22ID801 Data Driven Modelling and Analysis 2 1 3 4

Course Objectives

This course aims at enabling the graduate students to analyse the data that they obtain either from physical systems or from mathematical models. Further, the course will focus on imparting modelling skills to graduate students that will enable them to create models from data. The students will be exposed to conventional and the state-of-the art modelling techniques including AI/ML techniques.

Course Outcomes

After completing the course, the students will be able to

CO1: Analyse data from physical systems and mathematical models

CO2: Model systems from the first principles

CO3: Develop data driven models of systems of interest

CO4: Apply the state-of-the-art data analytics techniques to explore the dynamics of the systems of interest

Syllabus

Unit 1

Introduction to Mathematical Modelling – Different types of Mathematical Models – Discrete and Continuous Models – Numerical Methods for Nonlinear Models - Stability Analysis – EigenValues and EigenVectors – Dynamical System Approach.

Unit 2

Linear and Nonlinear Time Series Analysis – Time-Frequency Analysis of Data -Statistical Methods for Data Analysis – Dimensionality Reduction – SVD – Independent Component Analysis – ML Techniques for Data Analysis – DL Techniques for Data Analysis.

Unit 3

Decomposition Techniques for Data Analysis – Dynamic Mode Decomposition – Empirical Mode Decomposition – Variational Mode Decomposition - Equation Free Modelling – SINDy – Early Warning FrameWork for Catastrophic Transitions.

Textbooks/References

1. Data Driven Modelling & Scientific Computation: Methods for Complex Systems and Big Data – J. Nathan Kutz, Oxford University Press, First Edition, 2013.
2. Nonlinear Dynamics and Chaos – Steven H Strogatz, Westview Press,2015.
3. Modelling Complex System – Nino Boccara, Springer Publications, 2010.
4. Data Driven Science and Engineering – Steven L Brunton & J. Nathan Kutz, Cambridge University Press, 2019.
5. Principles of System Identification: Theory and Practice – Arun K Tangirala, CRC Press, 2015.

Evaluation Policy

Evaluation	Internal/External	Weightage
Assignments	Internal	25%
Presentations	Internal	25%
Submission of research article to Tier-1 Conferences or Q1/Q2 Journals*	External	50%

* - In order to achieve the course outcomes, a mandatory publication will be more suitable as an external evaluation component than a conventional exam. Since, PhD students are the target audience, they will be able employ the techniques learned from this course to their respective field of study to arrive at a publication.