Mechanical Engineering Dept. Department

Syllabus
ME 401: System Dynamics & Control (3-0-3)

Course Catalog Description:

Dynamics of mechanical, electrical, fluid and thermal systems. Transfer function and block diagram representations. Analysis and simulation of dynamic systems in the time and frequency domains. Design of basic controllers in the time and frequency domains. Stability of open- and closed-loop dynamic systems.

Course Pre-requisites:

- EE 234: Electronics & Microcontrollers
- EE 235: Electr. & Microcontrollers Lab
- MATH 202: Elements/Differential Equation
- ME 315: Heat Transfer

Course Co-requisites:

- ME 402: Measurements and Control Lab

Course Objectives:

1. Basic modeling methodologies for dynamic systems.
2. Methods for analyzing dynamic responses.
3. Classical control techniques using basic control actions.
4. Techniques for analyzing systems' stability.
5. Identify, formulate and design control system for engineering problems

Course Learning Outcomes:

CLO1. Demonstrate ability to derive simple dynamic models for basic engineering systems.

CLO2. Demonstrate ability to identify dynamic characteristics: natural frequency, damping, time constant, settling time, etc. of simple dynamic systems.

CLO3. Demonstrate ability to analyze systems' dynamic responses, in both time and frequency domains.

CLO4. Demonstrate knowledge of the basic characteristics, representations, and utilization of the P, PI, PD, and PID controllers.

CLO5. Demonstrate ability to characterize systems' stability based on Routh-Hurwitz criterion, Bode plots, and root locus.

CLO6. Demonstrate ability to perform computer simulations of basic control actions as applied to simple dynamic systems, and to show the effect of varying controller's parameters on stability and performance.

CLO7. Demonstrate knowledge of how control systems are crucial to the functionality and performance of dynamic systems.

Learning Resources:

- Dynamic Systems: Modeling, Simulation, and Control, C. A. Kluever, John Wiley 2015.
- 1. Modeling, Analysis, and Control of Dynamic Systems, 2nd Ed., W. J. Palm III, John Wiley 2002. 2. System Dynamics, 1st Ed., W. J. Palm III, Mc Graw Hill, 2005. 3. Modern Control Systems, 9th Ed., R.C. Dorf and R. H. Bishop, Addison-Wesley, 2001. 4. System Dynamics, by K. Ogata, 2004, 4th Ed., Prentice Hall.
- Blackboard Learn, MS Teams, and YouTube.
- MATLAB and SIMULINK

Lecture Assessment Plan:

Assessment Task	Week Due	Weight
2nd Major Exam	13	25.0%
Project	15	5.0%
Final Exam	16	30.0%
1st Major Exam	7	25.0%
Homework Assignments	weekly	5.0%
Quizzes	weekly	10.0%

Lecture Weekly Schedule:

Week#	Topics
1	Introduction to systems dynamics
	Laplace transform
2	Laplace transform (Continue)
3	Mechanical systems
4	Transfer function approach to modeling dynamic systems
5	Transfer function approach to modeling dynamic systems (Continue)
	Electrical and electromechanical systems
6	Electrical and electromechanical systems (Continue)
	Fluid systems
7	Fluid systems (Continue)
	Thermal systems
	Time-domain analysis of dynamic systems
8	Time-domain analysis of dynamic systems (Continue)

Week#	Topics
9	Time-domain analysis of dynamic systems (Continue)
	Frequency-domain analysis of dynamic systems
10	Frequency-domain analysis of dynamic systems (Continue)
11	Time-domain analysis and design of control systems
12	Time-domain analysis and design of control systems (Continue)
13	Time-domain analysis and design of control systems (Continue)
	Frequency-domain analysis and design of control systems
14	Frequency-domain analysis and design of control systems (Continue)
15	Frequency-domain analysis and design of control systems (Continue)
	Control of Dynamic Systems: Case-Studies