বিদ্যাসাগর বিশ্ববিদ্যালয়

# VIDYASAGAR UNIVERSITY

## M.Sc. Examinations 2020
## Semester IV
## Subject: APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING
## Paper: MTM 495 (Special Paper)
(Practical)

**Full Marks: 25** **Time: 3hrs.**

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

**Paper / Unit : MTM-495A (Special Paper-OM: Lab.: Dynamical Meteorology)**

*Answer any **One** of the following questions*

1.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 24.5 | 20.6 | |
| | Dynamic | 25.0 | 21.1 | |
| Set 2 | Static | 25.5 | 21.5 | |
| | Dynamic | 25.9 | 22.0 | |
| Set 3 | Static | 23.1 | 20.0 | |
| | Dynamic | 24.0 | 21.0 | |
| Set 4 | Static | 24.6 | 21.2 | |
| | Dynamic | 25.5 | 21.5 | |
| Set 5 | Static | 26.0 | 22.1 | |
| | Dynamic | 25.8 | 21.9 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

2.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 30.0 | 26.8 | |
| | Dynamic | 29.5 | 26.5 | |
| Set 2 | Static | 30.5 | 27.4 | |
| | Dynamic | 31.1 | 28.0 | |
| Set 3 | Static | 31.6 | 28.5 | |
| | Dynamic | 31.8 | 28.9 | |
| Set 4 | Static | 30.2 | 27.8 | |
| | Dynamic | 30.9 | 28.3 | |
| Set 5 | Static | 31.0 | 28.7 | |
| | Dynamic | 30.8 | 28.2 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

3.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 28.4 | 25.2 | |
| | Dynamic | 29.0 | 26.2 | |
| Set 2 | Static | 29.5 | 26.6 | |
| | Dynamic | 29.8 | 26.8 | |
| Set 3 | Static | 29.2 | 26.2 | |
| | Dynamic | 30.0 | 26.9 | |
| Set 4 | Static | 29.4 | 26.1 | |
| | Dynamic | 29.8 | 26.2 | |
| Set 5 | Static | 29.3 | 25.9 | |
| | Dynamic | 28.8 | 25.6 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

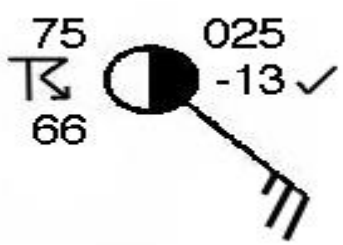
c) Calculate the saturation vapour pressure of the above set of 5 data.

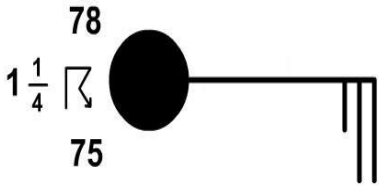
d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

4. Interpret the following surface station model:




5.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 33.0 | 29.6 | |
| | Dynamic | 33.5 | 29.0 | |
| Set 2 | Static | 32.7 | 28.8 | |
| | Dynamic | 33.1 | 29.1 | |
| Set 3 | Static | 33.8 | 29.5 | |
| | Dynamic | 34.0 | 30.2 | |
| Set 4 | Static | 34.4 | 30.6 | |
| | Dynamic | 34.9 | 31.7 | |
| Set 5 | Static | 34.3 | 29.9 | |
| | Dynamic | 34.6 | 30.3 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

6.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 30.2 | 27.4 | |
| | Dynamic | 31.0 | 28.0 | |
| Set 2 | Static | 30.5 | 27.7 | |
| | Dynamic | 30.7 | 27.3 | |
| Set 3 | Static | 29.6 | 26.9 | |
| | Dynamic | 30.0 | 26.8 | |
| Set 4 | Static | 29.2 | 26.5 | |
| | Dynamic | 29.8 | 26.8 | |
| Set 5 | Static | 28.9 | 25.8 | |
| | Dynamic | 29.8 | 26.6 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

7.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 35.6 | 32.8 | |
| | Dynamic | 36.0 | 33.2 | |
| Set 2 | Static | 35.7 | 32.8 | |
| | Dynamic | 36.1 | 33.4 | |
| Set 3 | Static | 35.8 | 32.5 | |
| | Dynamic | 36.4 | 33.2 | |
| Set 4 | Static | 35.4 | 33.6 | |
| | Dynamic | 35.9 | 33.8 | |
| Set 5 | Static | 35.3 | 32.9 | |
| | Dynamic | 35.5 | 32.6 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

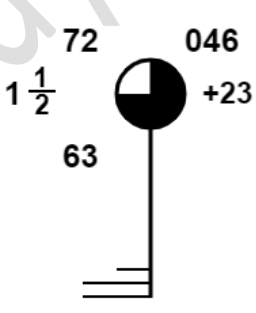
c) Calculate the saturation vapour pressure of the above set of 5 data.

