

Ex/SC/MATH/PG/DSE/TH/03/A6/2025

MASTER OF SCIENCE EXAMINATION, 2025

(2nd Year, 1st Semester)

MATHEMATICS

PAPER : DSE-03/A6

(Mathematical Ecology)

Time : Two Hours

Full Marks : 40

Use separate answer script for each Part.

PART—I (16 Marks)

Answer **Question No. 1** and *any one* from the rest.

1. (a) What is Allee effect? Discuss briefly about Allee effect.
(b) What do you mean by Ratio-dependent Prey-Predator model?
(c) Define the term :
 (i) Commensalism
 (ii) Obligate Mutualism
(d) What do you mean by Functional Response and Numerical Response functions in a Prey-Predator system? 2+2+2+2=8
2. With suitable assumptions, formulate a general mathematical model as proposed by Kolmogorov. Derive the conditions for existence of different equilibrium points. Also discuss the qualitative behavior of the model system. 2+2+4=8

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[Turn Over]

(2)

3. With proper justification/assumption, write down a general mathematical model of a Donor-controlled Prey-Predator system. How can you reduce general model to the 2-dimensional subsystem? Discuss the existence of the different equilibrium points and their stability properties. $3+1+4=8$

PART—II (24 Marks)

Answer *any three* questions from the following four questions :

1. Write down the simple food chain model with proper assumptions. Discuss about the equilibrium points and their stabilities. $3+5=8$
2. (a) Discuss the modified Gause model with proper validations.
- (b) Write down the Routh-Hurwitz criteria for three degree equations.
- (c) With the help of this criteria perform local asymptotic analysis for the interior endemic equilibrium point. $2+3+3=8$
3. (a) What do you mean by functional response? Also discuss the classifications of functional response.
- (b) Write down the De Angelis model with proper assumptions.
- (c) Discuss about the stability of the axial equilibrium point. $3+2+3=8$

(3)

4. (a) What do you mean by meta-population?
- (b) Write down the Levin's model of meta-population with proper assumptions.
- (c) Discuss about the Basic Reproduction number of the model. Also discuss the transcritical bifurcation diagram for Levin's metapopulation model. $2+3+3=8$

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