I. QUANTITATIVE METHODS I
BADM 7201
3 credits
No prerequisites

II. COURSE DESCRIPTION:
This course presents quantitative methods necessary for understanding mathematical models as used in quantitative research, entrepreneurial and managerial decision making. The course focuses on mathematical methods used in economic and managerial modeling like differential and integral calculus, optimizing techniques, linear algebra and linear programming. The models will be applied in various managerial areas like human resources, labor relations, marketing and organizational behavior.

III. COURSE OBJECTIVES
After completion of this course the student should be able to attain the following terminal and capacitating objectives:

1. Construct mathematical models of managerial situations applying functional mathematical analysis and set theory.
   1.1 Apply functional mathematical relations among variables.
   1.2 Apply in managerial situations polynomial, rational, linear, exponential and logarithmic functions.
   1.3 Explain the Fundamental Theorem of Algebra
   1.4 Apply set theory in the context of managerial situations involving groups and group behavior.
   1.5 Apply the concepts of union and intersection of sets to situations involving labor relations and collective bargaining.
   1.6 Solve simple economic models like breakeven and demand and supply.
2. Evaluate the use of linear algebra in managerial situations and to understand economic interrelations.
   2.1 Define the basic operations of matrix algebra including addition, multiplication and inverses of matrices.
   2.2 Use Excel to do basic matrix operations.
   2.3 Apply matrix algebra in the solution of linear multiple equations systems.
   2.4 Solve a system of linear equations using Excel.
   2.5 Use matrix algebra to apply it to the open Leontief input-output model of the economy.
2.6 Explain the intersectoral transactions in the economy and the matrix of technical coefficients.
2.7 Use Excel to derive the Leontief matrix and its inverse.
2.8 Determine the final intersectoral output of the economy given a final demand vector using Excel.
2.9 Explain Markov chains and apply them in changing states in the context of collective bargaining, market shares, group behavior, population and preference dynamics.

3. Apply differential and integral calculus and optimization techniques to situations in managerial decision making.
3.1 Define the concept of the limit of a function as it approaches a point in its domain.
3.2 Apply the concept of the change quotient and apply it to estimate changes in the values of functions.
3.3 Differentiate between continuity and differentiability.
3.4 Define the concept of the derivative as the limit of the change quotient.
3.5 Solve exercises utilizing the rules of differentiation of single and multiple variable functions: power, product, ratio, chain, implicit and inverse function rules.
3.6 Solve exercises involving the differentiation of exponential and logarithmic functions.
3.7 Apply the concepts of partial and cross differentiation.
3.8 Define the differential of a function and the process of total differentiation.
3.9 Construct channel maps of total differentiation detailing direct and indirect effects of variables and apply it in organizational behavior issues.
3.10 Apply the differential calculus analysis to understand point price elasticity of demand and its relation to marginal revenue and optimum pricing.
3.11 Apply the differential calculus analysis to understand total, marginal and average relations on functions.
3.12 Solve optimization exercises of single and multiple variable functions given constraints utilizing the Lagrange multiplier technique.
3.13 Solve profit maximizing and utility maximizing problems; solve cost minimization problems.
3.14 Apply optimization techniques to choose optimum timing of projects.
3.15 Apply the concepts of gradient vector, Hessian matrix and bordered Hessian matrix.
3.16 Define comparative statics and the envelope theorems of comparative statics.
3.17 Define the concept of the integral as an antiderivative and as a Riemann sum in the limit.
3.18 Explain the Fundamental Theorem of Calculus.
3.19 Derive the indefinite integral using the techniques of integration: power, substitution and by parts.
3.20 Derive the definite integral using the techniques of integration and given values in the domain of a function.

3.21

3.22 Apply integral calculus in investment, growth and capital accumulation issues of entrepreneurial and managerial importance.

4. Apply linear programming in entrepreneurial and managerial decisions.

4.1 Construct a linear programming model.

4.2 Differentiate between the objective function, decision variables, constraints and technical coefficients in a linear programming model.

4.3 Solve linear programming models using Excel Solver.

4.4 Define the concepts of shadow prices, viability and optimality ranges and be able to evaluate them in the context of managerial decisions.

4.5 Apply linear programming to choose the optimum projects for the firm.

4.6 Apply linear programming to choose the optimum asset allocation in investment situations with constraints.

4.7 Apply linear programming in scheduling problems.

4.8 Apply linear programming in plant location problems.

IV. COURSE CONTENT

Part I. Foundations of mathematical analysis

A. The number system
B. Economic models
   1. Variables, parameters, constants and coefficients
   2. Equations
   3. Endogenous and exogenous variables
C. Set theory
   1. Basic set operations
      a. Union
      b. Intersection
      c. Complement
      d. Joint vs. disjoint sets
D. Mathematical Framework of Analysis
   1. Functions
      a. Introduction to functions
      b. Polynomial and rational functions
      b. Exponential and Logarithmic Functions
   2. Mathematical Models and Data Analysis
   3. Equilibrium Analysis
E. Applications
   1. Breakeven model
   2. Demand and supply model

