BME 683
Physiologic Modeling and Model Predictive Control
Peter G. Jacobs, PhD
Spring 2017

Class re-schedule:

May 16 (potentially reschedule to May 19)

Reading materials:

- Modeling and Analysis of Dynamic Systems – 3rd edition, Close / Frederick *(We will go through this in the first few weeks as an overview.)*
- Modeling methodology for physiology and medicine, by Carson and Cobelli, 2013 *(We will read several chapters out of this book. If you don't purchase, I will make copies)*
- Mastering System Identification in 100 Exercises. Johan Schoukens, Rik Pintelon and Yves Rolain (2012). IEEE Press-Wiley *(chapters 1-4)*
- Prediction Methods for Blood Glucose Concentration, Kirchsteiger, Jorgensen, Renard, del Re (*select chapters*)
- Model predictive control system design and implementation using MATLAB, by Liuping Wang *(available as a PDF download)*

Schedule of topics / lectures	
Week 1	General introduction to physiologic modeling General introduction to model-predictive control Review of modeling physical systems • Translational mechanical systems Carson and Cobelli, Chapters 1-2 Close, Frederick, Newell Chapters 1-2
Week 2	Review of modeling physical systems • Rotational mechanical systems • Electrical systems • State-space representations • Input-output representations • Laplace transform solutions of linear systems Physical systems models in biology • Circuit models in neuroscience

	Close, Frederic, Newell Chapters 3, 4, 5, 6 Carson and Cobelli, Chapter 14 Models from literature (handouts) Problem set 1 assigned
Week 3	Review of modeling physical systems • Transform solutions of linear models • Transform function analysis • Developing a linear model Compartment models • Tracer experiments Close, Frederic, Newell Chapters 7, 8, 9 Carson and Cobelli, Chapter 10 Project 1 assigned
Week 4	System identification introduction • Least squares • Weighted least squares • Maximum likelihood • Model complexity Generation and analysis of excitations signals Physiologic modeling • Insulin modeling • Glucose modeling Shoukens, Pintelon, Rolain, Chapters 1-2 Problem set 2 assigned
Week 5	System identification • FRF measurements • Identification of linear dynamic systems Carson and Cobelli, chapter 6 Shoukens, Pintelon, Rolain, Chapters 3-4 Project 2 assigned
Week 6	System identification

	• Bayesian methods • Markov Chain Monte Carlo Carson and Cobelli, chapter 5-6 Select final project
Week 7	Glucose prediction models Systems biology Genomic and genetic data modeling Kirchsteiger, Jorgensen, Renard, del Re (select chapters) Carson and Cobelli, chapter 8-9
Week 8	Stochastic and probabilistic models of physiology Carson and Cobelli, chapter 11-12
Week 9	Model predictive control • Introduction and overview of framework • Example from artificial pancreas • Incorporating constraints Wang Chapter 1-2
Week 10	Model predictive control • Multiple input multiple output • Controller vs. plant complexity • Stability • Event-driven MPC Wang Chapter 3-4
Week 11	Implementation of MPC in Matlab Wang Chapter 10 Student presentations
Week 12	Student presentations Final exam