Mathematical Modeling of Dynamical System

1.1 Course Number: MA 322

1.2 Contact Hours: 3-0-0 Credits: 9

1.3 Semester-offered: 3rd Year-Odd

1.4 Prerequisite: Linear Algebra; Calculus; Differential Equations; Numerical Methods and Matlab

1.5 Syllabus Committee Member: Dr. C. Kundu, Dr. M.K. Rajpoot (convener), Dr. A. Kumar, Dr. G. Rakshit.

2. **Objective:**

This course emphasizes the prevailing abilities of mathematical programming to problems like costs minimization, resource allocation, efficiency optimization and offering better solution in many other key areas in economics, science, engineering, and industry by solving their respective decision-making problems.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	**Introduction to mathematical modeling**	Introduction to modeling; elementary mathematical models and general modeling ideas; general utility of mathematical models, linear systems.	7
2	**Stability theory for system of differential equations**	Stability theory of system of differential equations; Linear and nonlinear stability; Lyapanov's method; nonlinear system theory, basic principles of bifurcations; illustrations with help of computer programming	12
3	**Formulations of models for physical problems**	Role of mathematics in problem solving; concepts of mathematical modeling; system approach formulation; analyses of models; pitfalls in modeling; illustrations of models with engineering applications in mathematical biology, fluid dynamics finance, and economics.	12
4	**Probabilistic models and Mathematical techniques for**	Introduction to probabilistic models; simulation approach; orthogonal projections, singular value decomposition, principal component analysis, Fourier and Wavelet transformation and applications, kernel methods	10

	the validations of the models		
		Total	41

4. Readings

4.1 Textbook:

I. D. N. P. Murthy, N. W. Page and Ervin Y. Rodin, *Mathematical modelling: a tool for problem solving in engineering, physical, biological, and social sciences*, Pergamon Press, 1990.
II. L. Perko, *Differential Equations and Dynamical Systems*, Springer 3rd Ed, 2008.

4.2 Reference books:

I. W.E. Boyce and R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, 7th Ed, Wiley, 2001.
II. J. D. Murray, *Mathematical Biology,* Vol-I,3rd Ed, 2003.

5 Outcome of the Course:

After completion of the course students

- Should be able to understand and make mathematical model for the engineering/mathematical problems.
- Have adequate understanding of theoretical concepts of linear/nonlinear dynamical systems.