2-Year/1-Year Master's Program in Mathematics (NEP-2020)

MATHEMATICAL BIOLOGY

Master's Mathematics (3rd Semester) Total Credits: **04**
Course Code: MMTHDMB326 (15 hours per credit) Total Marks: **100**
Continuous Assessment: Marks 30, Theory: Marks 70 Time Duration: 2½ hrs

Course Learning Outcomes(CLO's): After successful completion of this course, students will be able to:

CLO1. Analyze and interpret population growth models, including continuous, discrete, and structured population models such as logistic and Leslie matrix models.

CLO2. Formulate and study mathematical models for interacting populations, including predator–prey and competition models, and perform stability analysis.

CLO3. Apply epidemiological models (SI, SIS, SIR, and related models) to understand the spread and control of infectious diseases.

CLO4. Model biological and physiological processes such as diffusion, blood flow, and enzyme kinetics using appropriate mathematical frameworks.

Unit-I:

Population and Growth Models: Overview of advanced mathematical modelling in biology. Linear and nonlinear growth and decay models. Continuous population models for single species. Logistic growth model and its properties. Discrete population models: Leslie matrix models, Fibonacci sequence and golden ratio with biological interpretations, Introduction to compartment models in biological systems. Limitations and assumptions in biological modelling.

Unit-II:

Interacting Population Models: Basic terminology in ecology. Mathematical models for interacting populations. Types of interactions: Predator–prey models, Competition models, Symbiotic interactions, Lotka–Volterra system and its analysis. Equilibrium points and local stability analysis. Phase-plane and geometrical interpretation of solutions. Introduction to almost linear systems.

Unit–III:

Epidemiological Models: Fundamentals of epidemiology. Mathematical modelling of infectious diseases: SI, SIS, SIR, and endemic SIR models, Concepts and applications: Threshold parameters and basic reproduction number (introductory idea), Case studies (e.g., HIV/AIDS models), Window period and ELISA testing (conceptual discussion), Control strategies: Vaccination models, Disease prevention and control measures.

Unit–IV:

Bio-Fluid Mechanics and Biochemical Modeling: Diffusion in biological systems, Fick's law of diffusion, Fick's perfusion law, Diffusion through membranes and slabs, Bio-fluid mechanics: Types of fluid flow and viscosity, Continuity equation and basic equation of motion, Circulatory system modelling: Structure and function (heart, blood, vessels), Mathematical models of blood flow, Poiseuille's law and applications, Stewart–Hamilton method for cardiac output, Biochemical models: Enzyme kinetics, Michaelis–Menten model and its analysis.

CLO-PLO Mapping Matrix (Strength version)

CLO	PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Average CLO
MMTHDMB326.1		3	2	3	2	3	3	2	3	**2.63**
MMTHDMB326.2		3	3	2	2	3	3	3	3	**2.75**
MMTHDMB326.3		3	2	2	1	3	3	1	2	**2.13**
MMTHDMB326.4		3	2	3	3	3	3	2	3	**2.75**
Average PLO		**3**	**2.25**	**2.5**	**2**	**3**	**3**	**2**	**2.75**	**2.57**

Books Recommended

1. Kapur, J. N. Mathematical Modelling, New Age International, 2023
2. Bender, E. A. An Introduction to Mathematical Modeling, Dover, 2000
3. Murray, J. D. Mathematical Biology I-II, Springer, 2002-2003
4. M. A Khanday, Introduction to modeling and Biomathematics, Dilpreet Publishers, New Delhi, 2016
5. Lin, C. C. & Segel, L. A. Mathematics Applied to Deterministic Problems in the Natural Sciences, SIAM, 1988