Spring 2018

AME 505: ENGINEERING INFORMATION MODELING

Department of Aerospace & Mechanical Engineering

University of Southern California

COURSE SYLLABUS

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Course Section:	28864R (campus) 29035D (den)
Course Unit:	3 Units
Prerequisite:	Graduate Standing
Class Hours:	Tuesdays 6:40pm – 9:20pm
Class Location:	RTH-109
Office Hours:	Tuesdays, 11am-12pm
Teaching Assistant:	TBD

AME505:

ENGINEERING INFORMATION MODELING

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Course Description and Objectives

Computer and information technologies have been applied to almost every corner of industries and engineering practices. To compete in today's relentless market and contribute to the engineering advancement, an engineer must have a good grasp of contemporary information technologies (IT), identify and model engineering problems in IT relevant terms, and develop quality IT solutions to these engineering problems. Engineering information modeling is fundamental for such IT solution developments. In this course, information modeling theories and techniques are introduced and applied, including symbolic and object-oriented modeling, product and process modeling for design and manufacturing, machine learning, information models for computer integrated and collaborative engineering, information modeling for life-cycle engineering. Developing system & computational thinking and fostering creativity are the two general goals of this class. The specific objectives for this course are for students to:

- *Understand information modeling principles and methodologies*: We will study basic approaches of information modeling including symbolic logic, artificial intelligence (AI) techniques, object-oriented technologies, machine learning, and design theory and methodologies. We will investigate and develop specific representations for (1) entities such as engineering system components and engineering activities; (2) relationships such as functional & spatial constraints among system components; (3) system behaviors expressed both qualitatively and quantitatively; and (4) functions expressed as design intent.

- *Develop basic skills through building an object-oriented and knowledge-based engineering support system*: Students will learn basic information modeling skills by using Java and other AI tools for their exercises and term projects. The hands-on experience will be useful for students to digest the principles and methodologies and to develop product and process models in their future engineering and research practice.

- *Understand the state of the art of model-based systems*: We will review the state of the art models as case examples reported in the literature. We will examine specific

representations and algorithms used to model engineering products and processes for improving design and manufacturing. In addition, we will hold discussion sessions to criticize these models.

- *Apply the learned knowledge and skills to solve engineering problems*: Students will form term project teams. Each team will prepare a project proposal and develop a proof-of-concept model-based application system for solving their selected engineering problem. Along with the development of their application system, project teams will present their proposal, modeling approach, their completed application system and future extensions.

Course Structure

The scope of this course covers four major components, namely, basic concepts and theories of information modeling, modeling techniques, programming techniques, and advanced topics. To make the learning process more effective and efficient, the course structure is designed to include the following modules.

Part 1: Basic concepts and theories of information modeling

The goal of this module is to introduce basic concepts and theories of information modeling.

- What is engineering information modeling?
- What is symbolic modeling?
- What are the basic concepts for modeling going beyond numbers and equations?
- How can we capture both know-what and know-how knowledge in computers?

Part 2: Object oriented modeling techniques

The goal of this module is to introduce basic modeling technique that students can use to solve their engineering problems.

- What object oriented modeling?
- What are foundations of the object-oriented modeling?
- What are the processes and guidelines for object-oriented modeling?
- Are there standard processes for IT system development?
- How can one verify and validate IT systems?

Part 3: Java programming techniques

In order for students to be able to apply their learned modeling knowledge and techniques to develop IT system solutions to their project problems, this module offers basic Java programming techniques.

- What is Java, and Java programming environment?
- What are the basic programming techniques using Java?
- How can one create information models in Java programming environment?
- What programming supports are available?
- How can one build graphical user interfaces (GUIs) easily?

Part 4: Advanced topics: machine learning and evolutionary computing

Recent progress in machine learning, datamining and evolutionary computing has led a new wave of artificial intelligence boom. In this module, these topics will be introduced. Students can apply these techniques in their team projects.

- What are the basic problems and concepts of datamining and machine learning?
- What techniques are available that can be applied?
- What is artificial neural network and how can it be applied?
- What is genetic algorithm and how can it be applied?

Prerequisite

Graduate standing. No restrictions on graduate students. Senior students may also take this class after receiving approval from the instructor.

Course Work

Classroom Lectures:

Weekly lectures will be offered on Thursdays. Students are required to complete reading assignments, indicated in the schedule page, before each lecture. Usually the weekly 3-hour classroom lecture is divided into two parts. During the first 80 minutes, the instructor will present and discuss the contents outlined in the schedule page. In the second 70 minutes, students will *work in groups* to discuss the topics lectured and discussed by the instructor and practice modeling methods by solving small engineering modeling problems (in the first several weeks) or their project design problems (as the course progresses). Active participation in classroom discussion is strongly required for all students.

