

University Studies Course Approval Proposal

Flag Requirements – Mathematics/Statistics Flag

The Department of Mathematics and Statistics proposes the following course for inclusion in University Studies as a course satisfying the requirements for a Mathematics/Statistics Flag. This was approved by the full department on Thursday, February 1, 2001.

Course: Multivariable Calculus (MATH 260), 4 s.h.

Catalog Description: A continuation of MATH 165. Partial differentiation and multiple integration are studied. *Prerequisite:* MATH 165.

This is an existing course, previously approved by A2C2.

Department Contact Person for this Course:

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General Discussion of University Studies – the Mathematics/Statistics Flag in relation to MATH 260

University Studies: Mathematics/Statistics Flag

Flagged courses will normally be in the student's major or minor program. Departments will need to demonstrate to the University Studies Subcommittee that the courses in question merit the flags. All flagged courses must require the relevant basic skills course(s) as prerequisites (e.g., the "College Reading and Writing" Basic Skill course is a prerequisite for Writing Flag courses), although departments and programs may require additional prerequisites for flagged courses. The University Studies Subcommittee recognizes that it cannot veto department designation of flagged courses.

The purpose of the Mathematics/Statistics Flag course requirement is to reinforce the outcomes specified for the basic skills area of mathematics/statistics. These courses are intended to provide students with significant practice in applying prerequisite mathematical or statistical knowledge.

Courses can merit the Mathematics/Statistics Flag if students will be required to make essential use throughout the semester of mathematical or statistical models appropriate to their prerequisite knowledge of those areas, and if the correct use of techniques based on such models will comprise a significant portion of a student's final grade. It is understood that mere rote computations, algebraic manipulations, or graphical design without inferential content would not merit a Mathematics/Statistics Flag.

These courses must include requirements and learning activities that promote students' abilities to:

- a. practice the correct application of mathematical or statistical models that are appropriate to their prerequisite knowledge of those areas; and**

At the very foundation of all higher level mathematics are the concepts explored in the first two courses of a three part calculus sequence. Multivariable calculus extends these results to higher dimensions, and introduces such concepts as vectors, gradients, line integrals, etc., which are absolutely essential to modeling any phenomena involving change in more than one dimension. Relevant models are examined as the concepts of multivariable calculus are introduced. The successful student must demonstrate an ability to apply the concepts introduced in multivariable calculus by accurately analyzing modeling problems involving those concepts.

- b. make proper use of modern mathematical or statistical methods appropriate to their level of prerequisite knowledge, to include, if statistics is used in a substantive way, the use of a statistical package with graphics capability when appropriate.**

The successful student will employ the use of computational and graphical aids (e.g. Mathematica, Matlab, TI-89, MathCad, and Derive) along with several modern qualitative, algebraic, and numerical methods to analyze models involving multivariable calculus.

Winona State University
Department of Mathematics and Statistics
Course Outline—M260¹

Course Title: Multivariable Calculus

Number of Credits: 4 s.h.

Prerequisite: MATH 165

Grading: Grade only for all majors, minors, options, concentrations and licensures within the Department of Mathematics and Statistics. The P/NC option is available to others.

Course Applies To: MTED Secondary Major, required.

Course Description: A continuation of MATH 165. Partial differentiation and multiple integration are studied. *Prerequisite:* MATH 165

Statement of Major Focus and Objectives of the Course: The major focus of this course is to provide students with:

- an understanding of how calculus of functions of one variable can be extended to handle higher dimensional situations, and
- an understanding of how vector methods can be used along with the concepts of calculus to handle in great generality problems of motion and flow.

Minnesota Standards of Effective Teaching Practice for Beginning Teachers: Note that a focus of the course will be to prepare students to develop the competencies outlined in the following Minnesota Standards of Effective Teaching Practice for Beginning Teachers.

