UNIVERSITY OF NEBRASKA-LINCOLN
Department of Electrical and Computer Engineering
in Collaboration with
Technical University of Clausthal, Germany

ECEN-498/898 Fall, 2018

Course Title: Computational Modeling and Simulation II: Continuous time Systems

Instructors: Dr. Hamid Vakilzadian and Dr. Dietmar Moeller

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Time: **8:30 - 10:00 Wednesdays and Fridays (UNL time) and 3:30-5:00 PM (Clausthal Time)**

Office Hours: 12:30-1:30 PM WF

References: Mathematical and Computational Modeling and System Simulation: Fundamental and Case Studies by Dietmar Moeller, Springer Publ.

Continuous Introduction to Transportation Analysis Modeling and Simulation – Computational Foundations and Multimodal Applications by Dietmar Moeller, Springer Publ. 2014, and notes

Continuous System Modeling, by Francois Cellier, Springer, 1991

Continuous System Simulation, by David Murray Smith, Springer, 1994

Notes and research papers

Prerequisite: Linear algebra and a programming language skill (MATLAB is preferred)

Note: This course is offered jointly by the Department of ECE, UNL, and Simulation Science Center Clausthal-Goettingen (SWZ), Technical University of Clausthal (TUC), Germany

The course will cover:

1. Intro. to Systems

- Classification, measurement, complexity, attributes, etc.

2. Intro. to Modeling

- Modeling methods, type of models, static/dynamic

3. **Representation of a Model**
- Representation of a System using Differential Equations
- Existence and Uniqueness of Solutions of Differential Equations
- Controllability, Observability, and Identifiability
- Linear State-Equation Models (1^{st}, 2^{nd}, multi)

4. Simulation Software
- Simulation packages; desired features; examples

5. Integration Algorithms
- Single step, multi-step, stiff
- Accuracy and stability of integration algorithms

6. Parameter Identification of Continuous Systems
- Least Square Method (Output-Error, Equation-Error)
- Consistency of Parameter Estimates
- Identifiability
- Sensitivity Analysis
- Error-Function Minimization by Gradient Methods and Direct Search Methods

7. Verification and Validation of Simulation Models
a. Verification of Simulation Models
b. Validation of Model Assumptions
c. Techniques for Increasing Model Validity

8. Project
Project work in an area of concentration chosen by the students' interest

At the end of this course students will be able to:
- Understand the core principles behind Computational Modeling and Simulation (CMS)
- Understand abstraction of systems being analyzed by CMS
- Learn how to develop models for application specific domains w.r.t constarints
- Verify and validate models of appropriate scale
- Understand the required semantics of a model for testing
- Develop a problem solving oriented competence in CMS