B. Sc. Mathematics (Hons.) Examination, 2023

(3rd Year, 2nd Semester)

Mathematical Modelling

Paper – DSE-3B

Time : Two hours Full Marks : 40

The figures in the margin indicate full marks.

Symbols / Notations have their usual meanings.

Answer ***any five*** questions.

1. What do you mean by a socio-ecological interaction? Describe any simple socio-ecological interaction model with appropriate assumptions. What are the equilibrium points of your proposed model? Deduce conditions under which the equilibrium points become stable. 1+2+2+3

2. Suppose two nations, R and U, are engaged in an arms race. Assuming $r(t)$ and $u(t)$ as the armament levels of the nations R and U at time t, describe the rate equations of their armament levels mentioning the basic assortment of psychological and strategic motivations. What is the equilibrium defence level? Under what parametric conditions the two nations will be able to avoid instability in the arms race? 3+2+3

3. Mention different characteristics of a queuing system. Describe Kendall's notations of queuing model with various choices. Write the probability distribution of service time with its mean and variance. 3+3+2

4. Suppose two individuals I_1 and I_2 are emotionally attached. Assuming that emotion is measurable, propose a linear model for their love affair with necessary assumptions. Deduce the simplified version of the proposed model with I_1's feelings toward I_2 are unaffected by the feeling of I_2 and I_1's own feelings. What would be their emotion levels after a long time? 3+2+3

5. a) What do you mean by the half-life of a drug? If a drug's elimination rate follows first-order pharmacokinetics, determine its half-life.

   b) A 60 kg patient was given a single dose of an antibacterial drug at a dose of 5 mg/kg. Blood samples were taken at various time intervals, and the concentration of the drug (C_p) in plasma was determined as given below:

Time (t) in hrs.	C_p (μg/ml)
0.0	8.40
0.25	8.21
0.50	7.87
1.0	7.23
3.0	5.15
4.0	4.20
6.0	3.09
12.0	1.11
18.0	0.40

What are the values of this drug's elimination rate constant and half-life? This antibacterial agent is ineffective at a plasma concentration of less than 3 μg/ml. When should the next dose of this drug be given? 4+4

6. a) Mention some advantages and disadvantages of maintaining an inventory.

   b) What do you mean by economic order quantity? Consider an EOQ model with no shortage, zero lead time and uniform demand. Using the algebraic method, determine the optimal order quantity, minimum inventory cost, optimal inventory cycle time, and the optimal number of orders of the EOQ model. 2+6