# M.Sc. 3rd Semester Examination, 2022

## APPLIED MATHEMATICS

*( Dynamical Oceanology and Meteorology/ Operations Research )*

PAPER – MTM-303(Unit-1 & 2)

*Full Marks* : 50

*Time* : 2 hours

*The figures in the right hand margin indicate marks*

*Candidates are required to give their answers in their own words as far as practicable*

## UNIT—1

*( Dynamical Oceanology and Meteorology )*

*Full Marks* : 25

A. Answer any *two* of the following questions : $2 \times 2$

1. Define salinity and sigma-*t* for sea water.

2. Write down the first law of thermodynamics.

3. Write down a short note on 'internal waves' and 'gravitational-gyroscopic waves'.

4. Define the term "equipotential surface".

B. Answer any *two* of the following questions : $4 \times 2$

5. Prove that a given volume of moist air is lighter than an equal volume of dry air at the same pressure and temperature deriving the relation

$$\rho = \frac{p}{R_d T}\left(1-(1-\varepsilon)\frac{e}{p}\right)$$

where symbols have their usual meaning.

6. Write down the physical principle for continuity of volume. Derive the equation of continuity of volume.

7. Define virtual temperature of moist, unsaturated air. Also, derive hypsometric formula.

8. Discuss how to satisfy the equation of continuity of volume for "estuarine flow" at a long, narrow coastal inlet which has a river at the inland end.

C. Answer any *one* of the following question : $8 \times 1$

9. (*i*) Define the Humidity Variables : 'Mixing Ratio' and 'Specific Humidity'.

   (*ii*) Explain adiabatic process. Derive Poisson's equation and further find out a relationship between temperature and specific volume during adiabatic process.

   $3 + (2 + 3)$

10. Derive the equation of motion in oceanography and write down the boundary conditions for obtaining solutions to this equation.

    $5 + 3$

[ *Internal Assessment* – 05 Marks ]

## UNIT—2

(*Operations Research* )

*Full Marks* : 25

**D .** Answer any *two* questions of the following : 2 × 2

**11.** Define the terms : 'backlogged' and 'planning horizon'.

**12.** Write the necessary and sufficient conditions for optimization of multi-variable objective function without constraints.

**13.** What decisions are made in inventory management ?

**14.** What do you mean by primitive priority and non-primitive priority ?

**E.** Answer any *two* questions of the following : $2 \times 4$

**15.** Derive the EOQ formulae of multi-item inventory model with the limitation on investment.

**16.** Derive the Kuhn-Tucker conditions of the following Non-linear programming problem :

Maximize $f(x_1, x_2) = 2x_1 + 4x_2 - x_1^2 - 2x_2^2$

subject to $x_1 + 3x_2 \leq 8$

$2x_1 - x_2 \leq 5$

$x_1, x_2 \geq 0.$

**17.** Find the optimum order quantity for a single product of which the price breaks are as follows :

| Range of quantity | Unit price (Rs.) |
|---|---|
| $0 < Q < 50$ | 20.00 |
| $50 \leq Q < 120$ | 16.00 |
| $120 \leq Q$ | 14.5 |

The monthly demand for the product is 450 units. The carrying cost is 20% of the unit price of the product and cost of ordering is Rs. 30.50 per month.

18. Explain multiple channels, single phase queuing system.

F. Answer any *one* question of the following : $8 \times 1$

19. A shop produces three items in lots. The demand rate for each item is constant and can be assume to be deterministic. No back orders are to be allowed. Also, the shop has only 650 sq.ft. of storage space. The pertinent data for the items are given in the following table :

| Item | I | II | III |
|---|---|---|---|
| Set-up cost (Rs.) | 100 | 200 | 175 |
| Cost per unit (Rs.) | 10 | 20 | 15 |
| Floor space required (sq. ft./unit) | 0.5 | 0.6 | 0.4 |
| Yearly demand rate (units) | 4000 | 5000 | 8000 |

The shop uses an inventory carrying charge of 20% of inventory valuation per annum. Determine the economic lot quantities for each item.

**20.** Obtain the differential-difference equation for the queuing model (M/M/c) : (∞/FCFS/∞).

[ *Internal Assessment* – 05 Marks ]