ADVANCED PROCESS DYNAMICS

PROF. PARAG A. DESHPANDE
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PRE-REQUISITES : The students should preferably be in their third year or later of the undergraduate degree.

INTENDED AUDIENCE : Senior undergraduate and masters students of chemical engineering; will be equally useful for the students of biotechnology, mechanical engineering, aerospace engineering and physics.

INDUSTRY SUPPORT : Honeywell, ABB

COURSE OUTLINE :

Analysis of dynamics of processes is an integral part of the design of process control systems. The development of a successful control strategy requires a thorough knowledge of the process dynamics under various process conditions. This course details the analysis of techniques for dealing with dynamical systems, both linear and non-linear.

ABOUT INSTRUCTOR :

Prof. Parag A. Deshpande is an associate professor of chemical engineering at the Indian Institute of Technology Kharagpur. He received his doctoral degree from the Indian Institute of Science Bangalore, graduating as the recipient of the best thesis of the year award in the department of chemical engineering. He joined IIT Kharagpur in 2012, and has been associated with it ever since. His research interests include computational analysis of catalytic and biocatalytic systems. He has taught several courses at IIT Kharagpur to undergraduate, masters and doctoral students including advanced mathematical techniques, chemical and statistical thermodynamics, classical and quantum methods in molecular simulations, and process dynamics.

COURSE PLAN :

Week 1: Motivation for the study of process dynamics, State-space domain analysis of linear autonomous first order systems, Lumped parameter analysis of cooling of a body
Week 2: Introduction to higher order systems, Phase plane analysis of linear autonomous second order systems, Analysis of a free spring-mass system
Week 3: Analysis of dynamics of non-autonomous systems, Similarity solution for non-autonomous higher order dynamics, Analysis of a forced spring-mass system
Week 4: Phase plane analysis of linear systems of order three and higher, Analysis of complex reaction systems
Week 5: Introduction to non-linear systems, Logistic population growth model, Logistic population growth with harvesting
Week 6: Logistic population growth with threshold population, Analysis of population dynamics in discrete domain, Analysis of fixed-points and bifurcation in discrete domain
Week 7: Higher order non-linear systems, Bifurcations in higher order non-linear systems, Reactor stability analysis
Week 8: Analysis of infectious disease dynamics, Analysis of atmosphere dynamics using Lorenz equations
Week 9: Analysis of system dynamics in transform domain - Review of Laplace transforms, Analysis of first order systems subjected to ideal forcing functions, Analysis of response of second order systems
Week 10: Analysis of (p,q) order systems, Analysis of inverse response systems
Week 11: Analysis of dynamics of discrete-time systems, Sampling and reconstruction of continuous variables
Week 12: Response of discrete-time systems, Stability of discrete-time systems