Part II. Linear Models and Matrix Algebra
A. Introduction to Matrix algebra
   1. Matrices and vectors
   2. Matrix operations and concepts
      a. Matrix addition and multiplication
      b. Determinants, minors and cofactors
      c. Matrix inverse
      d. Singularity
   5. Excel functions for matrices operations

B. Solving System of Equations
   1. Solving 2 x 2 systems
   2. Generalization to higher dimensions
   3. The Leontief System
      a. Intersectoral transactions matrix
      b. Coefficient matrix
      c. Leontief matrix
      d. Inverse of Leontief matrix
      e. Final demand and final output
   4. Markov chains
      1. State matrix
      2. Transition matrix
      3. Applications

Part III. Differential Calculus and Integral Calculus

A. Comparative Static Analysis and Derivatives
   1. The Nature of Comparative Statics
   2. Limit of a function
   3. Continuity and differentiability

B. Rules of differentiation; univariate functions.
   1. Power
   2. Product
   3. Quotient
   4. Chain
   5. Inverse function
   6. Logarithmic
   7. Exponential

C. Rules of differentiation; multivariate functions
   1. Derivatives of higher order
   2. Cross derivatives

D. Total Differentials and Total Derivatives
   1. Channel maps
   2. Direct and indirect effects

E. Applications
1. Consumers Utility Functions
2. Cost Functions
3. Revenue Functions
4. The Market Model
5. Market penetration

Part IV. Optimization Analysis

A. Derivatives and Extreme Values
   1. Stationary points
   2. First and second order conditions for maximum or minimum
   3. The nth derivative test for extreme points

B. Constrained Optimization
   1. Using the substitution technique
   2. Using the Lagrange multiplier technique
   3. Gradient vector
   4. Hessian matrix
   5. Bordered Hessian
   6. Comparative statics and envelope theorem

E. Applications
   1. Cost minimization for a given output
   2. Profit Maximization
   3. Optimum timing
   4. Utility maximization and consumer demand
   5. Least cost combination of inputs with Cobb Douglas production function

Part V. Integral Calculus

A. Definition of Integrals
   1. Antiderivative
   2. Riemann sum
   3. Fundamental Theorem of Calculus
   4. Properties of integrals

B. Rules for Integration: Indefinite Integrals
   1. Power
   2. Substitution
   3. By parts

C. Definite Integrals
D. Improper integrals
E. Applications
   1. Investment and capital accumulation
   2. Compound interest and present value
   3. Economic growth: Domar Model
   4. Population accumulation
Part V. Linear Programming

A. Mathematical Optimization

1. Decision variables
2. Objective function
3. Restrictions
4. Boundaries of decision variables

B. Graphical Solution

1. Inequalities
2. Isocurves
3. Viability Set
4. Corner solutions

C. General Solution sing Excel Solver

1. Optimization of objective function
2. Dual and shadow prices interpretation
3. Sensitivity Analysis
   a. Optimality Range
   b. Viability Range

D. Applications

1. Production decisions
2. Resource allocation
3. Optimal factor combination
4. Diet problem
5. Transportation
6. Investment planning
7. Capital Budgeting

V. COURSE ACTIVITIES

A. Power Point presentations by professor and student feedback
B. Class discussion of exercises
C. Communication among students and professor via e-mail

VI. EVALUATION CRITERIA

A. Partial Examinations: There will be two partial examinations.
B. Final Examination
C. Model construction project
All examinations will consist of questions that require detailed problem-solving work. Approximately 40% of the exam questions are based on the examples discussed in class presentations. Another 60% of the exam questions are based on homework problems. All examinations are closed notes. However, you are allowed to bring in two 3.5 inch index card, upon which you may write useful formulas, equations, and so forth for each of the mid-term exams, and three 3.5 inch index cards for the final. In addition, please bring a calculator with exponential and logarithmic functions (including $y^x$). The use of Excel will be needed for the solution of some exercises.

There will be no exam repositions or make-ups.

The final examination is scheduled to last for four hours. Final examination will be comprehensive and will cover the entire course contents with emphasis in the economic applications of methods.

For the model construction project the student will be required to construct a mathematical model of some issue or problem concerning his concentration interest in the Doctorate Program and apply the maximum of the mathematical analysis and techniques presented in class.

**Final Grade**

Your total course score will be determined by weighting the two partial exams by 20% each, the final exam by 50% and the model construction project by 10%.

The final grade distribution will be based upon the following scale:

- 100-85----A
- 84-72------B
- 71-60------C
- <60--------F

The professor could add a maximum of three percentage points to your final score for class participation.

**VII. EDUCATIONAL RESOURCES**

**Required Text**


**Strongly Recommended Texts:**


**Handouts:**

Angel A. Rivera:

1. Introducción básica a la matemática
2. Teoremas sobre logaritmos
3. Derivación de la fórmula cuadrática
4. Introducción al algebra de matrices
5. Concepto del límite
6. Reglas de diferenciación
7. Elasticidad punto de demanda y las funciones de ingreso
8. Introducción a la estática comparativa

Angel L. Ruiz, "Estimación de una Función Producción Cobb-Douglas para la Economía de Puerto Rico", Economic Research Unit, Department of Economics, University of P.R., *Serie de Notas de Clase, Num.4*.


**VIII. BIBLIOGRAPHY**