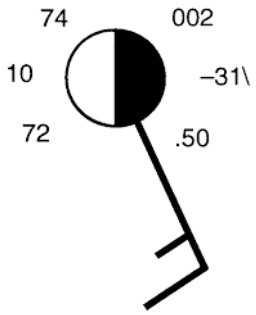
d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

8. Interpret the following surface station model:




9.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ (°c) | Wet bulb temperature, $T_w$ (°c) | |
|---|---|---|---|---|
| Set 1 | Static | 26.2 | 22.5 | |
| | Dynamic | 26.8 | 23.1 | |
| Set 2 | Static | 25.5 | 21.6 | |

| | | | | |
|---|---|---|---|---|
| | Dynamic | 25.9 | 22.0 | |
| Set 3 | Static | 26.1 | 22.7 | |
| | Dynamic | 26.9 | 23.0 | |
| Set 4 | Static | 25.6 | 22.4 | |
| | Dynamic | 26.3 | 22.8 | |
| Set 5 | Static | 26.0 | 22.6 | |
| | Dynamic | 26.4 | 23.3 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

10.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ ($^o$c) | Wet bulb temperature, $T_w$ ($^o$c) | |
|---|---|---|---|---|
| Set 1 | Static | 31.0 | 28.7 | |
| | Dynamic | 32.2 | 29.4 | |
| Set 2 | Static | 32.4 | 29.2 | |
| | Dynamic | 32.8 | 29.6 | |
| Set 3 | Static | 32.1 | 29.0 | |
| | Dynamic | 33.0 | 31.7 | |
| Set 4 | Static | 32.6 | 29.1 | |
| | Dynamic | 33.2 | 29.5 | |
| Set 5 | Static | 31.8 | 28.1 | |
| | Dynamic | 32.5 | 28.9 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

c) Calculate the saturation vapour pressure of the above set of 5 data.

d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

11.

| Data set | Hygrometer | Dry bulb temperature, $T_d$ ($^o$c) | Wet bulb temperature, $T_w$ ($^o$c) | |
|---|---|---|---|---|
| Set 1 | Static | 27.2 | 24.2 | |
| | Dynamic | 27.8 | 25.1 | |
| Set 2 | Static | 26.5 | 23.5 | |
| | Dynamic | 26.9 | 24.0 | |
| Set 3 | Static | 26.1 | 22.6 | |
| | Dynamic | 27.0 | 24.0 | |

| | | | | | |
|---|---|---|---|---|---|
| Set 4 | Static | 25.6 | 23.2 | |
| | Dynamic | 26.3 | 22.5 | |
| Set 5 | Static | 26.0 | 22.6 | |
| | Dynamic | 27.1 | 23.7 | |

Using the above data set, answer any

a) Find the relative humidity of the above set of 5 data.

b) Calculate the vapour pressure of the above set of 5 data.

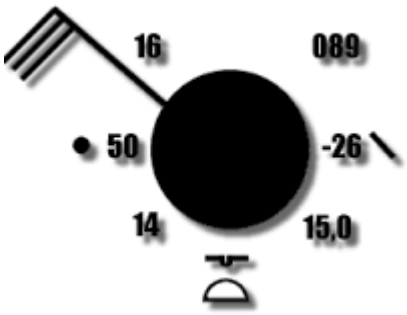
c) Calculate the saturation vapour pressure of the above set of 5 data.

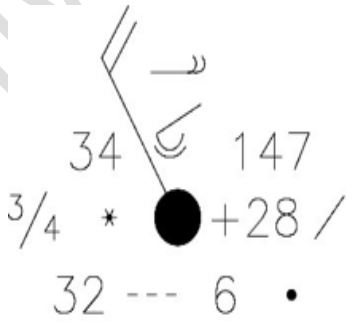
d) Find the dew point temperature by measuring dry bulb and wet bulb temperature of the above set of 5 data.

e) Calculate the wind speed and wind direction of the above set of 5 data.

f) Find the mixing ratio of the air of the above set of 5 data.

