Department of Electronics, Computer and Communications Engineering
School of Science and Engineering
Ateneo de Manila University
Second Semester, 2003-2004

CE 30: **Algorithms and Problem Solving** (3 units)
(Numerical Analysis)

CE 30 A: MW, 0730 – 0830, F113
F, 0730 – 0830, CTC 219

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1. Course Description

This course aims to equip students with numerical methods and algorithms that can be used to solve various science and engineering problems. The topics include error analysis, matrices, finding roots of equations, curve fitting, and numerical integration and differentiation. This course involves computer programming in C/C++.

Prerequisite: CE 21, CE 22, MA 21

2. Textbook

Erwin Kreyszig: *Advanced Engineering Mathematics*, 8th ed, 1999, Chap 17-19.

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3. Course Outline and Timeframe

CE 30 Timetable, 2nd Semester, 2003-2004

Week		Monday	Wednesday	Friday
1	Nov		12 start of classes	14 problem set: # 6, 9, 19 pp 836-837 sec 17.1
2		17 problem set: # 20,21,22 p 837 sec 17.1	19 problem set: # 6,8,9 p 847, sec 17.2	21 Faculty Day/ACP CE 30 holiday
3		24 problem set: #13,16,17 p 847, sec 17.2	26 problem set: #8,12,13 p 860, sec 17.3	28 problem set: #2,3,5 p 867, sec 17.4
4	Dec	1 problem set: #14,17,18 p 867, sec 17.4	3 problem set: #8,10,12 p 880, sec 17.5 sign up for Project 1	5 problem set: #16,18,20 p 880-881, sec 17.5
5		8 Immaculate Conception CE 30 holiday	10 problem set: #26,27,28 p 882, sec 17.5	12 problem set: #16,17,18 p 893, sec 18.1
6		15 problem set: #4,5,6 p 899, sec 18.2	17 problem set: # 1,3,5 p 905, sec 18.3 sign up for Project 1 defense	19 problem set: #6,7,8 p 905, sec 18.3 11 am: Project 1 due
7	Jan	5 Project 1 defense (Jan 5, 7, 9)	7 Project 1 defense (Jan 5, 7, 9)	9 Project 1 defense (Jan 5, 7, 9)
8		12 problem set: #4,6,8 p 916, sec 18.5	14 problem set: # 12,13,14 p 916-917, sec 18.5 sign up for Project 2	16 problem set: # 16,17,18 p 917, sec 18.5
9		19 problem set: # 2,5,6 p 924-925, sec 18.7	21 problem set: # 1,2,3 p 928, sec 18.8	23 problem set: # 4,5,6 p 928, sec 18.8
10		26 problem set: #7,9,10 p 951, sec 19.1	28 problem set: #11,12 p 951, sec 19.1 sign up for Project 2 defense	30 problem set: #13,14 p 952, sec 19.1 11 am: Project 2 due
11	Feb	2 President's Day CE 30 holiday	4 Project 2 defense (Feb 4,6,9)	6 Project 2 defense (Feb 4,6,9)
12		9 Project 2 defense (Feb 4,6,9)	11 problem set: # 2,3 p 955, sec 19.2 sign up for Project 3	13 problem set: # 5,6 p 955, sec 19.2
13		16 problem set: # 10,13 p 956, sec 19.2	18 problem set: # 1,5 p 961, sec 19.3	20 problem set: # 3,6 p 961, sec 19.3
14		23 problem set: # 7 p 961, sec 19.3	25 problem set: # 1 p 969, sec 19.4 sign up for Project 3 defense	27 problem set: # 3 p 969, sec 19.4 11 am: Project 3 due
15	Mar	1 Project 3 defense (Mar 1,3,5)	3 Project 3 defense (Mar 1,3,5)	5 Project 3 defense (Mar 1,3,5)
16		8 problem set: # 4 p 969, sec 19.4	10 problem set: # 5 p 970, sec 19.4	12 problem set: # 6 p 970, sec 19.4
17		15 problem set: # 9,10 p 970, sec 19.4	17 problem set: # 12 p 970, sec 19.4 sign up for Project 4 defense	19
18		22 11 am: Project 4 due defense: Mar 23-26	24	26

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Course outline (follows the outline in [Kreyszig]):

Numerical Methods in General
- Introduction
- Solution of Equations
- Interpolation
- Splines
- Numerical Integration and Differentiation

Numerical Methods in Linear Algebra
- Linear Systems: Gauss Elimination
- Linear Systems: LU-Factorization
- Linear Systems: Solution by Iteration
- Curve Fitting: Method of Least Squares
- Matrix Eigenvalues

Numerical Methods for Differential Equations
- Methods for First-Order Differential Equations
- Multistep Methods
- Methods for Systems and Higher Order Equations
- Methods for Elliptic Partial Differential Equations

4. Course Requirements

* four projects
* problem sets

4.1. Problem Sets

The timetable identifies problem sets for you to do. You are expected to have done the problem set assigned for a particular day when coming to class on that day.

You are not required to submit problem sets. You will not be penalized for doing them wrong. You are required to do them.

Bonus points will be given to those who submit correct answers to exercises in the problem sets under the following conditions:

* the exercise was done correctly; solutions and computations must be sufficiently detailed
* only the first correct solution of a given exercise gets bonus points
* the answer must be printed –NOT handwritten-- on short bondpaper, and must not have any erasures
* the exercise must be submitted either by an individual or a group of at most four
* the exercise must have been submitted by 11 am of the school day prior to the day for which the exercise was assigned; Saturdays, Sundays, and holidays shall not count as school days.

