \{4, 5, 6, 7, 8\}$. Find (i) $A \cup B$ (ii) $A \cap B$ (iii) $A \setminus B$ (iv) $(A \cup B)^c$

[2 Mark]

15. A ship-owner invests a principal amount of Rs. 5600 in a marine safety equipment fund. The fund offers an interest rate of 10% per annum for the first 3 years and 20% per annum for the next 2 years. Calculate the total

simple interest earned at the end of 5 years.

[2 Mark]

Section C

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

16. In a spherical triangle DEF, $D = 49^\circ 27.3'$, $EF = 49^\circ 34'$ and $F = 100^\circ 29.6'$. Calculate DE, E and DF. [10 Mark]

17. a) Three marine pilots independently assessed ten cargo vessels on their bridge ergonomics (1 = best, 10 = worst). Their rankings are.

Pilot A	7	4	10	5	9	8	6	2	1	3
Pilot B	4	1	9	10	7	3	2	5	6	8
Pilot C	10	2	8	5	7	6	9	1	4	3

Calculate Spearman's rank correlation coefficient. Based on the results, identify which pair of pilots has the nearest approach. [5 Mark]

- b) A marine engineer collected data from five cargo vessels of similar class to study the relationship between the number of crew member's X and the daily fuel consumption in tonnes Y. The data are as follows

Vessel	A	B	C	D	E
Crew (X)	6	2	10	4	8
Fuel (Y)	9	11	5	8	7

- (i) Find the regression line of fuel consumption on crew size (y on x).
(ii) Find the regression line of crew size on fuel consumption (x on y). [5 Mark]

18. a) Solve the following system of linear equations using Cramer's rule.

$$2x + y - z = 3; \quad x - y + 2z = -1; \quad 3x + 2y + z = 4 \quad [5 \text{ Mark}]$$

- b) Test the following system of equations for consistency, and if consistency

solve [5 Mark]

$$x + y + z = 6, \quad 2x + y + 3z = 13, \quad 5x + 2y + z = 12$$

19. a) Check whether the compound proposition $(P \vee \neg P) \wedge (Q \vee \neg Q) \wedge (R \vee \neg R)$ is a tautology, contradiction, or contingency with the help of a truth table. [5 Mark]

- b) Let $U = \{x_1, x_2, x_3, x_4\}$ be the universe set. Two fuzzy sets are defined as follows.

$$\text{Fuzzy set } A = \left\{ \frac{0.2}{x_1}, \frac{0.5}{x_2}, \frac{0.8}{x_3}, \frac{0.4}{x_4} \right\}$$

$$\text{Fuzzy set } B = \left\{ \frac{0.6}{x_1}, \frac{0.3}{x_2}, \frac{0.9}{x_3}, \frac{0.1}{x_4} \right\}$$

Compute the following fuzzy operations

1. $A \cup B$ 2. $A \cap B$ 3. A' 4. B' 5. $A \setminus B$

[5 Mark]

20. a) Solve the following Linear Programming Problem graphically

$$\text{Maximize } Z = 15x + 10y$$

Subject to

$$4x + 6y \leq 360$$

$$3x \leq 180$$

$$5y \leq 200$$

$$x, y \geq 0$$

[5 Mark]

b) Find the initial basis feasible solution for the following transportation using the Least Cost Method.

[5 Mark]

	S1	S2	S3	Supply
D1	2	1	3	10
D2	4	5	7	20
D3	1	8	6	15
Demand	12	18	15	

21. a) In a spherical triangle ABC, $A = 88^\circ 24.5'$, $c = 100^\circ 09'$ and $B = 97^\circ 46'$.

Calculate a and b.

[5 Mark]

b) A maritime transport company operates two types of vessels: Container carrier and tanker. The profit per voyage is ₹60,000 for the Container Carrier and ₹40,000 for the Tanker. Both vessel types use the same port crew and berthing facilities, which have a total availability of 120 crew-days and 90 berth-days per month. A Container Carrier voyage requires 4 crew-days and 2 berth-days, whereas a Tanker voyage requires 3 crew-days and 3 berth-days. Due to fuel supply limitations, the number of Tanker voyages cannot exceed twice the number of Container Carrier voyages. Additionally, charter agreements restrict the number of Container Carrier voyages to a maximum of 20 per month. Formulate the linear programming model for the problem. (The company wants to maximize total monthly profit.)

[5 Mark]

22. a) Find the eigenvalues and Eigen vectors of a Matrix

[5 Mark]

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$$

b) Solve the following assignment problem using Hungarian method. The matrix entries are processing time of each man in hours. **[5 Mark]**

	I	II	III	IV	V
A	25	15	18	20	25
B	18	20	12	14	15
C	21	23	25	27	25
D	17	18	21	23	20
E	18	18	16	19	20

