



## Course Syllabus: Robust Control - EE 376

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| <b>Division</b>                        | Computer, Electrical and Mathematical Sciences & Engineering |
| <b>Course Number</b>                   | EE 376   |
| <b>Course Title</b>                    | Robust Control   |
| <b>Academic Semester</b>               | Spring   |
| <b>Academic Year</b>                   | 2017/2018  |
| <b>Semester Start Date</b>             | 01/28/2018   |
| <b>Semester End Date</b>               | 05/24/2018   |
| <b>Class Schedule</b><br>(Days & Time) | 01:00 PM - 02:30 PM   Mon Thu                                |

### Instructor(s)

| Name           | Email                    | Phone         | Office Location                | Office Hours |
|----------------|--------------------------|---------------|--------------------------------|--------------|
| Jeff S. Shamma | jeff.shamma@kaust.edu.sa | +966128084409 | 3220, 3, Ibn Sina<br>(bldg. 3) |              |

### Teaching Assistant(s)

| Name | Email |
|------|-------|
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### Course Information

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| <b>Comprehensive Course Description</b>      | Robust control concerns the analysis and design of control systems that take into account the presence of system modeling errors. This course focuses on robust control methodologies for multivariable linear systems, i.e., systems modeled by linear differential equations with multiple control inputs and multiple measured outputs. Topics include: Signal and system norms and performance measures, robust stability and performance, uncertainty modeling, optimal disturbance rejection under the H <sub>2</sub> and H-infinity norms, Kalman filter and extended Kalman filter, structured uncertainty analysis and synthesis, and model reduction. |
| <b>Course Description from Program Guide</b> | Contents: Advanced methods for control design of multivariable linear systems subject to modeling errors. Topics: Signal and system norms and performance measures, robust stability and performance, linear fractional transformations, uncertainty modeling, optimal disturbance rejection, structured uncertainty analysis and synthesis, model reduction.   |
| <b>Goals and Objectives</b>                  | Analysis and design of multivariable linear control systems.  |
| <b>Required Knowledge</b>                    | Foundational material in linear systems including matrix exponential, stability, Lyapunov analysis, controllability, observability, stabilization by state feedback and output feedback. Also required is a strong background in linear algebra and familiarity with Matlab programming.  |
| <b>Reference Texts</b>                       | Green & Limebeer, "Linear Robust Control".<br>Zhou & Doyle, "Essentials of Robust Control".   |
| <b>Method of evaluation</b>                  | <b>25.00%</b> - Midterm exam<br><b>40.00%</b> - Homework /Assignments<br><b>35.00%</b> - Final exam   |
| <b>Nature of the assignments</b>             | Analytical (ungraded) and computational assignments (graded).   |
| <b>Course Policies</b>                       | Computational assignments to reflect independent effort. Late assignments not accepted once due date is finalized.  |
| <b>Additional Information</b>                |   |

## Tentative Course Schedule

*(Time, topic/emphasis & resources)*

| Week | Lectures                         | Topic   |
|------|----------------------------------|---|
| 1    | Mon 01/29/2018<br>Thu 02/01/2018 | Classical control review: Uncertainty mitigation, disturbance rejection, dynamic behavior modification. |
| 2    | Mon 02/05/2018<br>Thu 02/08/2018 | Single-input single-output (SISO) systems: Stability, performance, robustness, robust performance.      |
| 3    | Mon 02/12/2018<br>Thu 02/15/2018 | SISO systems, cont.   |
| 4    | Mon 02/19/2018<br>Thu 02/22/2018 | Multi-input multi-output (MIMO) systems: Singular values, structured singular value.                    |
| 5    | Mon 02/26/2018<br>Thu 03/01/2018 | MIMO systems, cont.   |
| 6    | Mon 03/05/2018<br>Thu 03/08/2018 | H2 synthesis: LQ regulator  |
| 7    | Mon 03/12/2018<br>Thu 03/15/2018 | H2 synthesis: Kalman filter   |
| 8    | Mon 03/19/2018<br>Thu 03/22/2018 | H2 synthesis: Extended Kalman filter  |
| 9    | Mon 03/26/2018<br>Thu 03/29/2018 | H2 synthesis: LQG regulators  |
| 10   | Mon 04/02/2018<br>Thu 04/05/2018 | Spring break  |
| 11   | Mon 04/09/2018<br>Thu 04/12/2018 | H-infinity synthesis: State feedback  |
| 12   | Mon 04/16/2018<br>Thu 04/19/2018 | H-infinity synthesis: Output feedback   |
| 13   | Mon 04/23/2018<br>Thu 04/26/2018 | H-infinity synthesis: Robust performance  |
| 14   | Mon 04/30/2018<br>Thu 05/03/2018 | Model reduction   |
| 15   | Mon 05/07/2018<br>Thu 05/10/2018 | Intro to adaptive control   |
| 16   | Mon 05/14/2018<br>Thu 05/17/2018 | Adaptive control, cont.   |
| 17   | Mon 05/21/2018<br>Thu 05/24/2018 | Review  |
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### Note

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