Course Syllabus ME 413: System Dynamics and Control
Spring Semester 2006-2007 (062)

ME Mission The department is committed to providing highest quality education in mechanical engineering, conducting world-class basic and applied research, addressing the evolving needs of industry and society, and supporting the development of more competitive and new industry in the Kingdom of Saudi Arabia.

Catalog Description

ME 413: System Dynamics and Control **(2-3-3)**

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.

Prerequisites ME 201, MATH 301

Textbook System Dynamics, by K. Ogata, 2004, 4th Edition, Prentice Hall.

References

1. Modeling, Analysis, and Control of Dynamic Systems, 2nd Edition, William J. Palm III, John Wiley & Sons, 2002.
2. System Dynamics, 1st Edition, William J. Palm III, Mc Graw Hill, 2005.
3. Modern Control Systems, 9th Edition, R.C. Dorf and R.H. Bishop, Addison-Wesley, 2001.

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

After taking this course, students will be able to:

1. demonstrate knowledge of the fundamental assumptions related to the derivation of simple dynamic models.
2. demonstrate ability to derive simple dynamic models for basic engineering systems.
3. demonstrate ability to identify dynamic characteristics – e.g. natural frequency, damping, time constant, settling time, etc. - of simple dynamic systems.
4. demonstrate ability to analyze systems' dynamic responses, in both time and frequency domains.
5. demonstrate knowledge of the basic characteristics, representations, and utilization of the P, PD, and PID controllers.
6. demonstrate ability to characterize systems' stability based on Routh-Hurwitz Criterion, Bode Plots, and Root Locus.
7. 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.
8. demonstrate ability to perform laboratory experiments to demonstrate the basic control actions as applied to simple mechanical, electromechanical, thermal, and fluid systems.
9. demonstrate knowledge of how control systems are crucial to the functionality and performance of dynamic systems.

Contribution of course to Meeting the Professional Component

Students will be introduced to modeling methodologies of basic dynamic systems; analyzing systems dynamic response and characterizing system parameters; understanding basic control actions, and analyzing stability of dynamic systems. In addition, laboratory sessions are designed to enhance students' ability to teamwork, experimental skills, communication skills, and use of computational techniques.

Relationship of the Course to Program Outcomes

1. Students shall have an ability to apply knowledge of mathematics, science, and fundamental engineering to various engineering problems (1, 2, 3, 5)
2. Students shall have an ability to use modern tools, techniques and skills necessary for practicing mechanical engineering, including computational tools, statistical techniques, and instrumentation, (1, 2, 3, 5)
3. Students shall have an ability to communicate effectively in written, oral, and graphical forms, including the use of professional-quality visual aids, (5, 7, 8)
4. Students shall have an understanding of the impact of control of dynamic systems on the society and environment, (9, 10)

Attendance

According to KFUPM rules and regulations, Attendance is **MANDANTORY** and will be checked at the beginning of each lecture. The only acceptable excuse for absence is the one authorized by the Deanship of Student Affairs on their prescribed form. This excuse should be presented to the instructor no later than one week following the resumption of class attendance. **For any unexcused absence, 1/2 mark will be deduced from the student overall grade.**

A regular student will not be allowed to continue in the course and take the final examination and will be given a **DN** grade if his unexcused absences are more than **20%** of the lecture and laboratory sessions scheduled for the course regardless of his performance.

HW

It is your responsibility to solve the homework as soon as the material is covered in the class. Homework solution will be published on WebCT. Quizzes will be given regularly based on the homework problems. Home works are assigned during lectures. All homework problems assigned during a given week are due in class one week from date of assignment, unless otherwise stated by your instructor. **Late HW is not accepted.**

Final Exam

Final Exam is **comprehensive** (i.e. covers all chapters as described in the syllabus).

Assessment Methods

- Homeworks
- Quizzes,
- Exams,
- Projects and Oral Presentations,
- Laboratory Reports.

Instructor's Name	Location	Tel.	E:mail	Office Hours
Dr. H. Al-Qahtani	22-215.3	2846	QahtaniH@kfupm.edu.sa	

Course and Lab Coordinator	Dr. A. Aziz Bazoune

TABLE 1: GRADING SYSTEM

Factor	Weight	Location	Date	Time
H W /Quizzes	**10 %**	Take Home/In Class	To Be Announced (TBA)	
Lab. Assignments (10%) and Project (10%)	**20 %**	In Lab.	Weekly	-----
1st Major Exam	**20 %**	**06-125**	**Tue. March. 27, 2007**	**18:00 → 20:00**
2nd Major Exam	**20 %**	**06-125**	**Tue. May. 1, 2007**	**18:00 → 20:00**
Final Exam	**30 %**	To Be Announced (TBA)	**Sat. June 9, 2007**	**07:30 AM**

TABLE 2: COURSE PLAN

Chapter	Topics	# of Lec.
1	**Introduction to systems dynamics**	**1**
2	**Laplace transform**	**4**
3	**Mechanical systems**	**3**
4	**Transfer function approach to modeling dynamic systems**	**2**
6	**Electrical and electromechanical systems**	**3**
7	**Fluid systems**	**2**
8	**Time-domain analysis of dynamic systems**	**3**
9	**Frequency-domain analysis of dynamic systems.**	**3**
10	**Time domain analysis and design of control systems:** Block diagrams reduction, Transient response specifications for a second order system (rise time, overshoot, settling time, etc.), Steady state error and system type, Routh stability criterion, Control actions (P,PI, PD, and PID controllers), Root-locus method	**6**
11	**Analysis and design of control systems in frequency domain:** Bode plots and Stability Measures in frequency domain (Phase and gain margins)	**3**

TABLE 3: HW

Chapter	Problem Set (Textbook)	Due Date Sec (02) and (04)	Due Date Sec (03)
2	B-2-5, B-2-7, B-2-14, B-2-17, B-2-20, B-2-24, B-2-25.	Mon., March. 5	Tue., March. 6
3	B-3-9, B-3-12, B-3-13, B-3-14, B-3-15, B-3-18, B-3-19, B-3-20	Sat, March. 17	Sun, March. 18
4	B-4-1, B-4-2, B-4-4, B-4-5, B-4-7, B-4-11.	Sat., March. 24	Sun., March. 25
6	B-6-4, B-6-7, B-6-8, B-6-10, B-6-11, B-6-12, B-6-19	Mon., April. 2	Tue., April. 3
7	B-7-2, B-7-3, B-7-4, B-7-5	Mon., April. 9	Tue., April. 10
8	B-8-3, B-8-4, B-8-7, B-8-8, B-8-10, B-8-11, B-8-12	Mon., April. 23	Tue., April. 24

9	B-9-1, B-9-2, B-9-3, B-9-4, B-9-7, B-9-8	Sat., May 5	Sun., May 6
10	Part I: B-10-2, B-10-3, B-10-4, B-10-9, B-10-11, B-10-12	Mon., May 14	Tue., May 15
10	Part II: B-10-14, B-10-15	Sat., May 26	Sun., May 27
10	Part III: B-10-7, B-10-19, B-10-20	Sat., June 2	Sun., June 3