USC Andrew and Erna Viterbi
School of Engineering

AME302 Dynamic Systems
Fall 2014 — MWF — 1:00-1:50pm

Instructor	Professor Ben Yang
	Office: OHE 400F; Phone: (213) 740-7082; Email: bingen@usc.edu
Meeting	Monday, Wednesday and Friday, 1:00-1:50 pm, MHP 101
Office Hour	TBD

TA	TBD
	Office: ; Phone: ; Email:
Office Hour	TBD
Discussion Session	A 60-min session each week, to address issues in lectures, home problems and project. Date, time and classroom location are to be determined.

Course Description

Modeling of lumped parameter elements and systems; free and forced response of first and second order systems; design oriented approach to dynamic systems. This course is suitable for undergraduate students in aerospace, bio, civil and mechanical engineering.

Learning Objectives

Math review: differential equations, Laplace transform and matrix theory
System representations: differential equations, transfer functions, state equations, block diagrams
Modeling of mechanical, electrical, fluid and thermal systems
Lagrange's equation for mechanical systems
Combined or mixed dynamic systems, electro-mechanical systems
Analytical solution of 1st-order and 2nd-order differential equations
Numerical solution of differential equations
Frequency and time response
Utility of software MATLAB/SIMULINK in modeling and simulation

Co-requisites: MATH 245
Recommended preparation: AME 309 or CE 309; AME 301 or CE 325.

Required Readings and Supplementary Materials

Textbook: William J. Palm III, System Dynamics, 3rd ed. McGraw-Hill, 2014.
ISBN: 978-0-07-339806-8

Class notes: downloadable from the web https://blackboard.usc.edu/

Description of Assignments

Two midterm exams, 12 sets of weekly homework problems, a project, and the final exam will be assigned and graded during the semester. The accumulated points that a student earned from all the assignments will be used to assign a grade for the student. The grading is curved.

Grading Breakdown

Two Midterm Exams (@15% each)	30%
Project[*]	10%
Homework	30%
Final Exam	30%
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Total	100%

Assignment Submission Policy

Weekly homework assigned, and due the following week. A final report for the project is due near the end of the semester.

Additional Policies

Late homework receives **NO** credits.

Course Outline

1. Introduction to AME 302 (Refer to Chapter 1)

2. Mathematics Review (Refer to Chapters 3)
   - Laplace transform & properties
   - Inverse Laplace transform by partial fraction expansion
   - Solution of differential equations via Laplace transform
   - Transfer functions of differential equations
   - Solution of differential equations via the method of undetermined coefficients (optional, handout)

3. Mechanical Systems (Refer to Chapters 2, 4 and 10 of the Textbook)
   - Three keys in modeling dynamic systems: (a) Fundamental principles; (b) models of basic elements; and (c) ways of analysis (synthesis)
   - Review of fundamental principles (Newton's laws) of mechanical systems
   - Inertia, spring and damping elements
   - Translational and rotational systems
   - Derivation of equations of motion (single and multi-body systems, coupled translational and rotational systems)
   - Transfer function formulation
   - State representation
   - Geared systems

- Block diagrams (Section 10.1)
- Lagrange's equations (optional, handout)

4. Electrical Systems (Refer to Chapter 6)
- Introduction
- Basic elements and concept of impedance (Sections 6.1 and 6.3)
- Transfer functions and state equations (Section 6.2)
- Passive circuit analysis (Section 6.2)
- Active circuit analysis (Section 6.3)

5. Thermal and Fluid Systems (Refer to Chapter 7)
- Fluid capacitance and fluid resistance
- Liquid-level systems
- Thermal capacitance and thermal resistance
- Dynamic models of thermal systems

6. Modeling and Simulation via MATLAB and SIMULINK
- Transfer function formulation and system response via MATLAB (Sections 2.10 and 4.7, and handout)
- State representation via MATLAB (Section 5.3 and handout)
- Solution of Differential equations via MATLAB (Section 5.4)
- Block diagram and SIMULINK (Sections 5.5, 5.6, 6.9 and 7.9)

7. Transient and Steady-State Response (Refer to Chapter 89)
- Categories of system response
- 1st-order systems (Section 8.1)
- 2nd-order systems (Sections 8.2 and 8.3)
- Higher-order systems
- Numerical solution of nonlinear systems via R-K method (Handout, optional)

8. System-Level Analysis
- Block diagrams with multiple inputs and multiple outputs
- Electro-mechanical systems
- Feedback control systems
- Stability
- Frequency response

Course Schedule: A Weekly Breakdown

Important	Dates		
		Midterm Exam 1	
		Midterm Exam 2	
		Project report due	
		Final Exam	

Week	Date	Materials Covered	Homework
1		Introduction	
		Math review - Differential equations	
		Math review - Differential equations	HW1
2		**Labor Day, university holiday, no class**	
		Math review - Differential equations	
		Mechanical Systems - translational systems	
3		Mechanical Systems - translational systems	HW 2
		Mechanical Systems - rotational systems	
		Modeling techniques - State equations	
4		Modeling techniques - State equations	HW 3
		Modeling techniques - Input Output Equations	
		Modeling techniques - Transfer functions	
5		Modeling techniques - Transfer functions	HW 4
		Modeling techniques - Block diagrams	
		Mechanical Systems - geared systems	
6		Lagrange equations	HW 5
		Electrical systems	
		Electrical systems	
7		Electrical systems: Active circuits	HW 6
		Solution and Performance Analysis, Inverse LT	
		Solution of differential equations by LT	Project assignment
8		Transient response	HW 7
		Midterm Exam 1	
		Block diagrams and MATLAB/SIMULINK	Presented by TA
9		Transient response	
		Transient response	HW 8
		Transient response	
10		Transient response	
		Frequency Response	HW 9
		Frequency Response	
11		Stability of dynamic systems	
		System-Level Analysis	HW 10
		System-Level Analysis	
12		System-Level Analysis	
		System-Level Analysis	HW 11

		System-Level Analysis	
13		System-Level Analysis	
		Midterm Exam 2	
		Thermal and fluid systems	HW 12
14		Thermal and fluid systems	
		Thanksgiving recess: Nov. 21-24	
		Thanksgiving recess: Nov. 21-24	
15		Thermal and fluid systems	Course evaluation
		Thermal and fluid systems	*HW 12 due*
		Course review	Course survey
16		**Project report due:**	
17		**Final exam: Wednesday, 11 am -1 pm**	

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.