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MMT–009

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

Term-End Examination

June, 2025

MMT-009 : MATHEMATICAL MODELLING

Time : $1\frac{1}{2}$ Hours *Maximum Marks : 25*

Weightage : 70%

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

1. (a) Differentiate between the following terms :

   (i) Discrete *vs.* Continuous models 1

   (ii) Deterministic *vs.* Stochastic models 1

(b) Calculate the expected return and standard deviation of the security : 3

Probabilities	Possible returns
0.15	0.20
0.20	0.16
0.40	0.12
0.10	0.05
0.15	– 0.05

2. Find a linear demand equation that best fits the following data and use it to estimate annual sales of home priced at ₹ 30 lakhs : 5

x = Price (lakhs of ₹)	y = Sales of new homes this year
16	126
18	103
20	82
22	75
24	82
26	40
28	20

3. Do the stability analysis of the following prey-predator model under toxicant stress in which predators are not affected by the toxicant and environment toxicant concentration is taken to be a variable depending upon time : 5

$$\frac{dN_1}{dt} = r_0 N_1 - r_1 C_0 N_1 - b N_1 N_2$$

$$\frac{dN_2}{dt} = -d_0 N_2 + \beta_0 b N_1 N_2$$

$$\frac{dC_0}{dt} = k_1 P - g_1 C_0 - m_1 C_0$$

$$\frac{dP}{dt} = Q - hP - kPN_1 + gC_0 N_1$$

where $N_1(0) = N_{10}$, $N_2(0) = N_{20}(0)$, $C_0(0) = 0$, $P_0 > 0$.

4. (a) Tumour growth is governed by the equation $\frac{dc}{dt} = \lambda c$.

If the tumour cells in a particular organ of a human body are 5×10^3, their growth increases upto 7.2×10^5 within five days. Find the value of λ. 3

(b) How would you compare the Markowitz model with the Sharpe model ? Explain through an example. 2

5. Patients arrive at the outpatient department of a hospital in accordance with a Poisson process at mean rate of 12 per hour and the distribution of time for medical examination by an attending physician is exponential with a mean of 10 minutes.

What is the minimum number of physicians to be posted for ensuring a steady state distribution ? For this number, calculate (i) the expected waiting time of a patient prior to being examined, (ii) the expected number of patients in the out-patient department and (iii) the expected number of physicians, remaining idle. 5

6. Determine an optimal transportation program for given table so that the transportation cost of 340 tons of a certain type of material from three factories A, B, C to five stores I, II, III, IV, V is minimised. The five stores must receive 40 tons, 50 tons, 70 tons, 90 tons and 90 tons respectively. The availability of the material at A, B and

C is 100 tons, 120 tons and 120 tons respectively : 5

	I	II	III	IV	V
A	4	1	2	6	9
B	6	4	3	5	7
C	5	2	6	4	8

× × × × ×