Standard 1 -- Subject Matter Objectives: To develop within the future teacher:

- the ability to use a problem-solving approach to investigate and understand mathematical content,
- the ability to formulate and solve problems from both mathematical and everyday situations,
- the ability to communicate mathematical ideas in writing, using everyday and mathematical language, including symbols,
- the ability to communicate mathematical ideas orally, using both everyday and mathematical language,
- the ability to make and evaluate mathematical conjectures and arguments and validate their own mathematical thinking,
- an understanding of the interrelationships within mathematics,
- the ability to connect mathematics to other disciplines and real-world situations,
- an understanding of and the ability to apply numerical computational and estimation techniques and the ability to extend them to algebraic expressions,
- the ability to use geometric concepts and relationships to describe and model mathematical ideas and real-world constructs,
- the ability to use algebra to describe patterns, relations and functions and to model and solve problems,

¹ Prepared by Barry A. Peratt on February 9, 2001. Last revision of this outline was done in Spring of 1998.

- a firm conceptual grasp of limit, continuity, differentiation and integration, and a thorough background in the techniques and application of calculus,
- the ability to use mathematical modeling to solve problems from fields such as natural sciences, social sciences, business and engineering,
- the ability to use calculators in computational and problem-solving situations, and
- the ability to use computer software to explore and solve mathematical problems.

Possible Texts: *Calculus: Single and Multivariate, 2nd Edition* by Hughes-Hallet et. al.

List of References and Bibliography:

- *Calculus, 9th Edition* by Thomas & Finney.
- *Calculus in Context* by Callahan & Hoffman.
- *The Calculus 7* by Leithold.

Methods of Instruction: Lecture, Discussion, Question/Answer Sessions, Calculators/Computers, Student Groups.

Evaluation Process: Exams, Quizzes, Final Exam, Graded Projects.

University Studies: *Mathematics/Statistics Flag*

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These courses must include requirements and learning activities that promote students' abilities to:

- a. practice the correct application of mathematical or statistical models that are appropriate to their prerequisite knowledge of those areas; and
- b. make proper use of modern mathematical or statistical methods appropriate to their level of prerequisite knowledge, to include, if statistics is used in a substantive way, the use of a statistical package with graphics capability when appropriate.

Topics below which include such requirements and learning activities are indicated below using lowercase, boldface letters **a.-b.** corresponding to these requirements.

Course Outline of the Major Topics and Subtopics:

- Differentiation
 - Second-Order Partial Derivatives **a.-b.**
 - Taylor Approximations **a.-b.**
- Optimization
 - Local Extrema **a.-b.**
 - Unconstrained Optimization **a.-b.**
 - Constrained Optimization and LaGrange Multipliers **a.-b.**
- Integration
 - Definite Integrals in Higher Dimensions **a.-b.**
 - Iterated Integrals **a.-b.**
 - Triple Integrals **a.-b.**
 - Double Integrals in Polar Coordinates **a.-b.**
 - Integrals in Cylindrical and Spherical Coordinates **a.-b.**
- Other Topics
 - Parameterized Curves (Motion, Velocity, and Acceleration) **a.-b.**
 - Vector Fields and Flows **a.-b.**
 - Line Integrals and Green's Theorem **a.-b.**
 - Flux Integrals **a.-b.**
 - Divergence Theorem, Curl, and Stoke's Theorem **a.-b.**

Approval/Disapproval Recommendations

Department Recommendation: Approved ____ Disapproved ____ Date ____

Chairperson Signature _____ Date _____

Dean's Recommendation: Approved ____ Disapproved ____ Date ____

Dean's Signature _____ Date _____

*In the case of a Dean's recommendation to disapprove a proposal, a written rationale for the recommendation to disapprove shall be provided to USS.

USS Recommendation: Approved ____ Disapproved ____ Date ____

University Studies Director's Signature _____ Date _____

A2C2 Recommendation: Approved ____ Disapproved ____ Date ____

A2C2 Chairperson Signature _____ Date _____

Faculty Senate Recommendation: Approved ____ Disapproved ____ Date ____

FA President's Signature _____ Date _____

Academic VP's Recommendation: Approved ____ Disapproved ____ Date ____

VP's Signature _____ Date _____

President's Decision: Approved ____ Disapproved ____ Date ____

President's Signature _____ Date _____