Mechanical Engineering Dept. Department

Syllabus
ME 413: Systems Dynamics and Control (2-3-3)

Course Catalog Description:

Dynamics of mechanical, fluid, electrical and thermal systems. Equations of motion. Dynamic response of elementary systems. Transfer functions and pole-zero diagrams. Simulation of dynamics of complex systems. Dynamic stability of systems. Open and closed-loop systems. Basic control actions. Laboratory sessions involving use of computers for simulation of dynamic systems and analysis of control systems.

Course Pre-requisites:

- MATH 333: Methods of Applied Maths. I
- ME 201: Dynamics

Course Objectives:

1. To teach students the basic modeling methodologies for dynamic systems.
2. To teach students methods for analyzing dynamic responses.
3. To teach students the classical control techniques using basic control actions.
4. To provide students with techniques for analyzing systems' stability.
5. To provide students with exposure to experimental laboratory applications of control to various dynamic systems.

Course Learning Outcomes:

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

CLO2. Demonstrate ability to analyze systems' dynamic responses, in both time and frequency domains.

CLO3. Demonstrate knowledge of the basic characteristics, representations, and utilization of the P, PI, PD, and PID controllers.

CLO4. Demonstrate ability to characterize systems' stability based on Routh-Hurwitz criterion, Bode plots, and root locus.

CLO5. 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.

CLO6. Demonstrate ability to perform laboratory experiments to demonstrate the basic control actions as applied to simple mechanical, electromechanical, thermal, and fluid systems.

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

Learning Resources:

- System Dynamics, by K. Ogata, 2004, 4th Ed., Prentice Hall.
- 1. Modeling, Analysis, and Control of Dynamic Systems, 2nd Ed., W. J. Palm III, John Wiley & Sons, 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.
- Blackboard Learn, MS Teams, and YouTube.
- MATLAB and SIMULINK.

Lecture Assessment Plan:

Assessment Task	Week Due	Weight
2nd Major Exam	13	20.0%
Final Exam	16	25.0%
1st Major Exam	7	20.0%
Homework Assignments	weekly	5.0%
Quizzes	weekly	10.0%

Lab Assessment Plan:

Assessment Task	Week Due	Weight
Lab Projects and Oral Presentations	15	6.0%
Lab Reports	weekly	14.0%

Lecture Weekly Schedule:

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

Week#	Topics
9	Time-domain analysis of dynamic systems (Continue)
10	Frequency-domain analysis of dynamic systems.
11	Frequency-domain analysis of dynamic systems. (Continue)
	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)
14	Time domain analysis and design of control systems (Continue)
	Frequency-domain analysis and design of control systems
15	Frequency-domain analysis and design of control systems (Continue)

Lab Weekly Schedule:

Week#	Topics
1	Introduction to MATLAB
2	Introduction to MATLAB (Continue)
3	Laplace Transforms
4	Mechanical Systems (1): Harmonic Oscillations - Experiment: The Mass-Spring System
5	Mechanical Systems (2): Translational Systems - Simulation: Modeling of a Suspension Car System
6	Mechanical Systems (3): Rotational Systems - Simulation: Modeling of Coupled Disks Assembly
7	Transfer Function Approach Using SIMULINK
8	Electromechanical Systems
9	Experiment: Undamped Dynamic Vibration Absorbers
10	First-Order System Transient Response and Control
11	Second-Order System Transient Response and Control
12	Second-Order System Transient Response and Control (Continue)
13	Lab Project
14	Lab Project (Continue)
15	Lab Project Presentations