MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Civil and Environmental Engineering

COURSE ANNOUNCEMENT

1.12 Computer Models of Physical and Engineering Systems Spring 1997

Date: Tuesday & Thursday Time: 9:00AM–10:30AM Room: 1-390

Feniosky Peña-Mora

Course Motivation

Models are used to help designers understand systems before they are built. Thus, models are needed for supporting the *design* of these systems. Physical and engineering systems are designed through a process of *synthesis* and *analysis* to achieve their intended functions. The focus of synthesis is to derive the *structure* of engineering artifacts. The analysis phase verifies that the derived structure provides the *behavior* to satisfy the intended function. Traditional approaches to modeling engineering systems have been driven by analysis and have focused on modeling the behavior of physical systems. However, analysis is only a part of the design. Modeling support for design must further include representation of the structure of artifacts which support the synthesis process. In this class, we take a holistic approach to modeling, driven by both synthesis and analysis, treating behavior and structure as an integral part of the whole.

Course Description

This course is structured in two sections. We adopt a top-down approach to study modeling: from conceptualization of the overall model to implementation of the model in C++. We will focus on the *syntactic* and *semantic* building blocks for the implementation of the object-oriented models representing the structure of physical and engineering systems, and for the solution of the mathematical equations representing the behavior of these systems.

Section 1: Object-Oriented Modeling
This part will focus on the *semantic* building blocks for abstractions of physical and engineering systems. We will introduce the Object Modeling Technique (OMT), broadly discussing the concepts of object, dynamic, and functional modeling.

Section 2: Numerical Methods
This part will focus on the *numerical techniques* to solve the equations that mathematically model the behavior of physical and engineering systems. We will cover numerical solutions for differentiation, integration, ordinary differential equations, partial differential equations, characteristic-value problems, and curve-fitting.

Required Texts

1) "On To C++" by Patrick Henry Winston (Addison-Wesley, 1994)

2) "Numerical Methods for Mathematics, Science, and Engineering" by John H. Mathews(Prentice-Hall, 1992)

Recommended Texts

3) "Object-Oriented Modeling and Design" by James Rumbaugh, Michael Blaha, William Premerlani, Frederick Eddy and William Lorensen (Prentice-Hall, 1991).

4) "Numerical Methods" by Robert W. Hornbeck (Prentice-Hall, QPI Series, 1975)

5) "C++ Primer" by Stanley B. Lippman (Addison-Wesley, 1995)

Readings

Most of the C++ readings will come from the the required texts. When readings are necessary from the recommended books or other sources, they will be included in several packets that will be available in class. There will be two major packets of information, one for each of the two parts of the course. These packets include copies of the lecture transparencies.

The student is responsible for reading the assigned material and is expected to come prepared for participation in class.

Assignments

The assignments in this class are divided in three kinds: 1) assigned readings, 2) seven written assignments, and 3) a term project.

There will also be a quiz and a final exam as indicated in the outline.

Course Requirements

(10% of total grade) Participation and reading assignments
(15% of total grade) Quiz
(35% of total grade) Written assignments (7 in total)
(25% of total grade) Term Project (TP)
(15% of total grade) Final exam

Written assignments are due in class as indicated in the outline. Partial credit will be given for assignments that are late. 10% will be subtracted for each day that an assignment is late for up to three days. In case a major problem is anticipated, please talk to the instructor or TAs.

The Term Project is a group effort divided into four phases. Each student is expected to spend effort equivalent to about four weeks of work for the project. Each of the phases is subject to the same partial credit structure for late submissions as for the written assignments.

Collaboration is expected within the limits set forth in the Guide for Collaborative Work included in the class packets.

Working knowledge of C and use of Athena are **hard** requirements for the class.

Teaching Staff

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  Thursday 10:30h-12:00h

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  Wednesday 14:00h-17:00h

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COURSE OUTLINE

SESSION	DAY	DATE	TOPIC	ASSIGNMENTS	READINGS
1	T	2/4	Introduction to Modeling and C++	Out(TP)	
			I. OBJECT-ORIENTED MODELING		
2	Th	2/6	Classes, Abstraction, Encapsulation	1st(TP), Out(1)	1(9-14), 3(2)
3	T	2/11	Relationships		3(3)
4	Th	2/13	Inheritance	Due(1), Out(2)	1(15-16,32,34,43)
5	Th	2/20	Virtual Functions, Polymorphism	Due(2), Out(3)	1(27-29,37-38,44,48)
6	T	2/25	Dynamic, Functional & Flow Modeling		3(4-6)
7	Th	2/27	Object Modeling as a Design Technique (I)	Due(3)	3(7-8)
8	T	3/4	Object Modeling as a Design Technique (II)		3(7-8)
			II. NUMERICAL METHODS		
9	Th	3/6	Matrices	2nd(TP),Out(4)	2(3.1-3.3),4(6.0-6.2)
10	T	3/11	Solving Non-linear Equations		2(2), 4(5)
11	Th	3/13	Solving Set of Equations	Due(4), Out(5)	2(3.4-3.7),4(6.3-6.7)
12	T	3/18	Interpolation (I)		2(4.1-4.3),4(4.0-4.4)
13	Th	3/20	**QUIZ #1**	QUIZ #1	
		3/24-3/28	**SPRING VACATION**		
			II. NUMERICAL METHODS cont.		
14	T	4/1	Interpolation (II)		2(4.4-4.6), 4(4.5-4.7)
15	Th	4/3	Curve-fitting	Due(5)	2(5), 4(7)
16	T	4/8	Numerical Differentiation and Integration		2(6), 4(8)
17	Th	4/10	Numerical Differentiation and Integration	3rd(TP),Out(6)	2(7)
18	Th	4/15	Num. Sol. Ordinary Differential Equations	Due(6), Out(7)	2(9.1-9.4), 4(9)
19	T	4/17	Num. Sol. Ordinary Differential Equations		2(9.5-9.6)
		4/21-4/22	**PATRIOT's DAY VACATION**		
			II. NUMERICAL METHODS cont.		
20	Th	4/24	Num. Sol. Ordinary Differential Equations	Due(7)	2(9.7)
21	T	4/29	Characteristic-Value Problems		2(9.8-9.9)
22	Th	5/1	Characteristic-Value Problems		2(11)
23	T	5/6	Num. Sol. Partial-Differential Equations		2(10.1),4(11)
24	Th	5/8	Num. Sol. Partial-Differential Equations	Due(TP)	2(10.3)
			PRESENTATIONS and REVIEW		
25	T	5/13	Selected Student Presentations		
26	Th	5/15	Course Summary and Review		