Subject Information Guide

Mathematical Control Theory @ UQ (MATH 4406/7406)

Semester 2, 2016

Administration and contact details

Host Department	The School of Mathematics and Physics
Host Institution	The University of Queensland
Name of lecturer	Dr. Yoni Nazarathy
Email Address	y.nazarathy@uq.edu.au
Homepage	https://www.smp.uq.edu.au/people/YoniNazarathy/

Subject details

Subject homepage URL	https://www.smp.uq.edu.au/people/YoniNazarathy/control4406_2016/index.html
Start date:	27/7/2016
End date:	7/11/2016 (due date of the final assessment)
Contact hours per week:	4
Lecture day and time: (Brisbane time)	Wed, 10 – 12 Thurs, 10 – 12 Office visit hour/call-in: Monday 1pm.

Subject content

1. Subject content description

The current (2016) edition of the course is focused on the mathematics of linear control theory. As a secondary aim, it presents a broader view of control theory and practice.

This course is taught every two years at UQ and is now taught for the third time by Yoni Nazarathy. The 2010 edition and editions previous to that, focused on continuous optimal control (calculus of variations). The 2012 edition contained a mix of linear control theory, continuous optimal control and other variants. The 2014 edition focused on Markov decision processes. This year, most emphasis is put on the mathematical details of linear control theory. The course also includes a few guest lectures from engineering control experts at UQ.

2. Week-by-week topic overview

A very detailed plan is on the course web-page.

3. Assumed prerequisite knowledge and capabilities

Students following this course should have ideally studied 2-3 courses focusing on calculus and differential equations, 1-2 courses focusing on linear algebra, 0-2 courses of analysis or other variants of rigorous mathematics, 0-2 courses of probability and/or stochastic processes, 0-2 courses of discrete mathematics and 1-3 courses involving computation (programming).
Hence as a minimum, 2 calculus courses, a course focusing on linear algebra and a course involving some programming is sufficient. Nevertheless, mathematical maturity is required, so the more previous courses taken, the better. Specifically, students should have experienced proofs and abstract mathematical thinking. Further, as detailed below, experience with computation and writing is needed (but also be further developed in this course).

Computation (programming): Home assignments will often (but not always) require use of computation tools (e.g. Octave, Julia, Matlab, Mathematica, R, etc…). The specific tool to use is the choice of the student. The details of how to use these tools are **not** taught in this course. The students need to be able to use the tools of their choice and simultaneously become more proficient. Since home assignments may be worked on in pairs, there is room to become more proficient in such computation tools via peer work. Assignment partners are required to circulate (a pair can only hand in two joint assignments).

Writing: Assignments must be handed in using electronic format. The typical tool to use is Latex (but any other option is acceptable). Handed in assignments need to be self-contained documents. Specifically they need to include a description of the questions asked and tasks carried out. Graphs need to be legible, perfectly labelled and legible when using B&W printing. Where applicable, hand-drawn illustrations (with photo pasting in the document) are acceptable. All assignments should be handed in via e-mail as pdf documents.

4. Learning outcomes and objectives

Students completing this course will have gained:

- A detailed mathematical knowledge of linear control theory and systems theory. This includes basic feedback control, observers, Kalman filtering, linear-quadratic optimal control and basic methods for handling multi-input-multi-output systems.
- A broad knowledge of engineering and mathematical control theory. This includes both elementary classic engineering control methods and advanced ones.

Auxiliary skills to be acquired and developed during the course: Linear Algebra, modelling, programming (not taught but required in some assignments), writing skills, working with colleagues (through peer assignment submission).

5. Learning resources

See the course web-page.

6. Assessment

The course assessment is comprised of 5 home assignments, 5 quizzes and a final report. The weight of the assignments is 40%, the weight of the quizzes is 40% and the weight of the final report is 20%. The assignment grade is taken as the average of the best 4 assignments. The quiz grade is taken as the average of the best 4 quizzes.

Assignments are to be submitted in pairs with the constraint that a pair can only hand in up to two joint assignments together. Assignments require some 10-30 hours of joint work and sometimes involve computational experiments. All submissions must be neatly electronically formatted.

The assignment grade is taken as the average of the best 4 out of 5 assignments.

Quizzes are 40 minutes in length and take place during the lectures (including at remote locations).

The final report is a 4-8 document written as an expository, self-contained paper describing control theory. Students should begin preparing this document a month before submission. Final reports are to be submitted individually (not in pairs).

Institution Honours program details

Weight of subject in total honours assessment at host department	2/16
Thesis/subject split at host department	6/10
Honours grade ranges at host department:	
H1	Enter range 85-100
H2a	Enter range 75-84
H2b	Enter range 65-74
H3	Enter range 50-64