# King Fahd University of Petroleum & Minerals
## College of Engineering Sciences
## Mechanical Engineering Department

| *ME 413: System Dynamics and Control* | *Course Syllabus* | *Spring Semester 2009-2010 (091)* |
|---|---|---|
| **Location** | **Tel.** | **E:mail** | **Office Hours** |
| 22-215.3 | 2846 | Qahtanih@Kfupm.Edu.Sa | SM: 03:30 → 05:00 |
| | | | Appointments |

**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 Ed., Prentice Hall.

**References**

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.

**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: 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**

Attendance is **MANDATORY** and will be checked at the beginning of each lecture. **Late coming** is strictly **not allowed** as it disturbs students and instructor. Excuses for absence should be approved by the Deanship of Student Affairs and submitted to the instructor within a week following the last day of absence. For any unexcused absence, 0.5 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 scheduled for the course regardless of his performance.

**H.W.**

It is your responsibility to solve the HW as soon as the material is covered in the class. Homework solution will be published on WebCT. All HW 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.**

**Assessment Methods** HW, Quizzes, Exams, Projects and Oral Presentations, Laboratory Reports.

**TABLE 1: GRADING SYSTEM**

| Assessment | Weight | Location | Date | Time |
|---|---|---|---|---|
| H W (8%)/ Quizzes (7%) (No make up quizzes) | 15 % | In Class | To Be Announced (TBA) | |
| Lab. Assignments (5%) & Project (10%) | 15 % | In Lab. | Weekly | |
| 1st Major Exam | 15 % | (TBA) | Wed., 11 Nov., 2009 | 5:30 → 7:30 p.m. |
| 2nd Major Exam | 20 % | (TBA) | Wed., 30 Dec., 2009 | 5:30 → 7:30 p.m. |
| Final Exam | 35 % | (TBA) | February 6, 2010 | 7:00 p.m. |

**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 | 6 |
| 11 | Analysis and design of control systems in frequency domain | 3 |

**TABLE 3: HW ASSIGNMENTS**

| Chapter | Problem Set (Textbook) | Due Date (To Be Announced) |
|---|---|---|
| 2 | B-2-2, B-2-6, B-2-14, B-2-19, B-2-20, B-2-23, B-2-25 | |
| 3 | B-3-8, B-3-12, B-3-14, B-3-16, B-3-17, B-3-20 | |
| 4 | B-4-2, B-4-3, B-4-5, B-4-6, B-4-7, B-4-8, B-4-11, B-4-11 | |
| 6 | B-6-5, B-6-6, B-6-9, B-6-12, B-6-19 | |
| 7 | B-7-2, B-7-3, B-7-4, B-7-5, B-7-7 | |
| 8 | B-8-2, B-8-2, B-8-4, B-8-8, B-8-9, B-8-11, B-8-12 | |
| 9 | B-9-1, B-9-2, B-9-4, B-9-6, B-9-7, B-9-12 | |
| 10 | B-10-1, B-10-2, B-10-3, B-10-4, B-10-8, B-10-10, B-10-13, B-10-14 | |
| 11 | B-11-3, B-11-4, B-11-7, B-11-8, B-11-9 | |