School of Engineering
University of California, Merced

ME290 - Topics in Mechanical Engineering
"Computational Methods for Modeling and Analysis of Dynamical Systems"

Syllabus for ABET

May 1, 2018

Designation:

Upper division graduate course

Catalog Description:

Lectures and computer laboratory

Text Books and Other Required Materials:

None

Course Objectives:

ME290 is a lecture and computer laboratory for graduate students. The course covers approximate solution methods for structural analysis such as weighted residuals and Ritz expansion, matrix computation, data-driven modeling methods of dynamical systems such as linear and nonlinear regression analysis, neural networks, deep-learning, and operational calculus. We shall also study applications including structural analysis, system identification, and fault detection and remaining useful life prediction of mechanical systems such as aircraft engines.

Computational and programming assignments will involve use of Matlab or Python.

Course Learning Outcomes:

Upon completion of ME290, students shall learn a range of analytical and numerical methods for structural analysis, system modeling, system identification, and fault detection.

Relationship to Program Learning Outcomes and Program Requirements:

This special offer of ME290 meets the following learning outcome of the graduate program.

PLO 1: Are able to identify significant research questions in mechanical engineering, and contextualize their research in the current literature of the field.

PLO 2: Are able to apply their knowledge of mathematics, science, and engineering to solve a problem, and to design and implement a suitable solution.

PLO 3: Are able to design and conduct experiments and/or simulations of mechanical systems, and to analyze and evaluate these solutions in the context of existing technologies.

Prerequisites by Topic:

Ordinary Differential Equations, Vibrations, Controls.

Topics:

Methods of variational principle, weighted residuals and Ritz expansion, matrix computation, data-driven modeling of dynamical systems, regression analysis, neural networks, deep-learning, and operational calculus, system identification, and fault detection.

Class/laboratory Schedule:

None

Professional Component:

Analysis of engineering systems, numerical simulations and optimization.

Grading Scheme:

This class is letter grade.

Contact Information:

Jian-Qiao Sun
jqsun@ucmerced.edu, Tel. 209-228-4540, Office: SE2-270

Office Hours:

Lecture: TR 9:00-10:15am in CLSSRM 270
TR 11:00-12:00 noon or by appointment

Course Outline – Fall 2018

Instructor	Jian-Qiao Sun SE2 270, (209)228-4540, jqsun@ucmerced.edu	
Office Hours	TR 11:00-12:00 noon or by appointment	
Lecture	TR 9:00-10:15am	CLSSRM 270
Final Exam	None	
TA	None	
Laboratory	None	
Textbooks	None	
Grading	Homework and Programming Assignment	(100%)

Course Outline

Duration	Topics	Reading
3 wks	Analytical methods for structural analysis • Weighted residuals and Ritz expansion • Admissible, comparison and modal functions • Matrix computation Finite element methods • Hamilton's principle • Galerkin's method of weighted residues • Method of least squares error	
4 wks	Regression analysis • Linear and nonlinear regression • Multi-dimensional regression • Neural networks • Deep learning	

3 wks	Operational calculus
	• Laplace transform and properties
	• Derivative estimation
	  o Model free control
	  o Nonlinear tracker for derivative estimate
	• System identification
	  o Method of least square error
	  o A spring-mass-damper example
	  o Nonlinear stiffness and damping	

3 wks	Algebraic method for estimation • Signal preparation • Model building • Parameter estimation	
1 wks	Applications • Structural analysis • System identification • Fault detection	