12. Interpret the following surface station model:



**Paper / Unit : MTM-495B (Special Paper-OR: Lab. OR methods using MATLAB and LINGO)**

*Answer any **One** of the following questions*

**Q1 a)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Simplex method.

$$\text{Max } z = 3x_1+4x_2$$

$$\text{Subject to, } x_1+x_2 \le 10$$
$$2x_1+3x_2 \le 18$$
$$x_1 \le 8$$
$$x_2 \le 6$$
$$x_1, x_2 \ge 0$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Revised Simplex Method.

$$\text{Max } z = 3x_1+5x_2$$

$$\text{Subject to, } x_1 \le 4$$
$$x_2 \le 6$$
$$3x_1+2x_2 \le 18$$
$$x_1, x_2 \ge 0$$

**Q2 a)** Write an algorithm and program in LINGO or MATLAB to solve the following QPP using Wolfe's modified simplex method.

$$\text{Max } z = 2x_1+x_2-x_1^2$$

$$\text{Subject to, } 2x_1+3x_2 \le 6$$
$$2x_1+x_2 \le 4$$
$$x_1, x_2 \ge 0$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following Queuing problem.

A telephone exchange has two long distance operators. The telephone company finds that, during the peak load long distance all arrive in a Poisson fashion at an average rate of 15 per hour. The length of service on this call is approximately exponentially distributed with mean length 5 minutes.

(i) What is the probability that a subscriber will have to wait for this long distance call during the peak hours of the day?

(ii) If the subscriber waits and are serviced in turn, what is the expected waiting time.

**Q3 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Geometric Programming Problem.

$$\text{Minimize } f(x) = 5x_1x_2^{-1}x_3^2+x_1^{-2}x_2^{-1}+10x_2^2+2x_1^{-1}x_2x_3^{-2}$$

**b)** Write an algorithm and program in LINGO or MATLAB to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} 2 & 3 \\ 1 & 0 \end{bmatrix}$$

**Q4 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Queuing problem.

In a car wash service facility information gather indicates that cars arrive for service according to a Poisson distribution with mean 5 per hour. The time for washing and cleaning for each car varies but is found to follow an exponential distribution with mean 10 minutes per car. The facility cannot handle more than one car at a time and has a total of 5 parking spaces. If the parking spot is full, newly arriving cars balk to 6 services elsewhere.

(i) How many customers the manager of the facility is losing due to the limited parking spaces?

(ii) What is the expected waiting time until a car is washed?

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following problem on Inventory.

The demand for an item is deterministic and constant over time and is equal to 600 units per year. The unit cost of the item is Rs. 50.00 while the cost of placing an order is Rs. 100.00.The inventory carrying cost is 20% of the item and the shortage cost per month is Rs. 1.Find the optimal ordering quantity. If shortages are not allowed, what would be the loss of the company?

**Q5 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding machines. The machining times available per week on different machines and the machining times required on different machines for each part are given below. Assuming that the profit per unit of each of the machine parts I and II is a normally distributed random variable, find the number of machine parts to be manufactured per week to maximize the profit. The mean value and standard deviation of profit are Rs. 50 and 20 per unit for part I and Rs. 100 and 50 per unit for part II.

| Type of Machine | Machining time required per piece (minutes ) | | Maximum time available per week ( minutes ) |
|---|---|---|---|
| | Part I | Part II | |
| Lathes | $a_{11} = 10$ | $a_{12} = 5$ | $b_1 = 2500$ |
| Milling Machines | $a_{21} = 4$ | $a_{22}=10$ | $b_2 = 2000$ |
| Grinding Machines | $a_{31} = 1$ | $a_{32} = 1.5$ | $b_3 = 450$ |

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Revised Simplex Method.

$$\text{Max } z = x_1+x_2$$

$$\text{Subject to, } 3x_1+2x_2\leq 6$$

$$x_1+4x_2 \leq 4$$
$$x_1, x_2 \geq 0$$

**Q6 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Geometric Programming Problem.

$$\text{Minimize } f(x) = 7x_1x_2^{-1} + 7x_2x_3^{-2} + 5x_1^{-3}x_2x_3 + x_1x_2x_3$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following problem on Inventory.

An engineering factory consumes 5000 units of a component per year. The ordering, receiving and handling cost are Rs.300 per order while trucking cost is Rs.1200 per order, internet cost Rs. 0.06 per unit per year, deterioration and obsolence cost Rs 0.004 per year and storage cost Rs. 1000 per year for 5000 units. Calculate the economic order quantity and minimum average cost.

