☒ Undergraduate

Prepared By: William Cherry
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REQUEST FOR

ADDITION OF COURSE TO
CORE CURRICULUM

College/School: Arts & Sciences
Department: Mathematics

Subject Prefix: MATH Course Number: 1710 Semester Credit Hours: 4

TCCNS Number (if applicable) MATH 2413 (common course number)

Hours Per Week: 4 Lecture; ___ Lab; ___ Recitation; ___ Other

Title Calculus I
Short Course Title : ______ (maximum 22 characters including spaces)

Category of Core Curriculum course is to be added: Mathematics

Catalog Description:

Limits and continuity, derivatives and integrals; differentiation and integration of polynomial, rational, trigonometric, and algebraic functions; applications, including slope, velocity, extrema, area, volume and work.

Prerequisite(s):

MATH 1650; or both MATH 1600and MATH 1610.

If course is cross-listed, indicate below:
Department: ______ Subject Prefix/Course Number: ______
Department: ______ Subject Prefix/Course Number: ______

Justification for course to be added to Core Curriculum (Include how course would satisfy each exemplary objective.):

Exemplary Educational Objectives

1. To apply arithmetic, algebraic, geometric, higher-order thinking, and statistical methods to modeling and solving real-world situations.

The "higher-oder" concept of the limits are used to model rates of change, such as instantaneous velocity, acceleration, and other rates common in the sciences and engineering. Limits are looked at from arithmetic, algebraic, and geometric viewpoints. Rates are visualized geometrically as slopes of tangent lines. Distance travelled and population are modelled geometrically as the area under a rate curve or population density function. The concept of probability density makes the connection between calculus and statistical methods. The unit on applied optimization problems allows students to use a variety of algebraic functions to model real-world situations, and optimal solutions are found by either graphical or algebraic means. Students are taught to use integrals to represent work done or hydrostatic pressure, and how to use them to calculate these quantities.

2. To represent and evaluate basic mathematical information verbally, numerically, graphically, and symbolically.

The course concentrates on the fundamental ideas of limits, derivatives, and integrals. Limits are explored numerically by plugging in numbers and seeing what happens, they are explored graphically, with the assitance of a graphing calculator, students describe the meanings of limits verbally, and they learn a number of symbolic rules for working with limits. Derivatives are explored numerically by looking at average rates of change over small time intervals, they are discussed verbally in the context of related rates and associated applications, they are explored graphically as the slope of a tangent line, and again, students learn a number of symbolic techniques for calculating derivatives. Integrals are explored numerically, as Riemann sums, they are explored verbally in the context of computing work done or hydrostatic pressure, they are visualized graphically as areas under curves, and students learn various symbolic techniques, such as substitution, to work with integrals.

3. To use appropriate technology to enhance mathematical thinking and understanding and to solve mathematical problems and judge the reasonableness of the results.

Graphing calculators are integrated into the course. The calculators are used as a graphing tool so students can get a good intuitive feel for how the graphs of different types of functions looks and how changing parameters affects the shape of the graph. The "zoom" feature of the calculator helps students to visualize the fundamental concepts of limit and derivative. The tabular features on the calculator help the students look at numerical results in a less tedious fashion, and let them do numerical exploration of limits, derivatives, and integrals. Students work with examples where using a tangent line approximation gives reasonable results over the short-term, but gives unreasonable results further out.

4. To interpret mathematical models such as formulas, graphs, tables and schematics, and draw inferences from them.

In the study of related rates, students learn the practical meaning of derivatives and associated mathematical notation in a real-world context, for example, a melting snowball, a growing pile of sand, and expanding air balloon, etc. They learn to make inferences about optimal solutions to problems in business, science, and engineering by making a careful analysis of a graph.

<u>Over-arching Objectives</u>

1. explore math

During the course, students explore two instances, the derivative and the integral, of a profound and fundamental concept in modern mathematics, the limit. Derivatives and integrals are explored from many different directions and in numerous different contexts.

2. make connections between different areas of knowledge and different ways of knowing

Students learn connections between abstract mathematical theory and its implications in science, engineering, and business. They experience "knowing" a function from different perspectives: symbolic (or algebraic), numerically, graphically (or geometrically), and verbally.

