No. of Printed Pages : 6

MMT–009

M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE) [M. SC. (MACS)]

Term-End Examination

December, 2025

MMT-009 : MATHEMATICAL MODELLING

Time : 1½ Hours *Maximum Marks : 25*

Weightage : 70%

Note : *Attempt any* ***five*** *questions. Use of calculator is not allowed.*

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1. (a) State the types of modelling you will use for the following two problems : 2

   (i) In a chemical process, the output quality and yield depend critically

on the levels assigned to relevant factors (temperature, pressure, concentration etc.). It is important to select these levels as well as to monitor and control the system to ensure that they stay at the desired levels. The problem is to build a model to help to achieve this.

(ii) The formation of sand dunes and their encroachment into de-forested land near deserts has become a serious problem in many parts of the world. It is needed to predict the spread of desert, as well as to devise policies to control the spread. The problem is to build a model to help solve this problem.

(b) A population satisfying exponential growth model increases by 10% in an hour. If the initial population is 1,00,000, then find the population after two hours. How much time is required by the population to grow to double of its initial size ? 3

2. The return distribution on the two securities X and Y are as given in table below : 5

Possible rates of returns for security		Associate probabilities
X	Y	$p_{xj} = p_{yj}$
0.19	0.18	0.33
0.17	0.16	0.25
0.11	0.11	0.22
0.10	0.9	0.20

Find σ_{xy} and ρ_{xy}.

3. A consulting firm has 3 counters in its office to receive people who have problems concerning their incomes, wealth and sale taxes. On the average 48 persons arrive in an 8-hour day. Each tax adviser spends 15 minutes on an average on an arrival. If the arrivals are Poissonly distributed and service times are according to exponential distribution, find : 5

   (i) average number of customers in the system;

   (ii) average number of customers waiting to served;

   (iii) average time a customer spends in the system;

   (iv) average waiting time for a customer; and

   (v) the number of hours each week a tax adviser spends performing his job.

4. Minimize $Z = 9x_1 + 10x_2$, subject to the constraints, using Branch and Bound method : 5

$$4x_1 + 3x_2 \geq 40$$

$$x_1 \leq 9,\ x_2 \leq 8$$

$x_1, x_2 \geq 0$ and are integers.

5. The continuous form of a reaction-diffusion equation model is given by the following equation : 5

$$\frac{\partial N}{\partial t} = 2N + D\frac{\partial^2 N}{\partial x^2}, \qquad 0 \leq x \leq 1.$$

The initial and boundary conditions are :

$$N(x, 0) = f(x) > 0, \quad \forall\, 0 \leq x \leq 1$$

$$\frac{\partial N}{\partial x} = 0 \quad \text{at } x = 0 \text{ and } x = 1, \quad \forall t.$$

Do the stability analysis for the given system.

6. Consider the data shown in below table :

x	y
2	1
9	17
3	3
5	9
1	0

Using a best fit line, estimate the value of y for $x = 6$ and 8. Also, obtain the estimate of the error variance of the best fit. 5

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