CURRICULUM PROPOSAL COVER SHEET
University-Wide Undergraduate Curriculum Committee

LSC Use Only	
Number	LS 53
Action	A
Date	2-2-89

UWUCC Use Only	
Number	
Action	
Date	

I. TITLE/AUTHOR OF CHANGE
COURSE/PROGRAM TITLE MA 127- Calculus I
DEPARTMENT MATHEMATICS
CONTACT PERSON JOHN BROUGHTON

II. THIS COURSE IS BEING PROPOSED FOR:
____ Course Approval Only
____ Course Approval and Liberal Studies Approval
✓ Liberal Studies Approval only (course previously has been approved by the University Senate)

III. APPROVALS

Ronald L McBride
Department Curriculum Committee

John Broughton
Department Chairperson

College Curriculum Committee

College Dean*

Director of Liberal Studies
(where applicable)

Provost
(where applicable)

*College Dean must consult with Provost before approving curriculum changes. Approval by College Dean indicates that the proposed change is consistent with long range planning documents, that all requests for resources made as part of the proposal can be met, and that the proposal has the support of the university administration.

IV. TIMETABLE

Date Submitted to LSC _____ to UWUCC _____

Semester/Year to be implemented _____

Date to be published in Catalog _____

Revised 5/88

[Attach remaining parts of proposal to this form.]

LIBERAL STUDIES COURSE APPROVAL FORM

About this form: Use this form only if you wish to have a course included for Liberal Studies credit. The form is intended to assist you in developing your course to meet the university's Criteria for Liberal Studies, and to arrange your proposal in a standard order for consideration by the LSC and the UWUCC. If you have questions, contact the Liberal Studies Office, 353 Sutton Hall; telephone, 357-5715.

Do not use this form for technical, professional, or pre-professional courses or for remedial courses, none of which is eligible for Liberal Studies. **Do not** use this form for sections of the synthesis course or for writing-intensive sections; different forms will be available for those.

PART I. BASIC INFORMATION

A. For which category(ies) are you proposing the course? Check all that apply.

LEARNING SKILLS

_____ First English Composition Course
_____ Second English Composition Course
__✓__ Mathematics

KNOWLEDGE AREAS

_____ Humanities: History
_____ Humanities: Philosophy/Religious Studies
_____ Humanities: Literature
_____ Fine Arts
_____ Natural Sciences: Laboratory Course
__✓__ Natural Sciences: Non-laboratory Course
_____ Social Sciences
_____ Health and Wellness
_____ Non-Western Cultures
_____ Liberal Studies Elective

B. Are you requesting regular or provisional approval for this course?

__✓__ **Regular** _____ **Provisional** (limitations apply, see instructions)

N/W course

C. During the transition from General Education to Liberal Studies, should this course be listed as an approved substitute for a current General Education course, thus allowing it to meet any remaining General Education needs? __✓__ **yes** _____ **no**

If so, which General Education course(s)? _____

PART II. WHICH LIBERAL STUDIES GOALS WILL YOUR COURSE MEET? Check all that apply and attach an explanation.

All Liberal Studies courses must contribute to at least one of these goals; most will meet more than one. As you check them off, please indicate whether you consider them to be primary or secondary goals of the course. [For example, a history course might assume "historical consciousness" and "acquiring a body of knowledge" as its primary goals, but it might also enhance inquiry skills or literacy or library skills.] Keep in mind that no single course is expected to shoulder all by itself the responsibility for meeting these goals; our work is supported and enhanced by that of our colleagues teaching other courses.

	Primary	Secondary
A. Intellectual Skills and Modes of Thinking:		
1. Inquiry, abstract logical thinking, critical analysis, synthesis, decision making, and other aspects of the critical process.	✓	
2. Literacy--writing, reading, speaking, listening		✓
3. Understanding numerical data	✓	
4. Historical consciousness		✓
5. Scientific inquiry	✓	
6. Values (ethical mode of thinking or application of ethical perception)		✓
7. Aesthetic mode of thinking	✓	
B. Acquiring a Body of Knowledge or Understanding Essential to an Educated Person	✓	
C. Understanding the Physical Nature of Human Beings		
D. Certain Collateral Skills:		
1. Use of the library		✓
2. Use of computing technology		✓

ADDENDUM TO LIBERAL STUDIES PROPOSALS: PART II

The Liberal Studies Goals met by the Calculus Courses MA 121, MA 122, MA 123, MA 124, and MA 127 are:

A. Intellectual Skills and Modes of Thinking:

1. Inquiry, abstract logical thinking, critical analysis, synthesis, decision making, and other aspects of the critical process is a primary goal of the course. It is apparent that the study of Mathematics requires that the student learn to apply the pattern of using these categories to collect data, clearly state the problem under study, apply the methods known to affect a solution to the problem, and then to analyze and interpret the resulting solution.
2. Literacy-writing, reading, speaking, listening, is a secondary goal of this course. All of these areas can be applied and improved during a course of study in mathematics. Reading skills are absolutely necessary for a clear understanding of the material; the writing of solutions to mathematical problems requires clarity of mind and organization of thought; the requirement of discussing mathematics in the classroom shows the student the importance of clear patterns of thinking and of the expression of those thoughts orally; and listening skills are very important in the understanding of mathematics. These skills can be improved through the writing of tests and of assigned papers, through the oral response to classroom questions, and through the reading of assignments.
3. Understanding numerical data is a primary goal of this course. No data is meaningful without interpretation and the study of mathematics attempts to train the student in the methods and skills needed to interpret data correctly.
4. Historical consciousness is a secondary goal. Students should have some awareness of the historical significance of the role of mathematics in the development of western and other civilizations and its importance in contemporary technological times.
5. Scientific inquiry is a secondary goal. Students should be made aware of the importance of mathematical logic and the role it plays in scientific inquiry and problem solving techniques used throughout science. In addition, students should be made aware that mathematics is the language of science and discovery.
6. Aesthetic mode of thinking is a secondary goal. Mathematics to mathematicians and other users is a beautiful art form for communication. An effort should be made to develop in the student a sense of this beauty and an appreciation for its power and utility.

B. Acquiring a Body of Knowledge or Understanding Essential to an Educated Person:

Secondary Goal

Although specific mastery of mathematics is not required of all students, it is important that all students taking mathematics in any

form develop a sense of the importance of mathematics to society. In addition, the course of study should develop in the student a feeling of confidence in their own ability to use the mathematical skills that have been learned in their particular mathematics course.

D. Certain Collateral Skills:

2. Use of computing technology is a secondary goal. Students need to be aware of the technology available in computing whether that technology be computers or calculators and, where possible, exposed to such even if only briefly.

PART III. DOES YOUR COURSE MEET THE GENERAL CRITERIA FOR LIBERAL STUDIES? Please attach answers to these questions.

A. If this is a multiple-section, multiple-instructor course, there should be a basic equivalency (though not necessarily uniformity) among the sections in such things as objectives, content, assignments, and evaluation. Note: this should not be interpreted to mean that all professors must make the same assignments or teach the same way; departments are encouraged to develop their courses to allow the flexibility which contributes to imaginative, committed teaching and capitalizes on the streangths of individual faculty.

What are the strategies that your department will use to assure that basic equivalency exists? Examples might be the establishment of departmental guidelines, assignment of repsonsibility to a coordinating committee, exchange and discussion of individual instructor syllabi, periodic meetings among instructors, etc.

B. Liberal Studies courses must include the perspectives and contributions of ethnic and racial minorities and of women wherever appropriate to the subject matter. **If your attached syllabus does not make explicit that the course meets this criterion, please append an explanation of how it will.**

C. Liberal Studies courses must require the reading and use by students of at least one, but preferably more, substantial works of fiction or nonfiction (as distinguished from textbooks, anthologies, workbooks, or manuals). **Your attached syllabus must make explicit that the course meets this criterion.**

[The only exception is for courses whose primary purpose is the development of higher level quantitative skills; such courses are encouraged to include such reading, but are not expected to do so at the expense of other course objectives. **If you are exercising this exception, please justify here.**]

D. If this is an introductory course intended for a general student audience, it should be designed to reflect the reality that it may well be the only formal college instruction these students will have in that discipline, instead of being designed as the first course in a major sequence. That is, it should introduce the discipline to students rather than introduce students into the discipline. **If this is such an introductory course, how is it different from what is provided for beginning majors?**

PART III (MA 127)

A. There will be a common syllabi of topics that should be covered by each of the individual instructors teaching this course. Such common syllabi should include but not be limited to topics which introduce the student to deductive reasoning, develop in the student problem solving skills, and enable the student not only to understand the underlying principles of formulae but also to have the ability to use and interpret numerical data.