3. be able to locate, evaluate and organize information including the use of information technologies

To develop a mathematical model, students need to extract essential information from the description of the problem or the given data. That information must then be organized into an abstract mathematical model or formula, which can then be evaluated, often with the assistance of a graphing calculator.

4. think critically and creatively, learning to apply different systems of analysis

Mathematical problems are analyzed symbolically, graphically, numerically, and verbally. The more challenging problems in the course require critical and creative thinking to re-arrange the data given into a more familiar form so that one of the standard methods taught in the course may be applied more directly. The conceptual exploration of limits and infinite sums requires critical and creative thought and can lead to discussions of some "paradoxes."

5. develop problem solving skills

Problem solving skills are developed throughout the course. Students are taught to systematically indentify information given to them and to organize it into a coherent mathematical model. They are asked to identify the assumptions underlying the problem. Students get practice in assigning mathematical variables in such a way as to ue fundamental ideas in calculus to create tractable algebra problems. After employing algebra to find a mathematical solution, they interpret the meaning of that solution to the original situation.

6. cultivate self-responsibility, building a foundation for life-long learning

Throughout the course, students reinforce their familiarity with technical mathematical terminology and symbolism. They also develop technical proficiency with symbolic calculation rules for derivatives and integrals, techniques they will need throughout their science, engineering of business courses. Students are responsible for reading the textbook and learning some of the material in the course on their own, they are responsible for completing their assignments in a timely manner, and they are responsible for seeking out help and assistance outside of class. All of these activities will leave them well-prepared to continue learning mathematics on their own outside of a formal mathematics class, and to apply mathematics during their other courses while still a student and in their careers later in life.

Consultation with University Curriculum Assessment Committee member:
Department: Mathematics Contact: William Cherry Date: 04/19/2009

New Core Curriculum Requests must include:
Syllabus: ☒ Maximum 4-page syllabus attached
Assessment: ☒ Consultation w/University Curriculum Assessment Committee member in this core component group.
☒ Assessment procedures (criteria to be used in assessing this course) must be attached separately

APPROVED:

Department Chair: J. Matthew Douglass Date: 4/24/09
College/School Curriculum Committee Chair: B Schraahe Date: 5/7/09
Dean of College/School: B Schraahe Date: 5/7/09
Core Oversight Committee Chair: ______ Date: ______
University Curriculum Committee (VPAA): ______ Date: ______

Math 1710 (Calculus I) Core Assessment Plan

Mathematics Department Core Assessment Plan

The Mathematics Department will assess core courses using a combination of questions on final exams targeted toward individual exemplary educational objectives and over-arching objectives and examination of project portfolios. The Department's Undergraduate Affairs Committee will review the assessment data for each of the department's core courses on a rotating basis. The Department's courses will grouped into four groups, according to target audience: Group I will include courses intended for general university students: Math 1580/1581 and Math 1680/1681; Group II will include courses intended primarily for business students: Math 1190 and Math 1400; Group III will include courses intended primarily for math, science, and engineering students: Math 1600, Math 1610, Math 1650, Math 1710; and Group IV will include courses intended for elementary education majors: math 1350 and Math 1351. The Undergraduate Affairs committee will review the assessment data for one group of courses each academic year and make recommendations about how the courses and the assessment process can be improved.

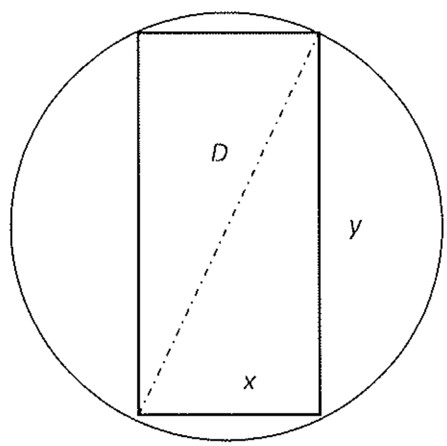
Targeted Questions on Final Exams

The exemplary educational objectives and most of the over-arching objectives will be assessed by targeted questions on the final exam. The Mathematics department will create a database of final exam questions that specifically target the objectives (examples given below) and all instructors will be required to include a certain number of questions on their final exams from this question database. Instructors will record and report the number of students getting these individual questions correct. The department will keep these statistics for review by the department's Undergraduate Affairs Committee. Not all objectives will be assessed in every section during every semester, but a rotation schedule will be set-up so that every objective is assessed periodically.

