ENG ME/SE/EC 501: Dynamic Systems Theory — State-space linear systems

Course Outline: (Fall 2022)

1. Mathematical preliminaries: linear algebra
   (i) Finite dimensional linear spaces
   (ii) Linear transformations and matrices
   (iii) Jordan normal form

2. State-space representation of linear control systems

3. Mathematical foundations of state-space representations
   (i) Existence and uniqueness results for linear ordinary differential equations
   (ii) Peano-Baker series and matrix exponentials
   (iii) Properties of the state-transition matrix

4. Points of contract with frequency-domain analysis
   (i) The resolvent; Newton’s algorithm
   (ii) Stability analysis in the frequency domain

5. Controllability and observability
   (i) The controllability Grammian; the observability Grammian
   (ii) Algebraic tests for controllability and observability

6. Shaping the dynamic response — Where do we put the closed-loop poles?
   (i) Analysis of second-order systems; dc-motor control example
   (ii) Design of regulators

7. Digital control theory
   (i) Modeling discrete-time and sampled-data systems
   (ii) Analysis of sampled data systems

8. Linear observers

9. Compensator design by separation of variables principle

10. Linear quadratic optimal control theory
    (i) The Pontryagin maximum principle
    (ii) Least squares theory and the matrix Riccati equation

11. Introduction to stochastic processes and stochastic control processes
    (i) Wiener processes
    (ii) The Ito calculus and the theory of stochastic differential equations
    (iii) Recursive estimation

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12. Nonlinear/geometric control theory
   (i) Introduction to the theory of differentiable manifolds
   (ii) Accessibility, controllability, and system Lie algebras
   (iii) Geometric mechanics and control of mechanical systems

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**Suggested Reading**

**Text:**


For a convenient guide to online shopping for the text, visit the course website:
http://people.bu.edu/johnb/ME501.html

**Other books:**


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**Grading**

Grades will be given for homework assignments (one every week or so), class participation, and a mix of quizzes and exams.

For up-to-date information about the class, visit: http://people.bu.edu/johnb/ME501.html.

(August 26, 2022)