



## Course Syllabus: Control Theory - ME 221B

<b>Division</b>	Physical Science and Engineering Division
<b>Course Number</b>	ME 221B
<b>Course Title</b>	Control Theory
<b>Academic Semester</b>	Spring
<b>Academic Year</b>	2016/2017
<b>Semester Start Date</b>	01/22/2017
<b>Semester End Date</b>	05/18/2017
<b>Class Schedule</b> (Days & Time)	09:00 AM - 10:30 AM   Mon Thu

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Meriem Taous Laleg	taousmeriem.laleg@kaust.edu.sa	+966128080371	4205, 1, Al-Khawarizmi (bldg. 1)	by appointment

Teaching Assistant(s)	
Name	Email

Course Information	
<b>Comprehensive Course Description</b>	The aim of this course is to introduce the student to the area of multivariable control analysis and design. We will introduce stability and robustness for multiple input multiple output control systems. We will then focus on optimal and robust control design such as LQR, LQG, H <sub>infinity</sub> , LMI synthesis. Many examples will be provided and designed controllers will be illustrated by simulation using Matlab and through experimental implementation in the control lab.
<b>Course Description from Program Guide</b>	An introduction to analysis and design of feedback control systems, including classical control theory in the time and frequency domain. Modeling of physical, biological, and information systems using linear and nonlinear differential equations. Linear vs. nonlinear models, and local vs. global behavior, Input/output response, modeling and model reduction, Stability and performance of interconnected systems, including use of block diagrams, Bode plots, the Nyquist criterion, and Lyapunov functions. Robustness and uncertainty management in feedback systems through stochastic and deterministic methods. Basic principles of feedback and its use as a tool for altering the dynamics of systems and managing uncertainty methods. Introductory random processes, Kalman filtering, and norms of signals and systems.
<b>Goals and Objectives</b>	<ul style="list-style-type: none"> <li>- learn tools to study multiple input multiple output systems (MIMO)</li> <li>- study the robustness for MIMO</li> <li>- learn different optimal and robust control strategies for MIMO systems</li> </ul>
<b>Required Knowledge</b>	control systems, linear algebra, differential equations, knowledge on Matlab is recommended
<b>Reference Texts</b>	1- Kemin Zhou, John C. Doyle, Essentials Of Robust Control, Prentice Hall 1997. 2- Michael Green and David J.N. Limebeer Robust Control, Pearson Education 3- Stephen Boyd, Laurent El Ghaoui, E. Feron, and V. Balakrishnan, Linear Matrix Inequalities in System and Control Theory. Volume 15 of Studies in Applied Mathematics. Society for Industrial and Applied Mathematics (SIAM), 1994

<b>Method of evaluation</b>	<b>25.00%</b> - Course Project(s) <b>25.00%</b> - Midterm exam <b>20.00%</b> - Homework /Assignments <b>30.00%</b> - Final exam
<b>Nature of the assignments</b>	Homework including MATLAB based computer exercises will be assigned frequently. No late homework will be accepted. Consultation with other students on the problems is permitted but each student must submit his own and personal solution. Two identical solutions will not be considered. Projects based on lab experiments will be also assigned.
<b>Course Policies</b>	Attendance is strongly recommended. Syllabus adjustments and all possible modifications in the schedule and deadlines will be given in the class. It is your responsibility to make up the material and keep informed of any announcements.  Also, be sure to note the following policies: 1- Solutions for the exams and homework must be labeled, written clearly and the pages must be numbered. 2- All exams are closed book. You may not use the textbooks, the notes or any other outside material. 3- The final exam will cover the whole course material.  4- Make up exams will be only given to students who have unforeseeable events. However, the makeup is possible only if the student informs me within 48 hours. A written proof must be also provided before the make up.
<b>Additional Information</b>	

### Tentative Course Schedule

*(Time, topic/emphasis & resources)*

Week/Lecture	Topic
1	Introduction and review of basic concepts for Single input single output systems
2	Multivariable frequency response (singular values + robust stability)
3	Multivariable frequency response (performance analysis)
4	Spaces and norms
5	Small gain theorem and robustness analysis
6	LQR (finite Horizon)
7	LQR control ( infinite horizon)
8	Kalman Filter
9	LQG
10	H infinity control (finite Horizon)
11	Hinfinity control (infinite Horizon)
12	H infinity filter
13	LMI design
14	LMI design
15	Model reduction and optimal model reduction
16	
17	
18	

#### Note

The instructor reserves the right to make changes to this syllabus as necessary.