B. Whenever appropriate, information will be introduced into the classroom discussion which will reflect the contributions made to mathematics by women and by racial minorities.

C. All students will be required to read a minimum of two of three specified essays designated for MA 127, and to submit a written report on each essay for evaluation. The Liberal Arts Curriculum Committee of the Mathematics Department will be responsible for maintaining a minimum reading list for this course. Instructors will be encouraged to create expanded reading lists of appropriate magazine/journal/etc. articles pertinent to the mathematics material discussed in this course. Additionally, instructors could require the students to report in writing on articles they have discovered through their own reading which pertain to mathematics and/or applications of mathematics.

D. The thrust of MA 127 is to develop in the student whose major is mathematics (or a natural science) an awareness of and an appreciation for the power and usefulness of differential calculus and its important role both in the history of mathematics and in a technological society, In particular, it should prepare the student for the further study of integral calculus (MA 128), multivariable calculus (MA227), and/or other mathematics courses. A partial list of topics that would be appropriate for this course would include real numbers, introduction to analytic geometry, and functions; limits and continuity; the derivative; topics on limits, continuity, and the derivative; additional applications of the derivative; and the differential and antidifferentiation. These topics would provide the course with a suitable mathematical strata that would improve the mathematical maturity of students to the point where they would be prepared to enroll in calculus II, MA 128, calculus III, MA 227, and/or other mathematics courses which require calculus as a prerequisite. Additionally, this course would enable the student to develop confidence in handling numerical problems, would present the student with an opportunity to develop an appreciation for mathematics, and would allow the introduction to students of hand held calculators and possibly computers.

E. #2.- The very nature of mathematical study requires that problems be clearly analyzed and defined, that solutions be generated for such problems, and that an interpretation be assigned to each possible solution in order that a correct choice may be made.

#4.- Mathematics is exactly the art of creative thinking. One moves from the collection of data to the definition of the problem to the abstract generalization in which a solution or solutions are

constructed to the interpretation of the solution or solutions to the application of the solution(s). This process requires one to recognize creativity and to engage in creative thinking.

#5.- One is constantly exposed to information which needs the principles of mathematics for proper interpretation. Skills mastered in this course can last one a life time.

ADDENDUM TO LIBERAL STUDIES PROPOSALS: PART III

B. Whenever appropriate, information will be introduced into the classroom discussion which will reflect the contributions made to mathematics by women and by minorities. Particular attention will be given to the following areas as they relate to this topic:

1. The classroom discussion will be sensitive to gender balancing with respect to language.
2. Quizzes, tests, examinations, and any other written information distributed to the students will be sensitive to gender balancing, especially in problem construction, and to minorities whenever possible.
3. Specific names and contributions made by women and other members of minority groups will be discussed in the classroom when the discussion of such is germain to the material being studied. It should be noted though that mathematics has been the domain of the male throughout history and only in recent time has there been numbers of women involved. Even today, there are too few women in the field of mathematics.

E. The Liberal Studies Criteria indicate six ways in which all courses should contribute to students' abilities. **To which of the six will your course contribute? Check all that apply and attach an explanation.**

_____ 1. Confront the major ethical issues which pertain to the subject matter; realize that although "suspended judgment" is a necessity of intellectual inquiry, one cannot live forever in suspension; and make ethical choices and take responsibility for them.

✓ 2. Define and analyze problems, frame questions, evaluate available solutions, and make choices

_____ 3. Communicate knowledge and exchange ideas by various forms of expression, in most cases writing and speaking.

✓ 4. Recognize creativity and engage in creative thinking.

✓ 5. Continue learning even after the completion of their formal education.

_____ 6. Recognize relationships between what is being studied and current issues, thoughts, institutions, and/or events.

PART IV. DOES YOUR COURSE MEET THE CRITERIA FOR THE CURRICULUM CATEGORY IN WHICH IT IS TO BE LISTED?