Examples of possible final exam questions targeting Exemplary Educational Objectives

1. To apply arithmetic, algebraic, geometric, higher-order thinking, and statistical methods to modeling and solving real-world situations.

A rectangular wooden beam is to be cut from a circular log. The strength of the beam S will be proportional to the width x of the beam times the square of the depth of the beam y. The following geometric figure shows how the beam will be cut from a log of diameter D:



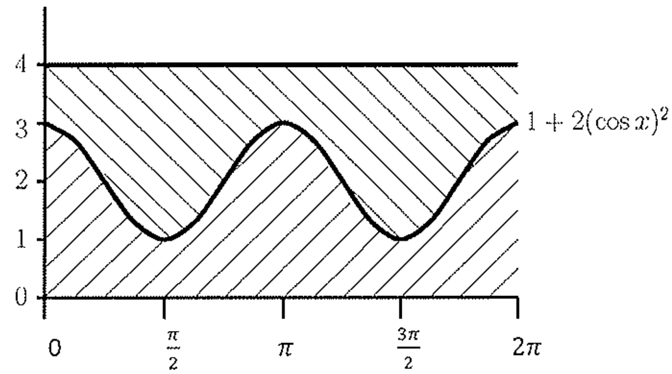
a) Express the strength of the beam S algebraically as a function of its width x. Think of the diameter D as constant.
b) Calculate dS/dx algebraically and determine over which physically relevant intervals S is increasing and S is decreasing.
c) Using the above, sketch a graph of S as a function of x, highlighting the optimal width x that produces the strongest beam.
d) How much stronger is the optimally cut beam than a beam cut with square cross section?

2. To represent and evaluate basic mathematical information verbally, numerically, graphically, and symbolically.

In this problem we will compute $\int_0^{2\pi}[1+2(\cos x)^2]dx$ three different ways: numerically, symbolically, and graphically.

a) (numerically) Use a rectangle sum with 8 rectangles to find a numerical approximation to the integral.
b) (symbolically) Let $F(x) = 2x + (\sin x)(\cos x)$. Use differentiation rules and the trigonometric identity: $\sin^2 x + \cos^2 x = 1$ to verify that $F'(x) = 1 + 2(\cos x)^2$. Then, use the Fundamental Theorem of Calculus to evaluate $\int_0^{2\pi}[1+2(\cos x)^2]dx$ exactly.

c) (graphically) Carefully explain in complete sentences how you could use the picture below to guess the exact value of $\int_0^{2\pi}[1+2(\cos x)^2]dx$, even if you did not know the function $F(x)$ in part (b).



3. To use appropriate technology to enhance mathematical thinking and understanding and to solve mathematical problems and judge the reasonableness of the results.

A calculus class is asked to find the tangent line to the graph of $y=x^x$ at the point x=2.

Mary makes the following table:

h	$f(2+h)=(2+h)^{(2+h)}$	$f(2)=2^2$	$\frac{f(2+h)-f(2)}{h}$
0.1	4.7496	4	7.4964
0.01	4.0684	4	6.8404
0.001	4.0068	4	6.7793

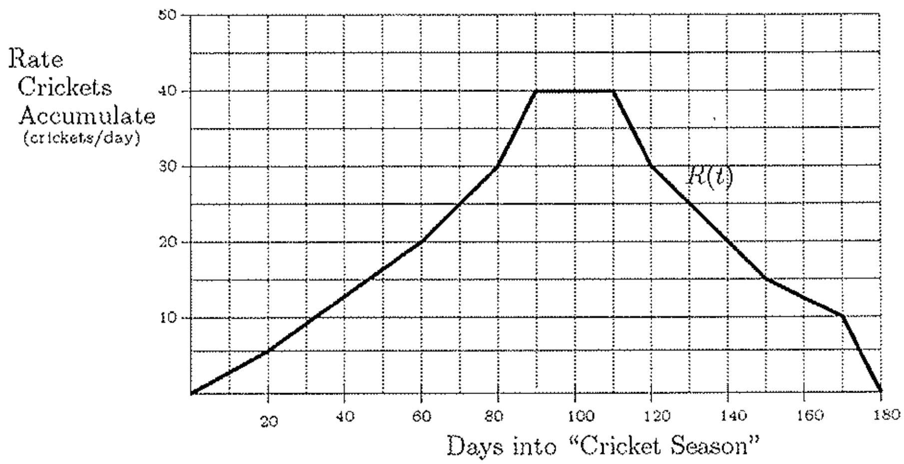
and concludes that $f'(2)\approx 6.8$ and so she says the requested tangent line is approximately: $y=4+6.8(x-2)$.

