ECE311F Dynamic Systems and Control
Instructors: Prof. Luca Scardovi (coordinator), Prof. Raymond Kwong

1 Calendar Description


2 Outline of the course

This course provides an introduction to the basic principles and methodologies for the analysis and design of feedback systems. Feedback loops are an essential feature in almost every engineering system ranging from power and automotive systems to space missions and are ubiquitous in biological systems. A control system is a dynamical system that operates on the fundamental paradigm of the feedback loop. The goal of a control system design is to obtain a desired dynamic response despite the presence of disturbances. In the first half of the course, students learn the fundamentals of modeling and stability analysis of control systems. In the second half, the most important design methods are taught.

3 Learning objectives of the course

To learn the fundamentals of modeling, stability analysis and design of control systems.

4 Major Topics

The following is the list of major topics covered in ECE311. In brackets is shown the tentative number of lectures devoted to each topic.

- Introduction to feedback and State Models (3)
- Linearization (2)
- Laplace transform review (2)
- Transfer functions (2)
- Transient response of a linear system (3)
- Stability (3)
- Frequency response (2)
- The concept of feedback (1)
- Routh-Hurwitz test for stability (2)
- Internal model principle (2)
- Nyquist stability (5)
- Bode plots (4)
- The concept of loopshaping (1)
- Lag compensation (2)
- Lead compensation (2)
- Loop shaping theory (2)
5 Prescribed text and reading material

The text is the course notes Linear Systems and Control, by Bruce Francis, last updated January 2011. The students can also refer to the text Feedback Systems: an Introduction for Scientists and Engineers, by K.J. Aström, R. M. Murray for further reading (not mandatory and available online).

6 Lecture and Tutorials

There are three lectures per week for each section (two sections in total). There is one hour per week (total 12 hours) for each of the three tutorial sections. Only one Lecture section is indicated below.

<table>
<thead>
<tr>
<th>Section</th>
<th>Day and Time</th>
<th>Location</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lec 01</td>
<td>Mon 10-11</td>
<td>SF3202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tue 11-12</td>
<td>SF3202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thu 10-11</td>
<td>SF3202</td>
<td>Sept. 7</td>
</tr>
<tr>
<td>Tutorials</td>
<td>Tue 9-10</td>
<td>GB303</td>
<td>Sept. 12</td>
</tr>
<tr>
<td></td>
<td>Wed 15-16</td>
<td>BA2165</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thu 14-15</td>
<td>BA2145</td>
<td></td>
</tr>
</tbody>
</table>

7 Laboratory Experience

Students learn to use the control design toolboxes in Matlab and Simulink. They will also be familiarized with realtime control using micro-controllers Arduino. The course has three labs where the students are divided in six sections:

1. Modeling and simulation in Matlab and Simulink of a magnetic ball suspension system (3 hrs).
2. Design and simulation of velocity and position controllers for a cart on a track (3 hrs).
3. Realtime control of velocity and position for a cart on a track (3 hrs).

<table>
<thead>
<tr>
<th>Section</th>
<th>Day and Time</th>
<th>Lab1</th>
<th>Lab2</th>
<th>Lab3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRA 01</td>
<td>Mon 12-15</td>
<td>Oct 23</td>
<td>Nov 6</td>
<td>Nov 20</td>
</tr>
<tr>
<td>PRA 02</td>
<td>Mon 12-15</td>
<td>Oct 30</td>
<td>Nov 13</td>
<td>Nov 27</td>
</tr>
<tr>
<td>PRA 03</td>
<td>Tue 12-15</td>
<td>Oct 24</td>
<td>Nov 7</td>
<td>Nov 21</td>
</tr>
<tr>
<td>PRA 04</td>
<td>Tue 12-15</td>
<td>Oct 31</td>
<td>Nov 14</td>
<td>Nov 28</td>
</tr>
<tr>
<td>PRA 05</td>
<td>Fri 12-15</td>
<td>Nov 3</td>
<td>Nov 17</td>
<td>Dec 1</td>
</tr>
<tr>
<td>PRA 06</td>
<td>Fri 12-15</td>
<td>Oct 27</td>
<td>Nov 10</td>
<td>Nov 24</td>
</tr>
</tbody>
</table>
8 Teaching Assistants

Seven teaching assistants are assigned to the course, for a total of 420 hours.

9 Grading

The final grade is calculated as follows:

1. Labs: 10%
2. Midterm 1: 20%,
3. Midterm 2: 20%,
4. Final Exam: 50%