Each curriculum category has its own set of specific criteria in addition to those generally applicable. The LSC provides copies of these criteria arranged in a convenient, check-list format which you can mark off appropriately and include with your proposal. **The attached syllabus should indicate how your course meets each criterion you check. If it does not do so explicitly, please attach an explanation.**

CHECK LIST -- MATHEMATICS
(Learning Skills Area)

Mathematics Criteria which the Course must meet:

_____ Introduce students to deductive reasoning

_____ Develop in the student problem solving techniques appropriate for the course.

_____ Enable the student to understand the underlying principles of formulas.

_____ Enable the student to use and interpret numerical information.

Courses appropriate to the Mathematics Learning Skills Area must be either:

_____ A. Mathematics courses that develop signficant mathematical skills required by a major discipline.

_____ B. Mathematics courses designed for Liberal Studies.

Additional criteria which courses in Category B must meet:

_____ Develop the student's confidence in handling numerical problems and data.

_____ Be sensitive to the diverse background characteristics of the student.

_____ Include elements on the history or appreciation of mathematics.

_____ Introduce the hand-held calculator or the computer as a tool.

From: Jim Reber (For Mathematics/Applied Mathematics Committee)
Subject: Math Department Reading Program (SPRING 1989)

To: Don Balenovich and Mel Woodard (MA127)
Doyle McBride and Gerry Buriok (MA128)
John Steelman (MA227)
Merle Stilwell and Ron McBride (MA 171)
Woody Speakman (MA271)
John Broughton (FYI)

At the meeting on February 25,1988, the Mathematics Department approved the required reading program for all students in core courses. The reading list will be modified periodically by the Mathematics/Applied Mathematics Committee so let me know any suggestions you have on readings or on the operation of the program.

We ask that you assign the readings listed below to your students and make some provision to have them complete the assignment. For example, you can assign a reaction paper on the readings (which has the advantage of having students do a little writing) and grade this as a quiz. Some instructors have required a paper but have not graded it and you should feel free to handle the assignment as you consider appropriate.

If you have any questions or concerns about the reading program, please talk with me about them. Please let me know how the program works in your course and how students react to the program. Faculty previously involved in the program include Doyle McBride (MA271), Ron McBride (MA127,128,227), Jim Reber (MA271), Dale Shafer (MA227), Bill Smith (MA127,128,227 & 171), Woody Speakman (MA 127,128,227,171), John Steelman (MA127,128), Merle Stilwell (MA128), Mel Woodard (MA227) and you can talk with them about the readings.

The material indicated below in [...] is now on reserve in the library. Students should ask for it at the reserve desk on the main floor under my name. (Having the material cross-listed under other faculty names did not work out well previously.) If this does not work effectively let me know. I have put all material on "one day" reserve (the other choice is "3 day"). Again if this is not satisfactory, let me know.

MA127 Calculus I

Read 2 of 3 essays on the nature of Mathematics from Volume 2 of Mathematics: People/Problems/Results

Alfred Adler: Math and Creativity [5 xerox copies]
Morris Kline: The Meaning of Math [5 xerox copies]
Paul Halmos: Math as Creative Art [5 xerox copies]

MA128 Calculus II

Read either one of the following selections:

Exerpts from The Mathematical Experience by Davis and Hersh:Introduction thru Chapter 1, and Chapter 6 [3 xerox copies of exerpts; 1 library copy of book; 2 Math. Dept. copies of book]

Exerpts from How to Solve It by Polya: parts I and II and at least 10 terms from III. [4 library copies of book; 5 pb copies belonging to Math. Dept.]

MA227 Calculus III

Read either one of the following selections:

Exerpts from Infinity by Lieber: Preface and Chapters 2 thru 14. [5 xerox copies of exerpts; 2 library copies of book]

Exerpts from Bridges to Infinity by Guillen: pages 1-72 and 105-115. [5 pb copies belonging to Math. Dept.]

MA171 Introduction to Linear Algebra

Read 3 articles from Scientific American as follows:

Choose one of these articles: "Linear Programming", Aug. 1954 or "The Allocation of Resources by Linear Programming", June 1981. [5 xerox copies of each article]

Choose one of these articles: "Input-Output Economics", Oct. 1951; " The Structure of U.S. Economy", April 1965; or "The World Economy by the Year 2000", Sept. 1980. [5 xerox copies of each article]

Choose one article from the "Mathematics and Modern World" issue of September 1964. ("Math in Social Sciences" is most relevant to MA171) [4 xerox copies of each article]

Note: Bill Smith has a set of these articles if you would like to review them before assigning them.

MA271 Introduction to Algebraic Structures

Choose either one of the following:

Flatland by Abbott [2 library copies; 5 pb copies belonging to Math. Dept.]

