88-89/10A

INDIANA UNIVERSITY OF PENNSYLVANIA
SENATE CURRICULUM COMMITTEE B-2

NEW COURSE PROPOSAL

Department: Mathematics

Person to Contact for Further Information: Dr. Joseph Angelo

Course Affected: MA 425 Applied Mathematical Analysis (New Course)

Desired Effective Semester for Change: Spring '88

Approvals: Department Committee Chairperson Ronald L McBride

Department Chairperson John Broughton

College Committee Chairperson C R Fuget

College Dean C R Fuget

A. DESCRIPTION AND ACADEMIC NEED

A1. Catalog description attached.

A2. Course syllabus and bibliography attached.

A3. This course will serve as an elective course for students with an undergraduate emphasis in applied mathematics. It provides the analysis theory which lies under the procedures and algorithms for operations research and statistics. It would also be suitable for computer science or science majors with a good background in calculus and linear algebra. It is not proposed for inclusion on the regular General Education course list.

A4. This course does not require changes in content of other existing courses.

A5. Traditional format will be used in the presentation of material.

A6. This course has not been offered as a Special Topics course yet, but that will be done during Main Session, 1987. The instructor will be James Reber.

A7. This is to be a dual level course. It will be required in the M.S. program unless the student has taken a comparable course as an undergraduate. The proposal is currently proceeding through the approval process. It has been approved by the Mathematics Department Faculty, and is ready for submission to the College Dean and the Graduate Committee of th Senate.

A8. Catalogs for several universities in a comparison group for IUP were examined. Included were catalogs for Clarion, Indiana State University, Marshall, Millersville, University of Pittsburgh, Penn State, Sam Houston, Shippensburg, West Chester University, Western Illinois, and West Virginia. Of those examined, only the following catalogs revealed similar courses:

Penn State University - MATH 405, Advanced Calculus for Engineers I: Real Variables; MATH 469, Mathematics of Algorithms (both dual level).

University of Pittsburgh - Math 157, Transformational Methods in Applied Mathematics (dual level); MA 220A, Real Analysis (graduate level).

Western Illinois - Course number 531, Real Variables; course number 581, Approximation Theory (both graduate level).

West Virginia University - Math 255, Advanced Real Calculus (dual level).

No single course listed above contains all of the topics of the proposed course

A9. Proposed course is not specifically recommended by a professional society, accrediting authority, law, or external agency; however it is a course of the type recommended by our external evaluators, Lightner and Merserve, especially with regard to the graduate program.

B. INTERDISCIPLINARY IMPLICATIONS

B1. The course will be taught by one instructor.

B2. No additional or corollary courses needed now or later.

B3. There is no relationship between the content of this course and the content of courses offered by other departments.

B4. Course is probably not applicable to a program in the School of Continuing Education.

C. EVALUATION

C1. Examinations will be used to evaluate student progress.

C2. The course may not be taken for variable credit.

D. IMPLEMENTATION

D1. a. Faculty currently available.

b. There is sufficient space and equipment.

c. No laboratory supplies are required.

d. Library resources are adequate.

e. No travel funds required.

D2. This course will be offered once each year during the second semester or summer term.

D3. There will probably be just one section each time the course is offered.

D4. Class size should not exceed 20 so that each student can receive appropriate attention from the instructor.

Catalog Description

MA 425 APPLIED MATHEMATICAL ANALYSIS I 3 s.h.

This course provides the necessary background for an understanding of mathematical programming, proofs of convergence of algorithms, convexity and factorable functions. It also develops necessary concepts in matrix theory which are required to develop efficient algorithms to solve linear and nonlinear programming models. Prerequisites: Calculus sequence, introductory linear algebra, or permission of the instructor.

MA 425 APPLIED MATHEMATICAL ANALYSIS I

DESCRIPTION

This course provides the underlying theoretical background necessary for an understanding of mathematical programming, convergence of algorithms, and applications of convexity and factorable functions. It includes concepts in matrix theory and vector analysis which are required to understand the development of efficient algorithms to solve linear and non-linear programming models.

OUTLINE

	Number of Periods
A. INTRODUCTION TO NECESSARY TERMINOLOGY, NOTION, SETS, FUNCTIONS, REAL OR COMPLEX NUMBERS	3

1. Sets and Functions
2. Groups and Fields
3. Fundamental Theorem of Algebra
4. Mean Value Theorem
5. Taylor's Theorem

B. BRIEF REVIEW OF LINEAR ALGEBRA	3

1. Vector Spaces
2. Partitioned Matrices
3. Linear Transformations

C. COLUMN VECTORS	6

1. Standard Form
2. Gauss-Jordan Pivoting
3. Gauss-Jordan Reduction Procedure
4. Elementary operations on the scalar form
5. Standard Procedures
    a. Finding Standard Matrices
    b. Resolving LI
    c. Finding the Standard Representation of a Subspace
    d. Finding a Basis for Null A
    e. Resolving Consistency of Ax = b
    f. Finding aGISF System
    g. Representing all Solutions of Ax = b
    h. Factoring a Matrix
6. Unitary Space
7. Gram-Schmidt Procedure

Number of Periods

D. RECTANGULAR MATRICES IN EUCLIDEAN SPACE 8

1. Geometric Interpretations
2. Three Fundamental Forms of k-Planes
3. Elementary Theorem of the Separating Hyperplane
4. Nonegative Solutions

   a. Theorem of the Alternative
   b. Gale's Theorem for Equations
   c. Farkas' Theorem
   d. Gordan's Theorem
   e. Stiemke's Theorem
   f. Gale's Theorem for Inequalities
   g. Von Neumann's Theorem for Semipositive Solutions
   h. Tucker's Theorem for Positive Solutions

5. Basic Solutions
6. Linear Inequalities

   a. Minkowski's Theorem
   b. Modularity Theorem
   c. Weyl's Theorem

E. SQUARE MATRICES IN UNITARY SPACE 6

1. Square Matrices
2. Cayley-Hamilton Theorem
3. Schur's Theorem
4. Unique Solutions
5. Gaussian Reduction Procedure
6. LDU Factorization Theorem
7. Definiteness
8. Diagonalization

   a. Jordan Canonical Form Theorem

F. DIFFERENTIAL CALCULUS ON R 8

1. Continuous Transformations
2. Extreme Value Theorem
3. Equivalence of Vector Norms
4. Equivalence of Natural Norms
5. Derivatives
6. Derivatives of Vectors and Matrices
7. Differentiating Composite Transformations
8. Taylor's Theorem
9. Inverse Transformation Theorem
10. Implicit Function Theorem
11. Tangent Space Theorem
12. Convex Functions

Number of Periods

G. OPTIMIZATION THEORY ON R 8

1. General Considerations
2. Equality Constraints
3. Lagrance Multiplier Theorem
4. Inequality Constraints

    a. Kuhn-Tucker Conditions for Inequality Constraints

5. Mixed Constraints

    a. Kuhn-Tucker Conditions for Mixed Constraints

6. Convex Programming

    a. Kuhn-Tucker Theorem for Convex Programming

7. Separation and Representation
8. Minkowski's Separation Theorem

Total: 42

The student will be asked to (i) complete a project related to one of the topics in applied analysis;
(ii) read and write reports on two articles found in the current literature;
(iii) complete a take-home final examination;
(iv) solve and make oral presentations of group problems.

Bibliography

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