CURRICULUM PROPOSAL FORM #3
University of Wisconsin-Whitewater

NEW COURSE

COURSE NUMBER: 760 - 672 / _____ EFFECTIVE TERM: Fall 1996

CROSS LISTED NO.: _____ - _____ / _____

COURSE TITLE: Numerical Analysis II

15 CHARACTER ABBREVIATION N U M E R I C A L _ A N A L 2
25 CHARACTER ABBREVIATION N U M E R I C A L _ A N A L Y S I S _ I I _ _ _ _

SPONSOR(S): Dr. D. Phanord, Dr. Verma

DEPARTMENT(S): Mathematics and Computer Science

COLLEGE(S): Letters and Sciences

CHECK IF THE COURSE IS TO MEET ANY OF THE FOLLOWING REQUIREMENTS:
____Writing Requirement
____Diversity Requirement
____General Studies, Area:_____
____Computer Requirement

CONTACT HOURS/CREDITS
Total Lecture Hours 48
Total Lab Hours ____
Total Contact Hours 48
Number of Credits 3

S THE COURSE REQUIRED IN: IS THE COURSE REPEATABLE: YES____, NO X

___Major,_____ No. of Times in Major____ and No. of Credits___

___Minor,_____ No. of Times in Degree___ and No. of Credits___

___Emphasis,_____

ATTACH THE FOLLOWING:

I. COURSE JUSTIFICATION
II. RELATIONSHIP TO PROGRAM OBJECTIVES
III. BUDGETARY IMPACT
IV. PROGRAMS AFFECTED IN OTHER ACADEMIC UNITS
V. COURSE DESCRIPTION
VI. REQUISITES
VII. TENTATIVE COURSE SYLLABUS
VIII. BIBLIOGRAPHY

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DEPARTMENT(S): Mathematics and Computer Science

COLLEGE(S): Letters & Sciences

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____Writing Requirement
____Diversity Requirement
____General Studies, Area:_____
____Computer Requirement

CONTACT HOURS/CREDIT
Total Lecture Hours 48
Total Lab Hours ___
Total Contact Hours 48
Number of Credits 3

IS THE COURSE REQUIRED IN:
__X__Major, Math BA/BS Minor
___Minor,_____
___Emphasis,_____

IS THE COURSE REPEATABLE: YES____, NX
No. of Times in Major____ and No. of Credit
No. of Times in Degree___ and No. of Credit

ATTACH THE FOLLOWING:

I. COURSE JUSTIFICATION
II. RELATIONSHIP TO PROGRAM OBJECTIVES
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I. **Course Justification**

By being a member of the Wisconsin Space Grant Consortium, and a JOVE Institution (Joint Venture between NASA and UW-Whitewater, the University has an obligation to provide its students a space science oriented education.

No one can pursue a career in applied sciences or more precisely in space related sciences without a mastery of computational mathematics. This mastery can be achieved by a complete understanding of numerical analysis.

In addition, many of our students of either Physics or Mathematics must take the GRE in order to secure admission in a reputable graduate program. The knowledge of numerical analysis is crucial to such an endeavor.

II. **Relation to Program Objectives**

The course is a requirement for the mathematics majors anticipating a career in applied mathematics.

Requirement for Mathematics BA/BS.

Also recommended to students anticipating a graduate study in Physics.

III. **Budgetary Impact**

None

IV. **Program Affected in Other Academic Unit**

None

V. **Course Description**

Emphasis on algorithmic approach to numerical analysis. Methods of iteration, interpolation and approximation applied to numerical differentiation and integration and to solution of nonlinear systems, difference equations, ordinary and partial differential equations. Consideration of rounding error and numerical stability. Extensive use of microcomputers and programs using a high level language, such as PASCAL.

VI. **Requisites**

prerequisite: 765-171 and Mathematics 760-458

VII. **Tentative Course Syllabus**

MATHEMATICS 760672, NUMERICAL ANALYSIS II

Course Outline

Text: Handbook of Numerical Analysis, by Ciarlet, P.G. and Lions, J.L., Editors. New York: Elsevier Science Publishing Company, Inc., 1990.

I. Numerical Solution of Differential Equations

A. Formulas of Open Type

Course Outline, Cont.

B. Formulas of Closed Type
C. Start of Solution
   1. Methods based on open-type formulas
   2. Methods based on closed-type formulas
   3. The special case F = Ay
   4. Propagated-error bounds
   5. Convergence of iterations
D. Application to Equations of Higher Order
   1. Propagated-error bounds
   2. Special second-order equations
   3. Change of interval
E. Use of Higher Derivatives
   1. A simple Runge-Kutta method
   2. Runge-Kutta methods of higher order
F. Boundary-value Problems
   1. Linear characteristic-value problems
   2. Selection of a method