Selections from Kline's Mathematics, The Loss of Certainty ("Chapter V. The Illogical Development of a Logical Subject") and Kasner and Newmans' Mathematics and the Imagination ("Chapter VI. Paradox Lost and Paradox Regained"). [5 xerox copies of each exerpt; 1 library copy of Kline and 2 library copies of Kasner and Newman]

COURSE NUMBER: New - MA 127/128/227 Old - MA 111/113/115

COURSE TITLE: Calculus I, II, and III

CREDITS: 4 Semester Hours Each

PREREQUISITE: Permission of the Mathematics Department

CATALOG DESCRIPTION:

These courses stress the theory of the calculus as well as the application in problem solving. Topics to be included are: Calculus I--real numbers, an introduction to analytic geometry, functions, limits and continuity, derivatives and applications, the differential and antidifferentiation; Calculus II--definite integrals and applications, logarithmic and exponential functions, trigonometric and inverse trigonometric functions, polar coordinates, hyperbolic functions, indeterminate forms, improper integrals and Taylor's formula; Calculus III--vectors in the plane, parametric equations, vectors in three dimensional space, solid analytic geometry, differential calculus of functions of several variables, directional derivatives, gradients, applications of partial derivatives, infinite series. Four hours lecture per week.

COURSE OUTLINE: (Calculus I)

I. Real numbers, intro to analytic geometry, and functions

- A. Sets, real numbers, and inequalities
- B. Absolute value
- C. Number plane and graphs of equations
- D. Distance formula and midpoint formula
- E. Equations of a line
- F. The circle
- G. Functions and their graphs
- H. Function notation, operations on functions, and types of functions

II. Limits and continuity

- A. Limit of a function
- B. Theorems on limits of functions
- C. One-sided limits
- D. Infinite limits
- E. Continuity of a function at a number
- F. Theorems on continuity

III. The derivative

A. The tangent line
B. Instantaneous velocity in rectilinear motion
C. The derivative of a function
D. Differentiability and continuity
E. Some theorems on differentiation of algebraic functions
F. The derivative of a composite function
G. The derivative of the power function for rational exponents
H. Implicit differentiation
I. The derivative as a rate of change
J. Related rates
K. Derivatives of higher order

IV. Topics on limits, continuity and the derivative

A. Limits at infinity
B. Horizontal and vertical asymptotes
C. Additional theorems on limits of functions
D. Continuity on an interval
E. Maximum and minimum values of a function
F. Applications involving an absolute extremum on a closed interval
G. Rolle's theorem and the mean-value theorem

V. Additional applications of the derivative

A. Increasing and decreasing functions and the first-derivative test
B. The second-derivative test for relative extrema
C. Additional problems involving absolute extrema
D. Concavity and points of inflection
E. Applications to drawing a sketch of the graph of a function

VI. The differential and antidifferentiation

A. The differential
B. Differential formulas
C. The inverse of differentiation
D. Differential equations with variables separable
E. Antidifferentiation and rectilinear motion

COURSE OUTLINE: (Calculus II)

I. The definite integral

A. The sigma notation
B. Area
C. The definite integral
D. Properties of the definite integral
E. The mean-value theorem for integrals
F. The fundamental theorem of the calculus

II. Applications of the definite integral

A. Area of a region in a plane
B. Volume of a solid of revolution: circular-disk and circular-ring methods
C. Volume of a solid of revolution: cylindrical-shell methods
D. Volume of a solid having known parallel plane sections
E. Work
F. Liquid pressure
G. Center of mass of a rod
H. Center of mass of a plane region
I. Length of arc of a plane curve

III. Logarithmic and exponential functions

A. The natural logarithmic function
B. The graph of the natural logarithmic function
C. The inverse of a function
D. The exponential function
E. Other exponential and logarithmic functions

IV. Trigonometric functions

A. The sine and cosine functions
B. The derivatives of the sine and cosine functions
C. Integrals involving powers of sine and cosine
D. The tangent, cotangent, secant, and cosecant functions
E. An application of the tangent function to the slope of a line
F. Integrals involving the tangent, cotangent, secant, and cosecant
G. Inverse trigonometric functions
H. Derivatives of the inverse trigonometric functions
I. Integrals yielding inverse trigonometric functions

V. Techniques of integration

A. Introduction
B. Integration by parts
C. Integration by trigonometric substitution
D. Integration of rational functions by partial fractions

1. The denominator with only linear factors
2. The denominator contains quadratic factors

E. Integration of rational functions of sine and cosine
F. Miscellaneous substitutions
G. The trapezoidal rule
H. Simpson's rule

