THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Lumped Parameter Modeling and System Analysis

MECHENG 7380

Credit Hours:
3.00 - 3.00

Course Levels:
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Mathematical model development and response prediction of linear lumped parameter dynamic systems. Input-output and state-space methods are used to develop insights into design, sensor placement and diagnostics, and actuator selection for control.

Prerequisites and Co-requisites:
Prereq: Math 2174, 2415 (415), or 4512 (512), or Grad standing in MechEng, or permission of instructor.

Course Goals / Objectives:
- Develop ability to model continuous-time, linear, lumped parameter systems, using input-output description and internal variable description
- Develop mathematical models based on direct methods
- Predict system response to specified inputs using impulse response, convolution integral, and frequency response approaches
- Predict system response to specified inputs using state space approaches, including the state transition matrix and solution of system equations
- Become familiar with concepts of state controllability, observability, and stability, along with methods of quantitative analysis
- Perform case studies and projects on systems of some complexity using modeling and response prediction techniques, in design, sensing, and actuation applications
- Become familiar with computing tools for analysis and design of lumped parameter systems

Course Topics:

- Course introduction and overview
- Input-output description of linear systems: impulse response, convolution function
- Laplace transforms, transfer functions, poles and zeros, relation to impulse response
- Frequency response, Fourier Series and periodic response, Fourier Transforms and transient response, Discrete Fourier Transforms
- Matrix analysis and state space description of lumped parameter systems
- Eigenvalues and eigenvectors, modal decomposition and Jordan forms
- State transition matrix and solution of system equations; impulse function matrix and transfer function matrix
- Controllability and observability; stability
- Project discussion
- Case studies of modeling and analysis of physical, multi-domain system response, including use of physical simulation

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Designation:

Elective