Quizzes:

Online quizzes will occur after each lecture, via Desire2Learn website, and are due before the next class session. Quizzes usually cover the materials in each lecture and class presentations.

Homework:

Each homework assignment usually has 2-3 short questions. The questions are usually about (1) the content of the previous lecture and (2) the reading assignment for the next lecture. The homework is intended to help students (1) digest key concepts learned from the lectures and (2) assimilate the reading materials and organize their thoughts about them for the class discussion and future practice. Clarity, conciseness and incisiveness are required.

Mid-term Exam:

Mid-term exam will be open-book. Problems of the exam will be similar to, and more comprehensive than, the homework questions.

Term Project:

For the term project, students will need to form teams of 4-5 people. Each team will work together to create a project topic by choosing a specific engineering application problem. Teams will need to develop specific information models, build system components, develop reasoning algorithms and compose a demonstrateable system as a solution to their selected project problem. The term project will give students the opportunity to review and apply the theories and modeling techniques they learned from the class.

Course Materials

Required: AME505 Course Reader (will be available on the course website).

Optional: *Object-Oriented Modeling & Design*, J. Rumbaugh, M. Blaha, Premerlani, W. Eddy, W. Lorensen, Prentice Hall, 1991

Others (will be added).

Grading Requirements

Students will be graded according to the following grading scheme:

Quizzes: 10%

A total of twelve (12) quizzes will constitute 10% of the overall grade. Online quizzes will occur after each lecture, via Desire2Learn website, and are due before the next class session at 5:30pm.

Homework: 30%

Total eight (8) homework assignments will constitute 30% of the overall grade, with each amounting to 3.75%. Each homework assignment has 2-3 short questions and/or one small modeling problem. Questions are usually open-ended. Thoughtfulness, clarity, conciseness and incisiveness are required.

Midterm exam: 25%

Midterm exam is open-book and open-note, limited to the materials that have been discussed in classroom lectures, quizzes, homework assignments, and team projects. Questions will be similar to, but more comprehensive than, the homework questions and design problems. There will be query questions and small modeling problems involved.

Term project: 35%

Note that 35% of your semester grade is based on the results of your term project, which is a team effort. All project work done by a team is first given a team grade. This team grade is then weighted for each student, based on confidential peer-evaluations by all team members at the end of the semester according to the following scheme.

Each student will be asked to fill out a questionnaire, which rate every team member (including him/herself) for the percentage participation to the team project, from 1 (10% participation) to 10 (100% participation). The evaluations are averaged in order to find each student's participation. The project grade of each student of a team will be weighted based on his or her percentage of participation.

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. Academic integrity will be strongly enforced.

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 the instructor as early in the semester as possible. DSP is 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.

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.

Course Schedule

Date	Lecture	Class Exercise	Readings	Quiz Due	Work Due
1/9	Course introduction & Engineering applications	Teaming CE#1: Discuss apps	Course Syllabus		
1/16	Introduction to symbolic systems	CE#2: Vending machine modeling CE#3: Q&As CE#4: Predicate logic & semantic net	Chapter1: p.21-68	Quiz#1	HW#1
1/23	Introduction to production systems	CE#5: Build a rule-based system with CLIPS	Chapter2: Production System	Quiz#2	HW#2
1/30	Entity relationship model & examples	CE#6: Build an entity-relationship model	Chapter3: E-R Model	Quiz#3	HW#3
2/6	Object-oriented modeling and system development	CE#7: Start building a system	Chapter4 (p.1-46)	Quiz#4	HW#4
2/13	Object-oriented analysis	CE#8: Discuss team project topic	Chapter5 (p.144-189)	Quiz#5	HW#5
2/20	Object-oriented modeling and UML	CE#9: Intro to Eclipse & UML modeling tool	Chapter6 (UML)	Quiz#6	Project proposal
2/27	Midterm Exam				
3/6	Java 1: concepts & structure	Lecture continue	Java & Eclipse book		
3/13	Spring Break. No class.				
3/20	Java 2: environment	CE#10: Program Java in Eclipse	Java & Eclipse book	Quiz#7	
3/27	Java 3: examples	Project briefing	Java & Eclipse book	Quiz#8	Progress Report
4/3	Introduction techniques for datamining	CE#11: Data mining problem	Chapters 10&11 (DM)		HW#6
4/10	Artificial neural network	CE#12: Ann examples	Chapter 12 (ANN)	Quiz#9	HW#7
4/17	Genetic algorithm & genetic programming	CE#13: GA examples	Chapter 13 (GA)	Quiz#10	HW#8
4/24	Advanced modeling topics	Project Presentation		Quiz#11	
5/8	Final Project Report PDF file due 9pm via email to yjin@usc.edu				Final Proj Report

CE: Class Exercise. NOTE: *Java* may be replaced with *Python* depending on the tool availability.