2/16

1304E27

Candidate's Seat No : _____

B.Sc. Semester-6 Examination

SE 311

Mathematics (E)

April-2023

Time : 2-30 Hours] [Max. Marks : 70

Instructions: (i) All the questions are compulsory and carry equal marks.

(ii) Notations are usual everywhere.

(iii) The right hand side figures indicate marks of the question/sub-question.

Q-1 (*a*) Discuss SI model. [9]

(*b*) If contact rate $\alpha = 0.001, I_0 = 1$ and $S_0 = 2000$, then determine :

(i) The number of susceptible left after 3 weeks.

(ii) The density of susceptible when the rate of appearance of the new cases is maximum. [9]

OR

Q-1 (*a*) Derive expression for number of infected persons considering General Deterministic model with removal (SIR model). [9]

(*b*) If $\rho = 50$ and $S_0 = 500$, find the number of susceptible left by the time 100 infected individuals are removed from circulation. Also find the number of infective if $I_0 = 2$. [9]

Q.2 (*a*) Discuss Lotka's model. [9]

(*b*) Find dominant Eigen value for the following problem:

$$f_a = \begin{cases} 0, a = 1 \\ 0, a = 2 \\ 6, a = 3 \end{cases} \quad \text{and} \quad p_a = \begin{cases} 1, & a = 1 \\ 1/2, & a = 2 \\ 1/6, & a = 3 \end{cases}$$ [9]

OR

Q. 2 (*a*) Formulate model given by Bernardelli, Lewis and Leslie and discuss its solution. [9]

(*b*) Assume that there is population that consists of 45 individuals in age class 1, 18 individuals in age class 2, 11 individuals in age class 3 and 4 individuals in age class 4. Compute the time – specific growth rate if Leslie matrix for this population is given by

$$\begin{bmatrix} 0 & 1 & 1.5 & 1.2 \\ 0.8 & 0 & 0 & 0 \\ 0 & 0.5 & 0 & 0 \\ 0 & 0 & 0.25 & 0 \end{bmatrix}.$$ [9]

P.T.O

E 27·2

Q.3(*a*) Derive expression for the size of the population considering Logistic Growth model. [9]

(*b*) If $birth\ rate = \left(\frac{1}{2} - \frac{1}{800}x\right)x$ and the $death\ rate = \left(\frac{1}{4} + \frac{1}{200}x\right)x$.
Further suppose that there is no immigration and no emigration.
Find expression for the population size $x(t)$ at any time t. [9]

OR

Q. 3 (*a*) Discuss exponential growth model considering effects of Immigration and Emigration on population. [9]

(*b*) A population $x(t)$is growing according to logistic equation, and $x(t_1) = n_1, x(t_1 + T) = n_2$ and $x(t_1 + 2T) = n_3$ then show that the carrying capacity is given by $K = \frac{\frac{1}{n_1} + \frac{1}{n_3} - \frac{2}{n_2}}{\frac{1}{n_1 n_3} - \frac{1}{n_2^2}}$. [9]

Q.4 Attempt any **Eight** of the following questions **in short:** **[16]**

(*a*) Define Carriers.
(*b*) In Discrete – Time Discrete – Age – Scale population models: for which values of largest absolute Eigen value, population of all age groups will grow?
(*c*) List limitations of exponential growth model propounded by Malthus.
(*d*) Write only basics equations of the SIS model when carriers is a function of time t.
(*e*) Draw graph of $\psi(r)$ (Lotka's model for population growth).
(*f*) Draw Logistic growth curve.
(*g*) Give any two names of Mathematical Models in epidemiology.
(*h*) SIS model with coefficient works as a function of which parameter ?
(*i*) Give any two names of Single-species population models – Age structured.
(*j*) What specifies Bernardelli, Lewis and Leslie (BLL) model ?
(*k*) Give any two names of Single-species population models – non-age structured.
(*l*) Describe any two effects of immigration and Emigration on population.

– – – × – – – × – – –