2022

M.Sc.

4th Semester Examination

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

PAPER—MTM-495

Full Marks : 25

Time : 2 Hours

The figures in the margin indicate full marks.

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

MTM–495A DYNAMICAL METEOROLOGY

Group—A

Answer any *one* question. 1×7

1.

Data set	Hygrometer	Dry bulb temperature, T_d(°c)	Wet bulb temperature, T_w(°c)
Set 1	Static	35.0	32.8
	Dynamic	34.5	31.5

Data set	Hygrometer	Dry bulb temperature, T_d(°c)	Wet bulb temperature, T_w(°c)
Set 2	Static	35.5	32.4
	Dynamic	36.1	33.6
Set 3	Static	36.6	33.5
	Dynamic	36.8	33.9
Set 4	Static	35.2	32.8
	Dynamic	35.9	33.3
Set 5	Static	36.0	33.7
	Dynamic	35.8	33.2

Using the above data set :

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

(b) Calculate the vapour pressure 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	33.0	29.8
	Dynamic	32.5	29.5
Set 2	Static	33.5	30.4
	Dynamic	34.1	31.0

Data set	Hygrometer	Dry bulb temperature, T_d(°c)	Wet bulb temperature, T_w(°c)
Set 3	Static	34.6	31.5
	Dynamic	34.8	31.9
Set 4	Static	33.2	30.8
	Dynamic	33.9	30.3
Set 5	Static	34.0	31.7
	Dynamic	33.8	31.2

Using the above data set :

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

(b) Calculate the saturation vapour pressure 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	37.4	34.2
	Dynamic	38.0	35.2
Set 2	Static	38.5	35.6
	Dynamic	38.8	35.8
Set 3	Static	38.2	35.2
	Dynamic	39.0	35.9

Data set	Hygrometer	Dry bulb temperature, T_d(°c)	Wet bulb temperature, T_w(°c)
Set 4	Static	38.4	35.1
	Dynamic	38.8	35.2
Set 5	Static	38.3	34.9
	Dynamic	37.8	34.6

Using the above data set :

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

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

4.

Data set	Hygrometer	Dry bulb temperature, T_d(°c)	Wet bulb temperature, T_w(°c)
Set 1	Static	32.0	28.6
	Dynamic	32.5	28.0
Set 2	Static	31.7	27.8
	Dynamic	32.1	28.1
Set 3	Static	32.8	28.5
	Dynamic	33.0	29.2
Set 4	Static	33.4	29.6
	Dynamic	33.9	30.7
Set 5	Static	33.3	28.9
	Dynamic	33.6	29.3

(Continued)

Using the above data set :

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

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

Group—B

Answer any *one* question. 1×4

5. For the air parcel whose pressure is 90 kPa, temperature being 30°C and mixing ratio being 6 g/kg, find its dew point, saturation mixing ratio and relative humidity from tephigram.

6. For the air parcel whose pressure is 80 kPa, temperature being 20°C and mixing ratio being 4 g/kg, find its dew point, saturation mixing ratio and relative humidity from thermodynamic diagram.

7. For the air parcel whose pressure is 100 kPa, temperature being 20°C and mixing ratio being 5 g/kg, using thermodynamic diagram, find its **lifting condensation level**, **state of the air parcel** when it reaches a pressure height of 40 kPa and how much liquid water has been condensed out at that height ?

8. Determine the new state of the air parcel having initial temperature = 30°C, mixing ratio = 5 gm/kg and pressure = 100 kPa after being lifted dry adiabatically to the pressure level 60 kPa.

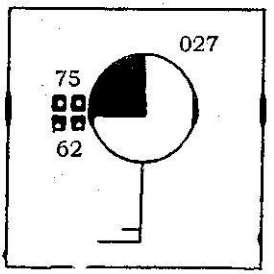
9. For the air parcel whose pressure is 90 kPa, temperature being 20°C and mixing ratio being 4 g/kg, find its lifting condensation level, state of the air parcel when it reaches a pressure height of 40 kPa and how much liquid water has been condensed out at that height?

Group – C

Answer any *one* question. 1×4

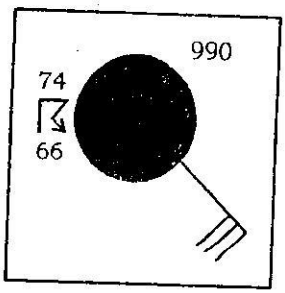
10. Plot the following data around a surface station model when the atmosphere has the following : in present wheather there is a thunderstorm, in past weather there was a light rain shower and the pressure tendency in last 3 hours is 0.3 mb.

11. Interpret the following surface station model :



12. Plot the following data around a surface station model when the atmosphere have the following : Temp 45°F, dewpoint 29°F, overcast, wind from SE at 15 knots, weather light rain, pressure 1004.5 mb.

13. Interpret the following surface station model :



[Laboratory Note Book + Viva – 05
Field Work – 05]

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MTM-495B
O.R. METHOD USING MATLAB AND LINGO

Group—A

Answer any *one* question. 1×6

1. (a) Write the code in LINGO to solve the following Geometric Programming Problem :
Minimize $f(x) = 7x_1x_2^{-1} + 7x_2x_3^{-2} + 5x_1^{-3}x_2x_3 + x_1x_2x_3$.

