MA 213 CALCULUS III (UK Course) (4 credit hours)

Official Course Description	A course in multi-variable calculus. Topics include vectors and geometry of space, three-dimensional vector calculus, partial derivatives, double and triple integrals, integration on surfaces, Green's theorem. Optional topics include the Stokes' theorem and the Gauss' divergence theorem. Prerequisites: A grade of C or better in MA 114 or in MA138 or equivalent.

COURSE OBJECTIVES (Approved Fall 2017)

Upon completion of this course, the student can:

1. Perform the operations of addition, subtraction, dot product, and cross product on vectors.
2. Find directional derivatives and the gradient of functions of several variables.
3. Find relative extrema of functions of several variables.
4. Evaluate line integrals within vector fields.
6. Identify various surfaces, including quadric surfaces, by their equations and their graphs.
7. Determine the equations of lines and planes and find distances in space.
8. Find derivatives and integrals of vector valued functions and tangent lines to space curves.
9. Determine the arc length, unit tangent vector, principal unit normal vector, and curvature of a vector-valued function.
10. Find partial derivatives of and apply chain rule derivative techniques to multivariable functions.
11. Find iterated integrals, double integrals over regions, and double integrals in polar coordinates.
12. Evaluate triple integrals in polar, spherical, and cylindrical coordinates.
13. Use Green's Theorem and the principle of path independence to evaluate line integrals within conservative vector fields.
14. Interpret derivatives of vector valued functions as velocity and acceleration functions.
15. Find the equations of planes tangent to surfaces and total differentials of functions of several variables.
16. Use multiple integration to solve problems involving volume, surface area, and center of mass.

OFFICIAL COURSE OUTLINE (Approved Fall 2017)

I. Vectors and Geometry in R^2 and R^3
   - A. Three-Dimensional Coordinate System
   - B. Vectors
   - C. The Dot and Cross Products
   - D. Equations of Lines and Planes
   - E. Surfaces in R^3

II. Parametric Equations in R^3
   - A. Curves Defined by Parametric Equations
   - B. Tangents and Area
   - C. Arc Length

III. Vector-Valued Functions
   - A. Vector Functions and Space Curves
   - B. Derivatives and Integrals of Vector Functions
   - C. Arc Length and Curvature
   - D. Velocity and Acceleration

IV. Partial Derivatives
   - A. Functions of Several Variables
   - B. Limits and Continuity
   - C. Partial Derivatives
   - D. Tangent Planes and the Total Differential
   - E. The Chain Rules
   - F. Directional Derivatives and Gradient Vectors
   - G. Extrema

H. Lagrange Multipliers

V. Multiple Integration
- A. Double Integrals over Rectangles
- B. Iterated Integrals
- C. Introduction to Polar Coordinates
- D. Double Integrals in Polar Coordinates
- E. Applications of Double Integrals
- F. Triple Integrals
- G. Introduction to Cylindrical and Spherical Coordinates
- H. Triple Integrals in Cylindrical and Spherical Coordinates

VI. Vector Calculus
- A. Vector Fields
- B. Line Integrals and the Fundamental Theorem
- C. Green's Theorem
- D. Curl and Divergence

GENERAL EDUCATION COMPETENCIES

A. Knowledge of human cultures and the physical and natural worlds through study in the sciences and mathematics, social sciences, humanities, histories, languages, and the arts.

B. Intellectual and practical skills, including
- inquiry and analysis
- critical and creative thinking
- written and oral communication
- quantitative literacy
- information literacy
- teamwork and problem solving

C. Personal and social responsibility, including
- civic knowledge and engagement (local and global)
- intercultural knowledge and competence
- ethical reasoning and action
- foundations and skills for lifelong learning

D. Integrative and applied learning, including synthesis and advanced accomplishment across general and specialized skills.

STUDENT LEARNING OUTCOMES FOR QUANTITATIVE REASONING (Approved Fall 2017)

In MA 213, students will learn to:

1. Interpret information presented in mathematical and/or statistical forms by (Gen Ed Comp B):
   - Performing the operations of addition, subtraction, dot product, and cross product on vectors.
   - Finding directional derivatives and the gradient of functions of several variables.
   - Finding relative extrema of functions of several variables.
   - Evaluating line integrals within vector fields.
2. Illustrate and communicate mathematical and/or statistical information symbolically, visually, and/or numerically by (Gen Ed Comp A, B, C):
   - Identifying various surfaces, including quadric surfaces, by their equations and their graphs.
   - Determining the equations of lines and planes and find distances in space.
3. Determine when computations are needed and execute the appropriate computations by (Gen Ed Comp A, B):
   - Finding derivatives and integrals of vector valued functions and tangent lines to space curves.
   - Determining the arc length, unit tangent vector, principal unit normal vector, and curvature of a vector-valued function.
   - Finding partial derivatives of and apply chain rule derivative techniques to multivariable functions.
   - Finding iterated integrals, double integrals over regions, and double integrals in polar coordinates.
   - Evaluating triple integrals in polar, spherical, and cylindrical coordinates.

- Using Green's Theorem and the principle of path independence to evaluate line integrals within conservative vector fields.

4. Apply an appropriate model to the problem to be solved by (Gen Ed Comp A, B, C):
   - Interpreting derivatives of vector valued functions as velocity and acceleration functions.
   - Finding the equations of planes tangent to surfaces and total differentials of functions of several variables.
5. Make inferences, evaluate assumptions, and assess limitations in estimation modeling and/or statistical analysis by (Gen Ed Comp A, D):
   - Using multiple integration to solve problems involving volume, surface area, and center of mass.