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Action-Date: App 11/5/96 Senate

CURRICULUM PROPOSAL COVER SHEET
University-Wide Undergraduate Curriculum Committee

I. CONTACT

Contact Person James L. Wolfe Phone 6104

Department Computer Science

II. PROPOSAL TYPE (Check All Appropriate Lines)

XX **COURSE** INTRO TO NUM METHODS
Suggested 20 character title

____ New Course* _____
Course Number and Full Title

XX Course Revision CO 250 Introduction to Numerical Methods
Course Number and Full Title

____ Liberal Studies Approval+ for new or existing course _____
Course Number and Full Title

____ Course Deletion _____
Course Number and Full Title

____ Number and/or Title Change _____
Old Number and/or Full Old Title

_____
New Number and/or Full New Title

____ Course or Catalog Description Change _____
Course Number and Full Title

____ **PROGRAM:** ____ Major ____ Minor ____ Track

____ New Program* _____
Program Name

____ Program Revision* _____
Program Name

____ Program Deletion* _____
Program Name

____ Title Change _____
Old Program Name

_____
New Program Name

III. Approvals (signatures and date)

Department Curriculum Committee

Department Chair

College Curriculum Committee 03/28/96

College Dean

+Director of Liberal Studies (where applicable)

*Provost (where applicable)

Part II. Description of the Curriculum Change

1. New Catalog Description and New Syllabus of Record

CO250 Introduction to Numerical Methods 3c-01-3sh

Prerequisite: CO110, MA122 or MA123 or MA127

Algorithmic methods for function evaluation, roots of equations, solutions to systems of linear equations, interpolation, curve fitting, numerical differentiation and integration; errors in computation. Introduction to Fortran90 programming and introduction to the use of a mathematical software package to graph functions.

New Syllabus - See attachment A.

2. Summary of proposed revision

The revision of CO 110 to use C++ instead of Fortran will mean that students entering CO 250 would not have previous exposure to Fortran. The revision would use approximately 8 hours of class to introduce Fortran and the mainframe system to the students at the beginning of the course. This model of presenting a second language to students has been used successfully in CO 310 for many years. The need to present some mainframe concepts is the result of teaching CO 110 on microcomputers, rather than the mainframe.

To allow for the inclusion of an introduction to Fortran and mainframe use in CO 250, some algorithms previous taught will be omitted. The lost material will not change the basic concepts being presented; it will mean that fewer alternative algorithms for a task will be presented than before.

3. Rationale for the revision.

This revision is part of an overall change to using C++ as a major programming language in our curriculum. The use of C (and its superset C++) in industry for a wide range of purposes has been growing very rapidly. The use of Fortran has been in decline, although the decline is much slower in the area of Numerical Analysis. Consequently, we feel that Fortran still needs to be used in CO 250.

Some teaching of Fortran is already being done in CO 250 to take advantage of some language features that are available for numerical methods. The change to more extensive use of Fortran should fit in well with current teaching. The loss of several alternative numerical algorithms should not cause significant degradation - all concepts currently presented will continue to be presented.

4. Old Syllabus

See attachment B.

Part III. Letters of Support

See attachment C.

CO 250 Introduction to Numerical Methods Attachment A

Course Syllabus

I. CATALOG DESCRIPTION

CO250 Introduction to Numerical Methods 3c-01-3sh

Prerequisite: CO110, MA122 or MA123 or MA127

Algorithmic methods for function evaluation, roots of equations, solutions to systems of linear equations, interpolation, curve fitting, numerical differentiation and integration; errors in computation. Introduction to Fortran90 programming and introduction to the use of a mathematical software package to graph functions.

II. COURSE OBJECTIVES

1. Students should know the role of and the limitations of the computer in solving mathematical and engineering problems.

2. Students should know how to implement mathematical algorithms using the Fortran 90 programming language.

3. Students should know how to use software packages such as Matlab as an aid in solving numerical problems.

4. Students should know selected numerical algorithms for solving a variety of commonly encountered mathematical problems.

III. COURSE OUTLINE

topic	hours
Introduction to Fortran 90 and Mainframe Operating System	9
Program format and introduction	
Operating system commands, symbols, and logicals	
Using the editor and compile, link and run	
Real, Integer and derived data types	
Programs and procedures	
Modules	
Control Structures	
One Dimensional Arrays	

CO 250 Introduction to Numerical Methods Attachment A

topic	hours
Input, Output and Files	
Errors in Computer Computations	3
Numerical calculations, precision, rounding	
Parameterized REAL variables in Fortran 90	
Conditioning and Stability	
Numerical algorithms and graphing	8-12
Data fitting by least squares approximation	
Introduction to MATLAB	
Bisection method for solving an equation	
Limitations of numerical algorithms	
Solving quadratic equations	
Newton's method for solving non-linear equations	
Secant method for solving non-linear equations	
Muller's method for solving non-linear equations	
Advanced topics in Fortran 90	5
Matrices and 2-dimensional arrays	
Array contructors for rank-n arrays	
Five classes of arrays	
Allocatable arrays	
Whole array operations, masks, sections	
More numerical algorithms	11-15
Solving systems of linear equations	
Solving a tridiagonal system of equations	
Interpolation	
Fitting a set of data points using a cubic spline	
Numerical differentiation	
Integration and numerical quadrature	
Hour exams	2

IV. EVALUATION METHODS

The final grade for the course will be determined as follows:

50 - 60% Tests.
At least three tests (two during the term and the final) consisting of mathematical problems and programming questions.

