MECH 529

Modelling of Dynamic Systems

3 Credits, First Term, 2012/13
Tuesdays and Thursdays in Room ??
5:00 to 6:30pm

Course Web Site: www.mech.ubc.ca/~ial (**Courses → MECH 529**)

***Note*: If you have difficulty registering for this course, please send an e-mail to the Instructor.**

Instructor

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Prerequisites

This graduate course is suitable for both Master's and Doctoral students. There are no specific prerequisites. But, students who have already taken introductory courses in circuit analysis, dynamics, fluid mechanics, and thermodynamics (or energy conversion) will be at an advantage.

Objectives

The course deals with the methodology of understanding and modeling a physical engineering system. The primary emphasis will be on the engineering problem of modeling rather than the applied mathematics of response analysis (and simulation) once a model is available, even though the latter aspects will also be covered in the course.

The students will learn to understand and model mechanical, thermal, fluid and electrical systems in a systematic and unified/integrated manner. For example, identification of lumped elements such as sources, capacitors, inductors, and resistors in different types of physical systems will be studied. Analogies among the four main types of systems (mechanical, thermal, fluid and electrical) will be presented in terms of these basic lumped elements and in terms of the system variables. Concepts of through and across variables, and flow and effort variables will be introduced. Multi-domain (or mixed) systems which consist of two or more of the basic system types will be considered as well.

Tools of modeling and model-representation such as linear graphs and block diagrams will be discussed. Important considerations of input, output, causality, and system order will be examined. Thevenin and Norton equivalent circuits and their application in mechanical systems using linear graphs will be studied. A brief overview of response analysis will be given.

Textbook

De Silva, C.W., *Modeling and Control of Engineering Systems*, Taylor & Francis/CRC Press, Boca Raton, FL, 2009.

MECH 529 COURSE LAYOUT

Week	Starts	Topic	Read
1	Sept 04	Introduction	Chapter 1
2	Sept 11	Model Types, Analogies	Chapter 2
3	Sept 18	Electrical Systems	Chapter 2
4	Sept 25	Fluid Systems	Chapter 2
5	Oct 02	Thermal Systems	Chapter 2
6	Oct 09	State-space Models	Chapter 2
7	Oct 16	Model Linearization	Chapter 3
8	Oct 23	Linear Graphs	Chapter 4
9	Oct 30	State Models from Linear Graphs	Chapter 4
10	Nov 06 **Thursday, Nov 08:**	Transfer Function Models **Intermediate Exam**	Chapter 5
11	Nov 13	Thevenin/Norton Equivalent Circuits and Linear Graph Reduction	Chapter 5
12	Nov 20	Simulation Block Diagrams	Chapter 5,
13	Nov 27 **Thursday, Nov 29:** **Monday, Dec 03:**	Response Analysis and Simulation Advanced Topics; Modeling Applications **Final Take-home Question Paper Given Out** **Final Take-home Exam Due**	Chapter 6

Examinations:

Nov 08, 2012 (Thursday): Intermediate Examination (In Class)
Dec 03, 2012 (Monday): Final Take-home Exam Due in Mech Office, by 4:00 p.m.

Grade Composition

Intermediate examination		40%
Attendance		10%
Final take-home examination		50%
	Total	**100%**

Course Objectives

Methodology of understanding and modeling a physical engineering dynamic system.

Primary Emphasis: Procedure of analytical modeling

Secondary: Response analysis and simulation once modeled

Systematic, Unified Approach to Modeling of:
mechanical, thermal, fluid, and electrical, systems

Analogies among these four types of systems

Multi-domain (Mixed) Systems: Have two or more basic system types

Identification of Lumped Elements (sources, capacitors, inductors, and resistors)

