MECH 4501 State Space Modeling and Control

September 1, 2021

Prof. D. L. Russell (donald.russell@carleton.ca)

MECH 4501 [0.5 credit] State Space Modeling and Control Review of matrices. Geometric structure and dynamics of linear systems. Controllability and observability. Pole placement design of controllers and observers. Design of regulator and servo systems. Transmission zeros. Eigenstructure assignment. Relationship to frequency or classical control techniques. Computer solutions using MATLAB. Applications.

Prerequisite(s): (MAAE 3500 or SYSC 4505) and fourth-year status in Engineering.

Lectures: Tuesday and Thursday 1:05 - 2:25, Online.

Zoom Link: https://carleton-ca.zoom.us/j/4945924903

Topics

1. Introduction: States, inputs and outputs. System Order. Constitutive equations and conservation laws. Analogies. Linearization.

2. State Space Models: Choice of state variables. Invariant aspects of state equations. Transfer functions.

3. Linear System Dynamics: Time domain solution. Properties of the A matrix. Eigenvalues and eigenvectors. State transition matrix. Resolvent.

4. Controllability and Observability: Canonical forms. Modal decomposition of the state equations. Zeros.

5. Controller Design: Pole Placement. Full-state feedback. Optimal control. Methods of choosing weighting matrices.

6. Observers: Full and Reduced Order. Optimal Observers - Kalman Filters.

7. Integrating controllers and observers: The separation principal. Output feedback.

Evaluation

	Date	Value
Assignments:	Roughly every 2-3 weeks	
Assign. 1: Modelling		7.5%
Assign. 2: Dynamics		7.5%
Assign. 3: Controller Design		7.5%
Assign. 4: Observer Design		7.5%
Midterm	TBD	20%
Examination	During Exam Period	50%
Total		100%

Suggested References

- Freidland, B., *Control System Design: An introduction to state-space methods.*
    Available online from the Carleton Library

- Ogata, K. *Modern control engineering.* (Prentice-Hall)

- Franklin, G., J. Powell and A. Emani-Naeini. *Feedback Control of Dynamic Systems.* (Addison-Wesley)

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website.

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website.

Academic Accommodations for Students with Disabilities The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).