VI. Hyperbolic functions

VII. Polar coordinates

A. The polar coordinate system
B. Graphs of equations in polar coordinates
C. Intersection of graphs in polar coordinates
D. Tangent lines of polar curves
E. Area of a region in polar coordinates

VIII. Indeterminate forms, improper integrals, and Taylor's formula

A. The indeterminate form
B. Other indeterminate forms
C. Improper integrals with infinite limits of integration
D. Other improper integrals
E. Taylor's formula

COURSE OUTLINE: (Calculus III)

I. Vectors in the Plane and Parametric Equations

A. Vectors in the plane
B. Properties of vector addition and scalar multiplication
C. Dot product
D. Vector-valued functions and parametric equations
E. Calculus of vector-valued functions
F. Length of arc
G. Plane motion
H. The unit tangent and unit normal vectors and arc length as a parameter
I. Curvature
J. Tangential and normal components of acceleration

II. Vectors in three-dimensional space and solid analytic geometry

A. R^3, the three-dimensional number space
B. Vectors in three-dimensional space
C. The dot product in V_3
D. Planes
E. Lines in R^3
F. Cross product
G. Cylinders and surfaces of revolution
H. Quadric surfaces
I. Curves in R^3
J. Cylindrical and spherical coordinates

III. Differential calculus of functions of several variables

A. Functions of more than one variable
B. Limits of functions of more than one variable
C. Continuity of functions of more than one variable
D. Partial derivatives
E. Differentiability and the total differential
F. The chain rule
G. Higher-order partial derivatives

IV. Directional derivatives, gradients, applications of partial derivatives, and line integrals

A. Directional derivatives and gradients
B. Tangent planes and normals to surfaces
C. Extrema of functions of two variables
D. Obtaining a function from its gradient
E. Line integrals
F. Line integrals independent of the path

V. Multiple integration

A. The double integral
B. Evaluation of double integrals and iterated integrals
C. Center of mass and moments of inertia
D. The double integral in polar coordinates
E. Area of a surface
F. The triple integral
G. The triple integral in cylindrical and spherical coordinates

VI. Infinite series

A. Sequences
B. Monotonic and bounded sequences
C. Infinite series of constant terms
D. Infinite series of positive terms
E. The integral test
F. Infinite series of positive and negative terms
G. Power series
H. Differentiation of power series
I. Integration of power series
J. Taylor series
K. The binomial series

ADDENDUM TO THE SYLLABI FOR THE COURSES MA 121, MA 122, MA 123, MA 124, AND MA 127

Course Objectives for the Calculus Courses MA 121, MA 122, MA 123, MA 124, and MA 127:

I. General Objectives:

A. Students will develop an appreciation for the nature, the breadth, and the power of mathematics and for its role in a technological society.
B. Students will develop an understanding for Mathematical Logic and will use that understanding as a basis for the improvement of their logical thinking.
C. Students will develop computational skills using the techniques studied in class.
D. Students will learn to communicate in the language of mathematics. This learning will involve reading, writing, listening, and speaking.
E. Students will develop the skill of applying the information learned in the classroom to the solution of problems. Such solutions will involve both the application of computation skills and theoretical (thinking) skills.
F. Students will learn to appreciate the meaningful role played by mathematics in both the development of our society and the scientific discoveries of contemporary times.

II. Some Specific Course Objectives:

A. Students will be able to understand and apply the concept of limits and of continuity.
B. Students will be able to apply the concept of limit to develop the derivative operation.
C. Students will develop and apply the rules for differentiation.
D. Students will be able to use the derivative to graph certain functions.
E. Students will be able to solve related rate word problems using the concept of the derivative.
F. Students will be able to understand and apply the concept of integration and the definite integral.
G. Students will study methods for the differentiation and integration of inverse, logarithmic, exponential, and trigonometric functions.
H. Students will study the application of other techniques of integration for more difficult functions.
I. Students will study the extension of the principles of calculus to multivariable functions.
J. Students will apply the principles of calculus to the study of infinite sequences and series and conditions for convergence for each.
K. Students will use the principles of calculus to solve certain elementary differential equations.
L. Students will apply calculus to certain specialized areas such as hyperbolic functions, polar coordinates, and

indeterminate forms and improper integrals.

M. Students will study the application of calculus to the 3-dimensional space of analytic geometry.

N. Students will understand vectors in 3-dimensional space and their related calculus properties.

O. Students will study the differentiation and integration of functions of several variables and will be able to intepret the results of these operations geometrically.