(b) Write the code in LINGO 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 obsolesce 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. 3+3

2. (a) Write the code in LINGO to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game :

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

(b) Write the code in LINGO 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	$\bar{a}_{11} = 10$	$\sigma_{a31} = 6$	$\bar{a}_{12} = 4$	$\sigma_{a12} = 4$	$b_1 = 2500$
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. 3+3

3. (a) Write the code in LINGO 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 the code in LINGO 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 ?

3+3

4. (a) Write the code in LINGO 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 the code in LINGO to solve the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game :

$$A = \begin{bmatrix} 8 & 0 \\ 30 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 8 & 30 \\ 0 & 2 \end{bmatrix}. \qquad 3+3$$

5. (a) Write the code in LINGO to solve the following Stochastic Programming Problem :

A manufacturing firn produces two machines' parts using lathes, milling machines and grinding machines. The machining times required on different machines for each part and the profit 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 have 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 machine	$a_{31} = 1$	$a_{32} = 1.5$	$b_3 = 450$	$\sigma_{b3} = 50$
Profit per unit (Rs.)	$c_1 = 50$		$c_2 = 100$	

(b) Write the code in LINGO to solve the following QPP using Wolfe's modified simplex method :

Max $z = 18x_1 + 3x_2 - 0.001x_1^2 - 0.005x_2^2 - 100$

Subject to, $2x_1 + 3x_2 \leq 2500$

$x_1 + 2x_2 \leq 1500$

$x_1, x_2 \geq 0.$ 3+3

6. (a) Write the code in LINGO to solve the following Geometric Programming Problem :

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

(b) Write the code in LINGO 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. 0.015. 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. 3+3

7. (a) Write the code in LINGO to solve the following Queuing theorem 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.

(b) Write the code in LINGO to solve the following LPP using Revised Simplex Method :

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

$$\text{Subject to, } x_1 \leq 4$$

$$x_2 \leq 6$$

$$3x_1 + 2x_2 \leq 18$$

$$x_1, x_2 \geq 0.$$

3+3

8. (a) Write the code in LINGO to solve the following QPP using Wolfe's modified simplex method :

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

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

$$2x_1 + x_2 \leq 4$$

$$x_1, x_2 \geq 0$$

(b) Write the code in LINGO to solve the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game :

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

9. (a) Write the code in LINGO to solve the following Geometric Programming Problem :

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 the code in LINGO to solve the following LPP using simplex method :

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

$$\text{Subject to, } x_1 + x_2 \leq 10$$

$$2x_1 + 3x_2 \leq 18$$

$$x_1 \leq 8$$

$$x_2 \leq 6$$

$$x_1, x_2 \geq 0. \qquad 3+3$$

10. (a) Write the code in LINGO 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 machine	$a_{31} = 1$	$a_{32} = 1.5$	$b_3 = 450$

(Continued)

(b) Write the code in LINGO to solve the following LPP using Revised Simplex Method :

$$\text{Max } z = x_1 + x_2$$
$$\text{Subject to, } 3x_1 + 2x_2 \leq 6$$
$$x_1 + 4x_2 \leq 4$$
$$x_1, x_2 \geq 0.$$

3+3

Group—B

Answer any *one* question. 1×9

11. Write a MATLAB code to solve the following LPP :

$$\text{Max } Z = 5x_1 + 3x_2 - 8x_3 - 7x_4 + 8x_5$$
$$2x_1 + 3x_2 + 4x_3 - 5x_5 \leq 8$$
$$x_1 + 2x_2 - 4x_4 + 3x_5 \leq 10$$
$$-x_1 + 3x_2 - 4x_3 + 5x_4 \geq 15$$
$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

12. Write a MATLAB code to solve the following IPP :

$$\text{Max } z = 3x_1 + 2x_2 - 3x_3 + 4x_4$$
$$4x_1 + 2x_2 + 4x_3 - 4x_4 \geq 6$$
$$-x_1 + 3x_2 + 3x_3 + x_4 \leq 6$$
$$-2x_1 + x_2 + x_3 + 4x_4 \geq 4$$
$$x_1, x_2, x_3, x_4 \geq 0$$

13. Write a MATLAB code to solve the following geometric programming problem :

Min $Z = 6x_1x_2^{-1} + 7x_2x_3^{-2} + 2x_{1-3}x_2x_3 + 2x_1x_2x_3$

14. Write a code in MATLAB to solve the following problem on inventory :

The demand for an item in a company is 28000 units per year. The company can produce the item at a rate of 2000 per month. The cost of one set-up is Rs. 1000 and the holding cost of one unit per month is Rs. 0.50. The shortase cost of one unit is Rs. 25 per month. Determine the optimum manufacturing quantity. Also, determine the manufacturing time and the time between setup.

[Laboratory note book & Viva – 05
Field visit with report – 05]

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