Linear and Robust Control Systems ELEC 9731
Session I 2015

Instructors:
Part I
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Part II
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[use subject: ELEC 9731]

Course Organisation
Prerequisites: Undergraduate Control Course
UOC: 6
Class Times: Wednesday, 6pm-9pm
Room: TBA

There are two parts to the course
Part I: Linear Systems and System Identification: weeks 1-6
See below.
Part II: Robust Control: weeks 7 -12
See below.

Aims:
Provide an introduction to linear system theory and system identification
from both an input/output and a state space point of view.
Provide an introduction to Robust Control
Optimal control, Optimal and Robust Filtering

Assessment:
To pass, students must obtain a pass level in each part of the course

Assignments (two for each part) 10% each
Exams (one for each part) (Take-home) 30% each
Assignments should have a School Assignment Sheet as the first page.
These sheets are available from the School Office,
or may be downloaded from the School web page.
Keep a copy your assignment
Late assignments will be penalised at 10% of the maximum value per day late.

Exam The same arrangements apply as for Assignments.

Assignment & Exam Timetable
Assignment 1: out - week 2 ; due - week 4
Assignment 2: out - week 4 ; due - week 6
Assignment 3: out - week 6 ; due - week 8
Assignment 4: out - week 8 ; due - week 10
Assignment 5: out - week 10 ; due - week 12
Exam: out - week 12 ; due - 16 days later
Resources

Part I

**Software:** Matlab (including Simulink)

**Textbook:** none.

**References:** in Library Open Reserve


(b) L. Ljung. System identification: Theory for the user


Part II

**Software:** Matlab (including Simulink)

**Textbook:**


(b) G.C. Goodwin, S.F. Graebe and M.E. Salgado (2000)

Control Systems Design. Prentice Hall.


**References**


Teaching Strategies
Lectures to give the basic material in written form, and to highlight the importance of different sections, and help with the formation of schema.
Assignments to give practice in problem solving, and to assess your progress.
Examination the final test of competency.

Learning Outcomes
At the end of the course the student will be familiar with basic aspects of multivariable linear system theory and control, from both an input/output and a state space point of view. The student will be able to use this knowledge to solve basic problem in multivariable linear system theory and multivariable control design.

Academic Honesty and Plagiarism
Plagiarism means copying. You cannot copy other people’s work of any kind; you cannot copy from any source. Plagiarism is a serious offence and (severe) penalties will apply; see https://student.unsw.edu.au/plagiarism

Administrative Matters
On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies; see: http://www.engineering.unsw.edu.au/electrical-engineering/administrative-procedures
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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| 1    | Matrix Review Handout  
   | Including: eigenvector decomposition; singular value decomposition; matrix inversion lemma; projection lemma; generalised inverses. |
| 2a   | Review SISO State Space  
   | Including: transformation between transfer function and state space; modal transformation; controllability; observability. |
| 2b   | state space decomposition theorem; polynomial division; Sylvester resultant and coprimeness. |
| 3    | Introduction to System Identification.  
   | Including: Finite Impulse Response (FIR) Modeling. |
| 4    | Noise Models  
   | Including: AR, ARMA, Spectrum. AR model fitting. |
| 5    | State Space Subspace ($S^4$) Methods.  
   | Including: Computational Aspects via SVD and QR algorithms. |
| 6    | Spectral Estimation & Estimation in Closed Loop.  
<p>| Including: Effect of filtering on spectra. Transfer Function estimation with cross-spectra. |</p>
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<th>Week</th>
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<tbody>
<tr>
<td>7</td>
<td>Introduction to Robust control. Kharitonov theorem; edge theorem.</td>
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<tr>
<td>8</td>
<td>Classical approach to robust control design. case studies.</td>
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<td>9</td>
<td>Robust PID controllers. case studies.</td>
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<tr>
<td>10</td>
<td>Optimal control. dynamic programming; linear quadratic optimal control problem; Riccati equations.</td>
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<tr>
<td>11</td>
<td>Model predictive control. Kalman filtering; case studies.</td>
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<tr>
<td>12</td>
<td>H-infinity control. differential games; H-infinity filtering; Kalman filtering versus H-infinity filtering; case studies.</td>
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