**Q7 a)** Write an algorithm and program in LINGO or MATLAB to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 3 & 2 \\ 0 & 1 \end{bmatrix}$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding machines. The machining times available per week on different machines and the profit on machine part are given below. The machining times required on different machines for each part are not known precisely (as they vary from worker to worker) but are known to follow normal distribution with mean and standard deviations as indicated in the following table.

| Type of Machine | Machining time required per unit(minutes) | | | | Maximum time available per week (minutes) |
|---|---|---|---|---|---|
| | Part I | | Part II | | |
| | Mean | Standard deviation | Mean | Standard deviation | |
| Lathes | $\bar{a}_{11} = 10$ | $\sigma_{a11} = 6$ | $\bar{a}_{12} = 4$ | $\sigma_{a12} = 4$ | $b_1 = 2500$ |
| Milling machines | $\bar{a}_{21} = 4$ | $\sigma_{a21} = 6$ | $\bar{a}_{22} = 10$ | $\sigma_{a22} = 7$ | $b_2 = 2000$ |
| Grinding machine | $\bar{a}_{31} = 1$ | $\sigma_{a31} = 2$ | $\bar{a}_{32} = 1.5$ | $\sigma_{a31} = 3$ | $b_3 = 450$ |
| Profit per unit (Rs) | | $c_1 = 50$ | | $c_2 = 100$ | |

Determine the number of machine parts I and II to be manufactured per week to maximize the profit without exceeding the available machining times more than once in 100 weeks.

**Q8 a)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Simplex method.

$$\text{Max } z = 2x_1+3x_2-x_3$$
$$\text{Subject to, } 2x_1+5x_2-x_3 \leq 5$$
$$x_1+x_2+2x_3 = 6$$

$$2x_1-x_2+3x_3 = 7$$
$$x_1 , x_2 \geq 0$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Revised Simplex Method.

$$\text{Min } z = x_1+x_2$$
$$\text{Subject to, } x_1+2x_2 \geq 7$$
$$4x_1+x_2 \geq 6$$
$$x_1 , x_2 \geq 0$$

**Q9 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Geometric Programming Problem.

Minimize $f(x) = 5x_1x_2^{-1} + 2x_1^{-1}x_2+5x_1+x_2^{-1}$

**b)** Write an algorithm and program in LINGO or MATLAB to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$\mathbf{A} = \begin{bmatrix} 8 & 0 \\ 30 & 2 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 8 & 30 \\ 0 & 2 \end{bmatrix}$$

**Q10 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding machines. The machining times required on different machines for each part and the profits on machine part are given below. If the machining times available on different machines are probabilistic (normally distributed) with parameters as given in the following table, find the number of machine parts I and II to be manufactured per week to maximize the profit. The constraint has to be satisfied with a probability of at least 0.99.

| Type of Machine | Machining time required per piece (minutes ) | | Maximum time available per week ( minutes ) | |
|---|---|---|---|---|
| | Part I | Part II | Mean | Standard deviation |
| Lathes | $a_{11} = 10$ | $a_{12} = 5$ | $b_1 = 2500$ | $\sigma_{b1} = 500$ |
| Milling Machines | $a_{21} = 4$ | $a_{22} = 10$ | $b_2 = 2000$ | $\sigma_{b2} = 400$ |
| Grinding Machines | $a_{31} = 1$ | $a_{32} = 1.5$ | $b_3 = 450$ | $\sigma_{b3} = 50$ |
| Profit per unit(Rs) | $c_1 = 50$ | | $c_2 = 100$ | |

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Simplex method.

$$\text{Max } z = 5x_1-x_2+3x_3$$
$$\text{Subject to, } 2x_1+2x_2-x_3 \geq 2$$
$$3x_1-4x_2 \leq 3$$

$x_2+3x_3 \leq 5$

$x_1, x_2 \geq 0$

**Q11 a)** Write an algorithm and program in LINGO or MATLAB to solve the following LPP using Revised Simplex Method.

$$\text{Max } z = 10x_1+9x_2$$

$$\text{Subject to, } 8x_1+15x_2 \geq 10$$
$$10x_1+6x_2 \leq 10$$
$$6x_1+24x_2 \leq 12$$
$$x_1, x_2 \geq 0$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following QPP using Wolfe's modified simplex method.

$$\text{Max } z = 18x_1+3x_2-0.001x_1^2-0.005x_2^2-100$$
$$\text{Subject to, } 2x_1+3x_2 \leq 2500$$
$$x_1+2x_2 \leq 1500$$
$$x_1, x_2 \geq 0$$

**Q12 a)** Write an algorithm and program in LINGO or MATLAB to solve the following Geometric Programming Problem.

$$\text{Minimize } f(x) = 2x_1+4x_2+10x_1^{-1}x_2^{-1}$$

**b)** Write an algorithm and program in LINGO or MATLAB to solve the following problem of Inventory.

The demand for an item in a company is 18000 units per year. The company can produce the item at a rate of 3000 per month. The cost of one set-up is Rs. 500 and the holding cost of one unit per month is Rs. 0.15.The shortage cost of one unit is Rs. 20 per month. Determine the optimum manufacturing quantity. Also determine the manufacturing time and the time between setup.