Tony, on the other hand, decides to work symbolically and using the power rule, he decides that $f'(x)=x\cdot x^{x-1}$ and so $f'(2)=2\cdot 2^1=4$, and so Tony says the requested tangent line must be $y=4+4(x-2)$.

Use a graphing calculator to help you decide whether Mary or Tony's tangent line looks more reasonable. Which tangent line is more reasonable?, and illustrate your answer with a sketch. If you think Tony's tangent line was more reasonable, explain the flaw in Mary's approach, or if you think that Mary's tangent line was more reasonable, explain the flaw in Tony's approach.

4. To interpret mathematical models such as formulas, graphs, tables and schematics, and draw inferences from them.

The rate $R(t)$ at which dead crickets would accumulate in William's apartment (measured in crickets per day) during cricket season if William did nothing to get rid of them is shown in the following graph:



Fortunately, William removes dead crickets from his apartment daily. William is able to remove up to 30 dead crickets from his apartment per day. Thus, until $R(t)$ exceeds 30 crickets per day, William is able to keep his apartment cricket free. Once $R(t)$ goes above 30, however, crickets start to pile up in William's apartment (and he gets very grossed out).

a) During what time period is the number of crickets in William's apartment increasing the fastest?
b) On what date did William's apartment have the most dead crickets and how many dead crickets were in his apartment that day? **Explain** in full sentences how you know.
c) On what date was William finally able to get his apartment cricket free again?

Examples of possible final exam questions targeting Over-Arching Objectives

1. explore math

Consider the family of functions $f(x) = x - k\sqrt{x}$, for $x \geq 0$ and k a positive constant.

a) Find the intercepts and critical points for f and explain how changing k affects the graph of f.
b) Show that f always has a local minimum point ¼ of the way between the two x-intercepts.

2. make connections between different areas of knowledge and different ways of knowing

In this problem you will compare two ways of filling a cylindrical water tank that is 10 feet high and has a radius of 5 feet. For this problem, assume that water weighs 62.4 lbs/ft^3

a) Compute the amount of work required to fill the tank with water if all the water is lifted to the top of the tank and then dropped into the tank.
b) Compute the amount of work required to fill the tank with water if water is pumped into the tank from the bottom, pushing any water already in the tank up higher.
c) Which of the above two ways requires less work? Explain how you could have guessed this using common sense.

3. be able to locate, evaluate and organize information including the use of information technologies

Consider the function $f(x) = \frac{(x+1)^2}{1+x^2}$.

a) Identify any asymptotes.
b) Compute $f'(x)$, find the critical points of *f*, and determine on what intervals the function $f(x)$ is increasing and decreasing.
c) Compute $f''(x)$, find the inflection points of *f*, and determine on what intervals the function $f(x)$ is concave up and concave down.
d) Putting the above information together and with the assistance of a graphing calculator, sketch a careful graph of $y = f(x)$ illustrating all important features of the graph.

4. think critically and creatively, learning to apply different systems of analysis

Find the interval [*a*,*b*] for which the value of the integral $\int_a^b (2 + x - x^2)dx$ is biggest.

5. develop problem solving skills

A high speed bullet train accelerates and decelerates at the rate of 1000 mi/hr^2 and has a maximum cruising speed of 200 mi/hr. Suppose the train starts at one station from rest and must stop at another station in 30 minutes. What is the maximum distance it can travel under these conditions?

Portfolio of Students Projects to assess "*cultivate self-responsibility, building a foundation for life-long learning"*

The department will maintain a library of projects suitable for group work. All instructors will assign one project as part of their course, although they will have flexibility in deciding what portion of the students' grades will be based on the project and whether and to what extent the project will involve group work. To complete this assignment, students will have to work on a problem that requires them to read, think, and learn about mathematics not directly discussed in class. Successful completion of the project will demonstrate that students are able to learn mathematics on their own or together with a group of their peers, thus forming a foundation for them to continue learning mathematics after they leave the university.

