Spring 2015

ME 597B (Schedule 461674) MATH 597G (Schedule 462166) PHY 597C (Schedule 521980)

THERMODYNAMICS, INFORMATION THEORY AND CHAOTIC DYNAMICAL SYSTEMS

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Office Hours: By appointment

Lecture Class Time and Location: MW 2:30 PM to 3:45 PM   221 Hammond
Recitation Class Time and Location: R 5:45 PM to 7:00 PM   214 Reber

Instructional Objectives:
This 3-credit course is offered at the first year graduate level, and it provides an inter-disciplinary background for a variety of research fields in engineering and science. Application examples are developed in this course.

Course Description:

Chapter 00: Introduction & Motivation
- Concepts of Equilibrium Thermodynamics: Maxwell Relations, and Gibbs-Duehem Relation
- Concepts of Dynamical Systems
- Relationship between Thermodynamics and Dynamical Systems

Chapter 01: Dynamical Systems and Nonlinear Maps
- Introduction to Nonlinear Maps (e.g., Logistic, Kaplan-Yorke, and Lorenz)
- Bifurcation, Strange Attractors, and Chaos
- Discussion on Hyperbolic and Non-hyperbolic Systems

Chapter 02: Symbolic Dynamics and Ergodic Theory
- Introduction to Symbolic Dynamics and Coding
- Cylinders and Relevant Measures
- Measure Preserving Transformations, Poincare Recurrence Theorem, and Ergodicity & Mixing

Chapter 03: Thermodynamics and Information Theory
- Notion of Entropy from Thermodynamic and Information-theoretic Perspectives
- Introduction to Maximum Entropy Principle and Its Equivalence to Minimum Energy
- Relationship of Entropy to Thermodynamic Parameters
- Shannon Information, Renyi Information, Kolmogorov-Sinai Entropy and Topological Entropy

Chapter 04: Statistical Mechanics and Their applications to Dynamical Systems
- Different Canonical forms and Gibbs Distribution
- Introduction to Spin systems
- 1D and 2D Ising Models and Potts Models
- Graph-theoretic Approach to Multi-dimensional Systems: Markov Random Fields

Chapter 05: Fractals, Multifractals and Scaling
- Introduction to Fractals: Hausdorff Measure and Fractal Dimension
- Multifractals and Singularity Spectrum
- Scaling & Exponents in the Context of Chaos and Phase Transitions in Thermodynamic Systems

Text Book:
References:


