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Q. No. PHO - 441

ND/B.Tech./Even

Reg/2022-23

2022-23

QUANTITATIVE BIOLOGY

PHO - 441

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Answer Question 1 and any *two* of the rest of the questions.

Graph paper shall be supplied, if required.

1. Consider a biological system depicted by the following equation: $\dot{y} = ky - y^2$

   (a) Using graphical method, analyse the flow diagrams for $k = 4$, and classify the stability of fixed point(s).

   (b) Perform the same analysis for $k = -4$.

   (c) Point out the qualitative change observed in the steady states for both values of the parameter k, and comment about the value of k, where this characteristics transition occurs. 5+5+5 [CO1, CO2]

2. For the growth of a particular bacteria with initial population p_0, the following model fits the data :

$$\dot{p} = 0.7p\left(1 - \frac{p}{20}\right)$$

P.T.O.

(a) Point out the significance of the numbers 0.7 and 20 present in the equation.

(b) Predict and draw the time trajectories for $p_0 = 0.0, 5, 15, 20$ and 25 and justify your answer from the model. 1+4 [CO4]

3. (a) Define Potential, in the context of steady states of dynamics.

(b) Identify the fixed points and comment about their stability, using the idea of Potential landscape: $\dot{z} = z - z^3$.

1+4 [CO1, CO3]

4. (a) From Taylor Series Expansion, derive the expression for characteristics time in the context of Linear Stability Analysis.

(b) Classify stability of the fixed points of the dynamical equation $\dot{x} = \cos x$ using Linear Stability Analysis.

3+2 [CO2]

Course Outcomes :

- CO1 : To see living systems from the perspective of engineering, physics, mathematics and computer science.
- CO2 : To understand systems based approaches in biological science.
- CO3 : To use web-based resources that will help them in modelling complex biological processes.
- CO4 : To choose an appropriate modelling technique for a complex biological system.