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

Term-End Examination

December, 2022

MMT-009 : MATHEMATICAL MODELLING

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

Weightage : 70%

Note : *(i) Attempt any **five** questions.*

(ii) Use of scientific non-programmable calculator is allowed.

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1. (a) List the *two* essentials and *two* non-essentials in the problem to develop a model to obtain good estimates for future demand so as to help the soft drink company make right decisions. 2

(b) Assume that the return distribution of security is as given follows : 3

Possible return	**Associated Probability**
0.01	0.2
0.07	0.2
0.08	0.3
0.1	0.1
0.15	0.2

Find the standard deviation of the security.

2. Consider the data shown in table given below : 5

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

Use a best fit line to estimate the value of y for $x = 6$ and 8.

3. Do the stability analysis of the following Prey-Predator model under toxicant stress in which it is assumed that the predators are not

affected by the toxicant because they are generally strong : 5

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

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

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

where $N_1(0) \geq 0, N_2(0) \geq 0, \; C_0(0) = 0$.

4. (a) Differentiate between the following terms : 2

   (i) Linear and Non-linear models

   (ii) Static and Dynamic models

   (b) For the equation :

$$\frac{dc}{dt} = \lambda c, \lambda = \text{constant}$$

   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

5. Obtain the optimal solution of the following transportation problem : 5

	D_1	D_2	D_3	a_i
O_1	7	3	4	2
O_2	2	1	3	3
O_3	3	4	6	5
b_j	4	1	5	

a_i's and b_j's represent supplies and requirements in a real situation and the elements of the matrix represent the corresponding casts.

6. Four counters are being run on the frontier of a country to check the passports and necessary papers of the tourists. The tourists choose a counter at random. If arrivals are Poisson at the rate λ and the service time is exponential with parameter $\frac{\lambda}{2}$, what is the steady state average queue at each counter ? 5