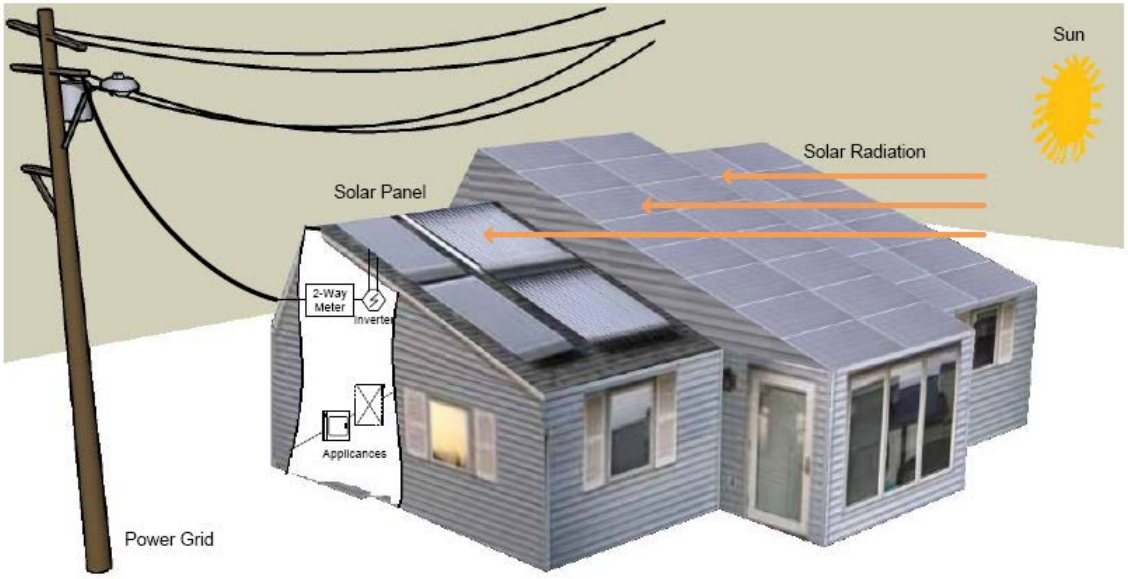
Through and Across Variables; Flow and Effort Variables

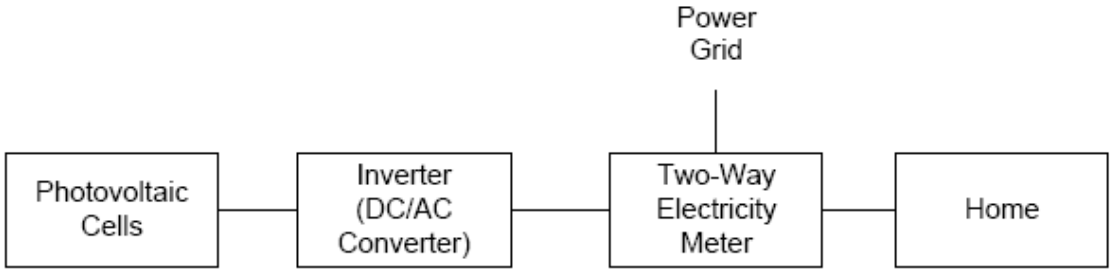
Systematic Tools of Modeling: Linear graphs, bond graphs, block diagrams

Important Considerations: Input, output, causality, system order

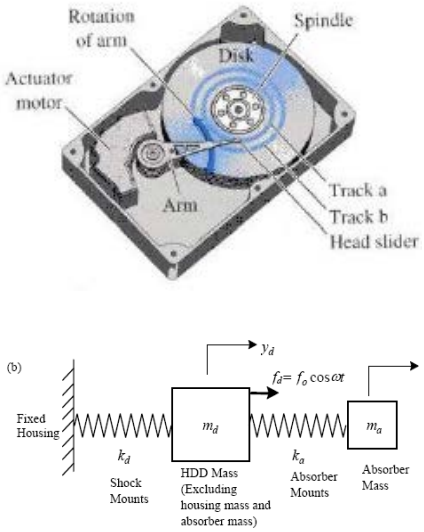
Response Analysis and Simulation

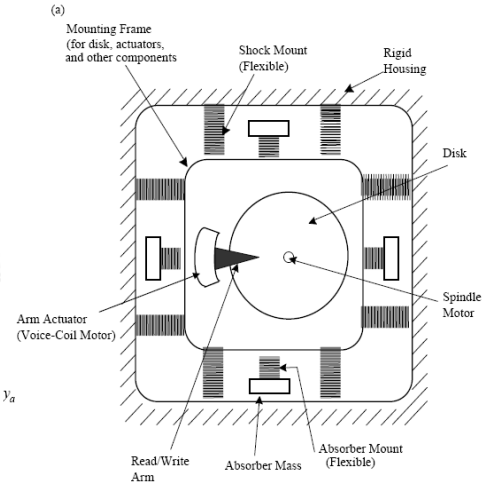
Multi-Domain System Example



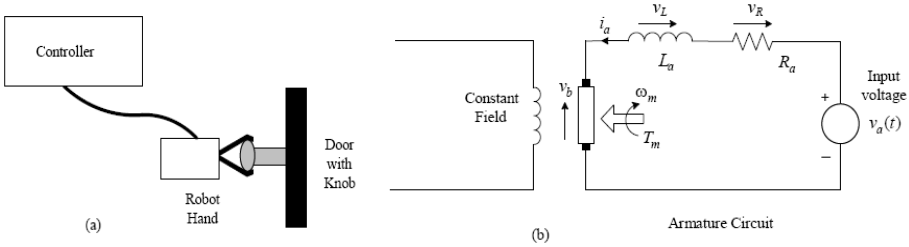


Analytical Model Example: Computer Hard Disk Drive (HDD)





Multi-Domain Example Using Linear Graphs



Robotic Door Opener