



Ph.D. Qualifying Exam: System Dynamics

Department of Mechanical Engineering University of Utah

Exam Description:

Students should be prepared to model the dynamics of mechatronic systems including mechanical translation, mechanical rotation, electric, hydraulic, and thermal domains. Students may use any graphical modeling technique of their choice, including the following:

- Bond Graphs (Karnopp, Margolis and Rosenberg: Chapters 1-5)
- Linear Graphs (Rowell and Wormley: Chapters 1-6)
- Electric Circuit Analogs (i.e. reformulating a mechanical, hydraulic, or thermal system as an equivalent electric circuit)
- Free-Body Diagrams

Recommended References:

System Dynamics: Modeling and Simulation of Mechatronic Systems. D.C. Karnopp, D.L. Margolis, and R.C. Rosenberg. 5th Edition. John Wiley, 2012, ISBN: 0470889084.

System Dynamics: An Introduction, D. Rowell and D. Wormley. Prentice-Hall, 1997. ISBN: 0132108089.

Exam Materials:

Students may bring a department issued calculator. No other materials will be allowed during the exam.

Topics:

Given a mechatronic system including one or more of domains, students should be prepared to:

- Identify key lumped-parameter elements that source, dissipate, store, and transduce energy
- State/justify key assumptions regarding what effects can or cannot be neglected
- Use a graphical technique to illustrate the interconnections between elements
- Identify/justify how many independent states are needed to represent the dynamics of the system
- Use model reduction or revisit modeling assumptions to eliminate excess and/or dependent states
- Derive state equations and output equations in standard state space form
- Identify nonlinearities, use linearization techniques, and express state equations in matrix form
- Discuss their results and the ramifications of their modeling assumptions