40 - 50% Projects, labs, quizzes, and homework.
At least five computer projects will be assigned. Projects will be graded on output and style. Quizzes, lab sessions and short homework papers from the textbook problem sets may also be assigned.

V. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

Textbook: Ellis, Phillips, and Lahey, Fortran90 Programming, Addison Wesley, 1994.

VI. SPECIAL RESOURCE REQUIREMENTS

There are no special resource requirements for this course. There is a Fortran90 compiler on the mainframe and MATLAB is available both in the Stright 220 lab and in the Johnson Data Center.

VII. BIBLIOGRAPHY

Burden, Richard and J. Douglas Faires, Numerical Analysis, Third Edition, Prindle, Weber & Schmidt, 1985.

Cheny, Ward and David Kincaid, Numerical Mathematics and Computing, Third Edition, Brooks/Cole, 1994.

Etter, Engineering Problem Solving with MATLAB, Prentice Hall, 1993.

Fortran 90, ISO/IEC JTC1/SC22/WGS Internal document N692 Submitted as Text for ISO/IEC 1539:1991, 1991.

Lastman, Gary J. and Naresh K. Sinha, Microcomputer-Based Numerical Methods for Science and Engineering, Saunders, 1989.

Kerrigan, Migrating to Fortran90, O'Reilly, 1993.

Mathews, John H., Numerical Methods for Mathematics, Science, and Engineering, Prentice Hall, 1992.

Metcalf, Michael and John Reid, Fortran 90 Explained, Oxford University Press, 1990.

Attachment B

CO 250 - SYLLABUS

Catalog Description

CO 250 INTRODUCTION TO NUMERICAL METHODS 3 s.h.

Prerequisites: CO 110, MA 122 or MA 123 or MA 127

Algorithmic methods for function evaluation,, roots of equations, solutions to systems of equations [operations], matrix operations, curve fitting, interpolation, numerical integration and differentiation, errors in computation.

COURSE SYLLABUS

OBJECTIVE: To provide the student an introductory understanding of a structured, algorithmic, computer-oriented approach to some basic techniques of numerical analysis. Additional experience in FORTRAN is afforded, together with experience in use of standard numerical software packages, and graphical display/analysis of subject functions.

Representative Course Outline:

I. Preliminary Topics:

a. Review of calculus
b. Computer arithmetic, "round-off" (chopping) errors, loss of significance
c. Algorithms and convergence
d. Function approximation, Taylor polynomials, truncation error
e. Review and reinforcement of FORTRAN; use of software libraries.

[Project 1]

II. Roots of Equations in One Variable:

a. Bisection method
b. Fixed-point iteration
c. Newton, Secant, Mueller methods
d. Error analysis for iterative methods

[Project 2, with graphics, curve-plotting]

TEST 1

III. Interpolation; Polynomial Approximation

a. Lagrange polynomials
b. Iterated interpolation - methods of Neville and Aitken
c. Divided differences, Newton formulas
d. Cubic spline interpolation

[Project 3, with curves]

IV. Numerical Differentiation and Integration

a. Differentiation methods
b. Richardson extrapolation
c. Newton-Cotes and composite integration rules
d. Romberg method
e. Gaussian quadrature

[Project 4]

TEST 2

V. Systems of Linear Equations

a. Gaussian elimination and backward substitution
b. Elementary concepts of linear algebra-matrix inversion-determinant
c. Pivoting strategies
d. Special types - band, tridiagonal, symmetric matrices
e. Direct factorization - LU, Doolittle, Crout, Choleski

[Project 5]

VI. Least-Square Approximation

a. Matrix methods for linear combination of approximating functions

FINAL EXAM

Attachment C

To: James Wolfe, Chairman
Computer Science Department Curriculum Committee

From: Gerald Buriok, Chairman
Mathematics Department GmB

Date: October 24, 1995

Subject: Curriculum Proposal for CO 250

The Mathematics Department supports your department's proposed changes in CO 250 Introduction to Numerical Methods. We understand that these changes were necessitated, in part, by the change in programming languages in CO 110 from FORTRAN to C++. Your new syllabus for CO 250 indicates the students will now receive instruction in FORTRAN and its implementation on the VAX system as part of CO 250 rather than in CO 110. This is acceptable, as are changes in content to allow time the introduction of FORTRAN.