II. Least-squares Polynomial Approximation
A. The principle of Least Squares
   1. Least-squares approximation over discrete
   2. Orthogonal polynomials
   3. Legandre approximation
   4. Laguerre approximation
   5. Hermite approximation
   6. Chebyshev approximation
B. Factorial Power Functions and Summation Formulas
   1. Polynomials orthogonal over discrete ranges
   2. Gram approximation
C. Smoothing formulas

III. Gaussian Quadrature and Related Topics
A. Hermite Interpolation
   1. Hermite quadrature
   2. Gaussian quadrature
   3. Legendre-Gauss quadrature
   4. Laguerre-Gauss quadrature
   5. Hermite-Gauss quadrature
   6. Chebyshev-Gauss quadrature
   7. Jacobi-Gauss quadrature

B. Formulas with Assigned Abscissas
   1. Radan quadrature
   2. Lobatto quadrature
   3. Chebyshev quadrature
C. Algebraic Derivations

Course Outline, Cont

III. Approximations of Various Types
- A. Fourier Approximation: Continuous Range
- B. Fourier Approximation: Discrete Range
- C. Exponential Approximation
  1. Determination of constituent periodicities
  2. Optimum polynomial interpolation with selected abscissas
  3. Chebyshev interpolation
- D. Economization of Power Series
- E. Approximation by Continued Fractions
  1. Nature of continued-fraction approximations
  2. Determination of convergence of continued fractions
  3. Thiele's continued-fraction expansions

IV. Numerical Solution of Equations
- A. Sets of Linear Equations
  1. The Gauss reduction
  2. The Crout reduction
- B. Determination of the Inverse Matrix
  1, Inherent errors
  2. Gauss-Seidael interation and relaxation
- C. Iterative Methods for Solving Nonlinear Equations
  1. Iterated synthetic division
  2. Bernoulli's iteration
- D. Graeffe's Root-squaring Techniques
  1. Iterated synthetic division with quadratic factors-Lin iteration
  2. Dairstow iteration

Credits: 3

Offered: Second semester of each year

Pre-requisite: Computer Science 760171 and Mathematics 760471

Accepted credit toward what majors and minors: Mathematics major and minor

Catalog Description: Emphasis on algorithmic approach to numerical analysis. Methods of iteration, interpolation and approximation applied to numerical differentiation and integration and to solution of non-linear systems, difference equations, ordinary and partial differential equations. Consideration of rounding error and numerical stability. Extensive use of digital computer equipment.

Graduate Students: Will be responsible for a research paper and a research project.

VIII. **Bibliography**

Handbook of Numerical Analysis, Ciarlet, P.G. and Lione, J.L., Editors. New York, Elsevier Science Publishing Company, Inc., 1990.

Numerical Analysis., Kincaid, David and Cheney, Ward, Brooks/Cole, Pacific Grove, CA, 1991.

Bibliography, Cont.

Numerical Methods, Faires, J. Douglas and Burden, Richard L., P.W.S. Kent, Boston, 1993.

Numerical Analysis, Maron, M.J., Macmillan, New York, 1987.

Numerical Analysis (Theory and Practice), Asaithambi, N.S., Saunders College Publishers, New York, 1995.

Numerical Mathematics and Computing, 3rd Edition, Cheney, Ward and Kincaid, David, Brooks/Cole, Pacific Grove, CA, 1994.

Numerical Recipies, the Art of Scientific Computing, Press, William H., Flanery, Brian P., Teukolsky, Saul A. And Vetterling, William T., Cambridge University Press, New York, 1989.

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SIGNATURE PAGE
CURRICULUM PROPOSAL FORM #3
NEW COURSE

COURSE NUMBER: 760 / 672 / ______
CROSSLISTED NUMBER: ______ / ______ / ______

COURSE TITLE: Numerical Analysis II

Proposal Sponsor ______ Date of Submission 3/29/96

Chair of Sponsoring Department ______ Department: Math & C.S. Approval Date: 3/29/96

Chair, College Curriculum Committee ______ Approval Date: 4/4/96

Dean of College ______ College: L&S Approval Date: 4/8/96

FOR UNDERGRADUATE ACTIONS:

IF COURSE IS TO BE CONSIDERED AS A DIVERSITY/ G.S. OPTION:

Chair, Div. Comm./ Gen. Ed. Review Comm. ______ ___Recommended ___Not Recommened ______ Date

Chair, University Curriculum Committee ______ ___Approved ___Not Approved ______ Date

Chair, Faculty Senate ______ ___Approved ___Not Approved ______ Date

FOR GRADUATE ACTIONS:

Chair, Graduate Council ______ ✓ Approved ___Not Approved 4/11/96 Date

Provost & Vice Chancellor ______ 5/3/96 Date Received

RECORD OF OTHER ACADEMIC UNITS CONSULTED

ACADEMIC UNIT	SIGNATURE	DATE	*ACTION

*Indicate Approve, No Contest, or Disapprove, for graduate programs only)

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Chair, Faculty Senate	___Approved ___Not Approved	Date

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Chair, Graduate Council	✓ ___Approved ___Not Approved	Date: 4/11/96
Provost & Vice Chancellor		Date Received

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