Two bonus points will be given if the exercise was submitted by an individual. N+1 bonus points will be given if the exercise was submitted by N students. In this case the N+1 points will be equally distributed among the N students. Bonus points are added directly to the class standing.

Demerits will be given to those who come to class without having done the problem set. One demerit is given for the first offense, two demerits for the second, three for the third, and so on. Demerits are subtracted directly from the class standing.

4.2. Projects

Four projects shall be required. Project options follow.

Projects may be done individually, or in groups of two or three. Individuals shall sign up for projects first, followed by groups of two, followed by groups of three. Most project options have quotas, meaning that at most a given number of students may choose those options.

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Options for Project 1:

1. Do exercise 24 on p. 847-848.
2. Do exercise 25 on p. 848.
3. Do exercise 24 on p. 881-882.
4. Write code for computing cubic splines; use your code to do exercises 11-16 on p. 867.
5. Write code for adaptive integration with Simpson's Rule; use your code to compute the definite integrals A, B, and J on p. 880.
6. Formulate your own problem and finalize details of your proposed project before 11 am, Dec. 2.

Options 1 to 5 have quotas of 8 each.

Options for Project 2:

1. Do exercise 9, p 905.
2. Do exercise 13, p 899.
3. Write code implementing Crout's Method and use it to do exercises 1-6, p 899.
4. Write code implementing Doolittle's Method and use it to do exercises 7-11, p 899.
5. Write code implementing Gauss Elimination; use your code to do problems 4-18, p 893.
6. Formulate your own problem and finalize details of your proposed project before 11 am, Jan 8.

Options 1 to 5 have quotas of 8 each.

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Options for Project 3:

1. Write code implementing the Improved Euler Method (Heun's Method); use your code to solve the differential equations in problems 5 – 8, p 951.
2. Write code for the classical Runge-Kutta Method of Fourth Order; use it to solve the differential equations in problems 5 – 8, p 951.
3. Write code for the Adams-Moulton Method of fourth order; use it to solve the differential equations in problems 4-6, p 955.
4. Write code for the Adams-Bashforth Method of fourth order; use it to solve the differential equations in problems 4-6, p 955.
5. Formulate your own problem and finalize details of your proposed project before 11 am, Feb 10.

Options 1 to 4 have quotas of 9 each.

Options for Project 4:

1. Do exercise 16, p 971.
2. Formulate your own problem and finalize details of your proposed project before 11 am, Mar 10.

Project Requirements

The following must be submitted by the due dates and times for each project:

* diskettes containing all relevant source codes, executables, input files, output files, graphs, and diagrams
* a hardcopy of documentation for the project

In general, the documentation for the project must include:

* an introduction to the project describing the nature of the project and its objectives. DO NOT just copy the statement of the problem from the book.
* a discussion of the theory behind the algorithm involved
* well documented source code
* a detailed presentation of the results and how they were generated
* discussion and analysis of the results, and conclusions

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Rating of Projects

Each project is graded over 100 points.

Completion of the project counts for 50 points. This is mostly based on demonstration of working code during the project defense, and the availability of the required results. Roughly, 25 points are given for working code, and 25 for the use of the software in obtaining the required data or results.

Assuming the project is complete, the remaining 50 points come from considering the quality of the implementation and the ability to discuss the project in the written documentation. About 20 points are given for the quality of the implementation, as manifested by modularity of the implementation, a systematic approach to the problem, and well-documented source code. About 10 points are given for the ability to introduce the project and discuss its goals and methodology in the documentation. About 20 points are given for a systematic presentation and analysis of the results obtained, and for conclusions based on the results.

Projects submitted late shall be penalized 20 pts per day late or fraction thereof, excluding Saturdays, Sundays, and holidays. For instance, if a project is submitted beyond 11 am of the due date, but before 11 am of the following day, the penalty shall be 20 pts. If the due date falls on a Friday, late submission before 11 am of the following Monday incurs a 20-pt penalty, while submission after 11 am of Monday but before 11 am of Tuesday incurs a 40-pt penalty, assuming Monday and Tuesday are not holidays.

5. Grading System

Each of the four projects will be graded over 100 points. The average of the four project scores shall be the “basic class standing” or BCS.

The class standing (CS) is computed as

$$CS = BCS + B - D,$$

where

B is the number of bonus point earned, and
D is the number of accumulated demerits.

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The final grade (FG) will be determined from the class standing (CS) as follows:

$$FG = \begin{cases} F & \text{if } CS < 50, \\ D & \text{if } 50 \leq CS < 60, \\ C & \text{if } 60 \leq CS < 69, \\ C+ & \text{if } 69 \leq CS < 77, \\ B & \text{if } 77 \leq CS < 86, \\ B+ & \text{if } 86 \leq CS < 92, \\ A & \text{if } 92 \leq CS. \end{cases}$$

Your instructor has the prerogative of giving a higher grade than that determined from the class standing.

Demerits are points deducted from your class standing for offenses against the conduct of the course. These offenses include, but are not limited to:

* failure to contribute to class discussion
* failure to do problem sets
* disrupting class discussion
* speaking out of turn in class
* doing work unrelated to CE 30 during class time

One demerit is given for the first time an offense is committed. Successive offenses of the same nature shall be awarded two demerits, three demerits, and so on.

6. Class Policies

On attendance

Attendance may or may not be checked on a given class day. Attendance may be checked at any time during class. If attendance is checked, absence from class at the time attendance is checked shall be considered a cut.