UNIVERSITY OF MARYLAND
A.JAMES CLARK SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
CENTER FOR ENVIRONMENTAL ENERGY ENGINEERING

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ENME 809A: Steady State and Dynamic Modeling of Energy Systems

Semester: Spring 2021

Day(s): TBD

Time: TBD

Location: TBA

Instructor: Jiazhen Ling

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Course Objectives:

- To teach a thorough understanding of approaches and challenges to modeling, simulation and design/optimization of energy conversion systems
- To introduce steady state and transient modeling tools, such as EES, Modelica and typical solvers
- To enable students' capability of critically assessing the strengths and challenges of sophisticated energy system design and simulation tools

Course Description:

Using heat pumps as an example, students will learn how to apply their background knowledge of thermodynamics and heat transfer classes to designing high-efficient and environmental-friendly energy conversion systems. The class will introduce fundamental and advanced modeling approaches to predict the performance of energy systems and their components under steady state and dynamic conditions. The course will further build on examples of software used in industry, such as the tools under development in CEEE, to explore underlying approaches and assumptions. As a result, students will be proficient in the use of sophisticated modeling tools and in the critical assessment of the strengths and challenges of these energy system design and simulation tools.

Course Outline:

No prior refrigeration theory background is required;

Rankine and reverse Rankine cycles and working fluids

Modeling of heat and mass transfer in energy systems

Modeling of common energy conversion components

Heat exchanger steady-state simulation and optimization

Modeling of energy conversion cycles, common issues and solutions

Component and system optimization

Dynamic modeling technique vs. steady state modeling technique

Typical dynamic modeling examples for components and cycles

Dynamic modeling common issues and solutions

Understanding and assessing modeling results, uncertainty and internal and thermodynamic consistency

Prediction of seasonal performance

Direct and indirect CO_2 emissions and global warming impact (LCCP tools)

Prerequisites:

Undergraduate heat transfer, fluid mechanics and thermodynamics

Course Evaluation:

In-class (or take-home) quizzes and take-home course projects

Textbooks:

Radermacher, R., Hwang Y., (20050, *Vapor Compression Heat Pumps with Refrigerant Mixtures*, CRC Press, ISBN # 0-8493-3489-6 (recommended not required)

Chapra, S. C., & Canale, R. P. (2010). *Numerical methods for engineers*. Boston: McGraw-Hill Higher Education (recommended not required)

Magrab, E. B., Azarm, S., Balachandran, B., Duncan, J., Herold, K., & Walsh, G. (2007). *Engineers guide to MATLAB*. Prentice Hall Press. (recommended not required)

Software:

Engineering Equation Solver (EES), OpenModelica, MATLAB, CEEE in-house simulation tool (provided in class), LCCP tool