2023

M.Sc.

4th Semester Examination

APPLIED MATHEMATICS

PAPER : MTM-495A

(Practical)

(Special Paper-OM : Lab.: Dynamical Meteorology)

Full Marks : 25

Time : 2 hours

The figures in the right-hand margin indicate marks.

Answer *any* **one** question from each Group.

GROUP—A

Answer *any* **one** question from the following : $7 \times 1 = 7$

1. Find the relative humidity near the science building taking a set of 5 data.

2. Calculate the vapour pressure near the science building taking a set of 5 data.

3. Calculate the saturation vapour pressure near the science building taking a set of 5 data.

4. Find the dew point temperature by measuring dry bulb and wet bulb temperature near the science building taking a set of 5 data.

5. Find the mixing ratio of the air near the science building measuring of wet and dry bulb temperatures taking a set of 5 data.

GROUP—B

Answer *any* **one** question from the following : $4 \times 1 = 4$

1. For the air parcel whose pressure is 80 kPa, temperature being 30 °C and mixing ratio being 4 g/kg, find its dew point, saturation mixing ratio and relative humidity from thermodynamic diagram.
2. For the air parcel whose pressure is 90 kPa, temperature being 20 °C and mixing ratio being 6 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?
3. Determine the new state of the air parcel having initial temperature = 25 °C, mixing ratio = 5 gm/kg and pressure = 80 kPa after being lifted dry adiabatically to the pressure level 60 kPa.

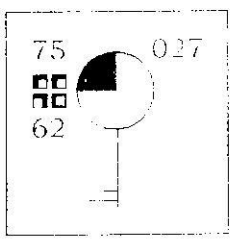
4. For the air parcel whose pressure is 70 kPa, temperature being 20 °C and mixing ratio being 4 g/kg, find its lifting condensation level, state of the air parcel when it reaches a pressure height of 40 kPa and how much liquid water has been condensed out at that height?

GROUP—C

Answer *any* **one** question from the following : $4 \times 1 = 4$

1. Plot the following data around a surface station model when the atmosphere has the following status : in present weather there is a thunderstorm, in past weather there was a light snow and the pressure tendency in last 3 hours is −0·3 mb, temperature being 25 °C and wind blowing from south-east direction with speed 20 knots. 4

2. Interpret the following surface station model :



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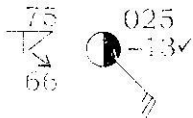
3. Plot the following data around a surface station model when the atmosphere have the following : Temp 77 F, dew point 68 F, overcast, wind from ES at 25 knots, present weather light snow, pressure 999·8 mb. The pressure here has fallen 0·3 mb the last 3 hours. 4

4. Interpret the following surface station model :



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Note Book + Viva 5

Field Work 5

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2023

M.Sc.

4th Semester Examination

APPLIED MATHEMATICS

PAPER : MTM-495B

(Practical)

(Lab for Operations Research)

Full Marks : 25

Time : 2 hours

The figures in the right-hand margin indicate marks.

Answer from **both** the Groups as directed.

GROUP—A

(LINGO)

Answer *any* **one** question from the following : $6 \times 1 = 6$

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

   max $Z = 4x_1 + 6x_2 - 2x_1^2 - 2x_1x_2 - 2x_2^2$

   subject to, $x_1 + 2x_2 \leq 2$

   $x_1, x_2 \geq 0$

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

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

3. Write a code in LINGO to solve the following problem of Inventory :

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

4. Write a 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	$\bar{a}_{11} = 10$	$\sigma_{a11} = 4$	$\bar{a}_{12} = 4$	$\sigma_{a12} = 4$	$b_1 = 2500$
Milling machines	$\bar{a}_{21} = 4$	$\sigma_{a21} = 0$	$\bar{a}_{22} = 10$	$\sigma_{a22} = 7$	$b_2 = 2000$
Grinding machine	$\bar{a}_{31} = 1$	$\sigma_{a31} = 2$	$\bar{a}_{32} = 1.5$	$\sigma_{a31} = 3$	$b_3 = 450$
Profit per unit (₹)	$c_1 = 50$		$c_2 = 100$		

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.

