MATHEMATICAL MODELLING: ANALYSIS AND APPLICATIONS

PROF. AMEEYA KUMAR NAYAK
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IIT Roorkee

PRE-REQUISITES : Basic Calculus

INTENDED AUDIENCE : UG students of technical universities/colleges

COURSE OUTLINE :

This course provides introduction of mathematical modeling and analysis in biological sciences. It is designed for students in both applied mathematics and bio-medical / biological sciences. The major content of this course is chosen from population dynamics. This course covers the fundamentals of deterministic models in both discrete and continuous time domain. This course includes both linear and non-linear models with sufficient amount of theoretical background. The relevant concepts and solution methods of various difference and differential equations are provided. We have also focused on graphical solution for clear analysis of nature of models.

ABOUT INSTRUCTOR :

Prof. Ameeya Kumar Nayak is Associate Professor in Department of Mathematics at IIT Roorkee and actively involved in teaching and research in the direction of numerical modeling of fluid flow problems for last ten years. His research interests are in the fundamental understanding of species transport in macro and micro-scale confinements with applications in biomedical devices and micro electro mechanical systems. He has authored and co-authored more than 32 peer-reviewed journal papers, which includes publications in Springer,ASME, American Chemical Society and Elsevier journals. He is also active in writing book chapter with reputed international publication house.

COURSE PLAN :

Week 1 : Overview of mathematical modeling, types of mathematical models and methods to solve the same; Discrete time linear models – Fibonacci rabbit model, cell-growth model, prey-predator model; Analytical solution methods and stability analysis of system of linear difference equations; Graphical solution – cobweb diagrams; Discrete time age structured model – Leslie Model; Jury's stability test; Numerical methods to find eigen values – power method and LR method.

Week 2 : Discrete time non-linear models- different cell division models, prey-predator model; Stability of non-linear discrete time models; Logistic difference equation; Bifurcation diagrams.

Week 3 : Introduction to continuous time models – limitations & advantage of discrete time model, need of continuous time models; Ordinary differential equation (ODE) – order, degree, solution and geometrical significance; Solution of first order first degree ODE – method of separation of variables, homogeneous equation, Bernoulli equation; Continuous time models – model for growth of micro-organisms, chemostat; Stability and linearization methods for system of ODE's.

Week 4 : Continuous time single species model – Allee effect; Qualitative solution of differential equations using phase diagrams; Continuous time models – Lotka Volterra competition model, prey-predator models.