5. Write a code in LINGO to solve the following LPP using simplex method.

Max $Z = 2x_1 + 3x_2 - x_3$

subject to, $2x_1 + 5x_2 - x_3 \leq 5$

$x_1 + x_2 + 2x_3 = 6$

$2x_1 - x_2 + 3x_3 = 7$

$x_1, x_2 \geq 0$

6. Write a code in LINGO to solve the following QPP using Wolfe's modified simplex method.

Max $Z = 2x_1 + 3x_2 - x_1^2$

subject to, $x_1 + 2x_2 \leq 4$

$x_1, x_2 \geq 0$

7. Write a code in LINGO to solve the following Geometric Programming Problem :

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

8. Write a 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.

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

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

GROUP—B

(MATLAB)

Answer *any* **one** question from the following : $9 \times 1 = 9$

1. Write a MATLAB code to solve the following problem using the Dual Simplex method.

Minimize $Z = -x_1 - \frac{x_2}{3} + R x_3$

subject to, $x_1 + x_2 + 2x_3 \leq 2$

$$x_1 + \frac{x_2}{4} + 8x_3 \leq 1$$

$$x_1 - x_2 + 7x_3 \leq 2$$

$$-\frac{x_1}{4} - x_2 + 8x_3 \leq -10$$

$$-x_1 - x_2 + 5x_3 \leq -8$$

$$-x_1 + x_2 + 6x_3 \leq 2$$

$$x_1 + \frac{x_2}{4} + 7x_3 = \frac{1}{2}$$

where $x_1, x_2, x_3 \geq 0$ and R is your roll number.

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

Minimize $Z = 3x_1 + 50x_2 + (R-50)x_3$

subject to, $-x_1 - 2x_2 - 3x_3 + 4x_4 \leq -20$

$3x_1 - 2x_2 + 4x_3 + 6x_4 \leq 50$

$x_1 + 4x_2 - 7x_3 + 4x_4 \leq 13$

where x_1, x_2, x_3, x_4 are non-negative integer variables, and R is your roll number.

3. Write a MATLAB code to find the values of x_1, x_2, x_3, x_4 that

Minimize $f(x) = \frac{1}{2}x_1^2 + x_2^2 - x_1x_2 - 2x_1 - 6x_2 + 3x_3$

subject to, $x_1 + x_2 + 2x_3 \leq 2$

$-x_1 + 2x_2 - 3x_3 \leq 2$

$2x_1 + x_2 + 7x_3 \leq 3$

$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0$

4. Write a MATLAB code to solve the following QPP :

Minimize $Z = x_1^2 + x_2^2 - 2x_3^2 + 3x_4^2$

subject to, $x_1 + x_2 + 3x_3 - 2x_4 = 2$

$5x_1 + 2x_2 + x_3 - 2x_4 = 5$

$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0,\ x_4 \geq 0$

(Continued)

5. $(M \mid M \mid 1) : (\infty \mid FCFS/\infty)$

In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter arrival time follows an exponential distribution and the service time distribution is also exponential, with an average of 36 minutes. Write a program in MATLAB to find the following :

(a) The average number of trains in the system

(b) The average number of trains in the queue

(c) Mean (or expected) waiting time in the queue (excluding service time)

(d) Expected waiting time in the system (including service time)

6. You have to supply your customers 250-*R* (your roll number) units of a certain product every Monday (and only then). You obtain the product from a local supplier at ₹60 per unit. The cost of ordering and transportation from the supplier is ₹150 per order. The cost of carrying inventory is estimated at 15 % per year of the cost of the product carried.

Write a program in MATLAB to find the following :

(a) The lot size which will minimize the cost of the system.

(b) Determine the optimal cost.

7. A contractor has to supply 10000-2*R* (*R* is the roll number of the student) bearings per day to an automobile manufacturer. He finds that, when he starts a production run, he can produce 25000 bearings per day. The cost of holding a bearing in stock for one year is ₹2, and the set-up cost of a production run is ₹1800.

Write a program in MATLAB to find the following :

(a) The lot size which will minimize the cost of the system.

(b) Determine the optimal cost.

(c) Cycle time.

8. Write a MATLAB code to estimate the probability of obtaining 8 or more heads if a coin is tossed 10 times. Use the Monte Carlo simulation technique for this purpose. The real value is approx. 0.0547.

LNB + Viva-voce 3

Field visit 5

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