Some examples of projects that could go into this library are: a project that asks the students to investigate the rate of convergence of Newton's method for finding roots, an applied optimization project that requires more careful algebraic organization than the standard homework problems, or a related rates problem, such as determining how long it takes for a snowball to melt, that requires unusual insight.

The department will collect and retain a random sample of the projects completed in Math 1710 each semester. Every fourth year the Undergraduate Affairs Committee will review these portfolios and assess how well Math 1710 is cultivating self-responsibility and building a foundation for life-long learning in the students.

MATH 1710

Semester Year/Dates

COURSE/Section # MATH 1710	COURSE TITLE: Calculus I
INSTRUCTOR:	**OFFICE:** **OFFICE PHONE:**
OFFICE HOURS: Four (4) hours/wk and also by appt.	**CLASS MEETS:** Four (4) hours/wk.
EMAIL:	**WEB ACCESS:**

COURSE DESCRIPTION: 4 hours. Limits and continuity, derivatives and integrals; differentiation and integration of polynomial, rational, trigonometric, and algebraic functions; applications, including slope, velocity, extrema, area, volume and work. Satisfies the Mathematics requirement of the University Core Curriculum.

Prerequisite: Math 1650 or both Math 1600 and Math 1610.

TEXT: *Thomas' Calculus*, Media Updgrade by M. Weir, J. Hass, and F. Giordano, Addison Wesley, 2008, Chapters 2-6.

GRAPHING CALCULATOR: TI 83, TI 83Plus, TI 84 or equivalent.

MATH LAB:
Web site: www.math.unt.edu/mathlab
The UNT Math Lab is located in GAB 440
Monday - Thursday: 7 am – 9 pm
Friday: 7 am – 4 pm
Saturday: Noon – 5 pm
(Closed Sundays and holidays)

ATTENDANCE POLICY:
Class attendance is mandatory. Students are responsible for all information given in class, regardless of his/her attendance.

MAKE-UP TEST POLICY: Tests and exams must be taken in class as scheduled. Makeup exams will only be given in very exceptional circumstances, such as serious illness, and must be arranged in advance.

ACADEMIC DISHONESTY: Cheating on final exams, on in-class tests, or on quizzes is a serious breach of academic standards and will be punished severely and generally result in a student failing the course. All work done on in-class exams and quizzes must represent only the student's own work, unless otherwise stated in the directions. See http://vpaa.unt.edu/academic-integrity.htm for details on academic integrity at UNT.

EVALUATION:

Average of in-class exams	60%
Homework	15%
Final exam	25%

GRADE ASSIGNMENT:
A: [90%, 100%]; B: [80%, 90%); C: [70%, 80%); D: [60%, 70%); F: [0%, 60%), 59% is an F
The student's grade is determined by his/her performance on the evaluation criteria and the grade assignments listed above.

POLICY REGARDING INCOMPLETES: Beginning specified date, a student that qualifies may request a grade of "I", incomplete. An "I" is a non-punitive grade given only if ALL three of the following criteria are satisfied. They are: 1) The student is passing the course; 2)The student has a justifiable (and verifiable) reason why the work cannot be completed as scheduled; and 3)The student arranges with the instructor to complete the work within one academic year.

FINAL GRADE:
Final grades online access: http://www.unt.edu/grades

DISABILITY ACCOMMODATIONS:
It is the responsibility of students with certified disabilities to provide the instructor with appropriate documentation from the Dean of Students Office.

Electronic access for homework assistance is available at: www.math.unt.edu/mathlab/emathlab

Students are responsible for meeting all university deadlines (registration, fee payment, prerequisite verification, drop deadlines, etc.). See the printed Schedule of Classes and/or University Catalog for policies and dates.

Course Content:

Chapter 2: Limits and Continuity
- 2.1 Rates of Change and Limits
- 2.2 Calculating Limits Using the Limit Laws
- 2.3 The Precise Definition of a Limit
- 2.4 One-Sided Limits and Limits at Infinity
- 2.5 Infinite Limits and Vertical Asymptotes
- 2.6 Continuity
- 2.7 Tangents and Derivatives

Chapter 3: Differentiation
- 3.1 The Derivative as a Function
- 3.2 Differentiation Rules
- 3.3 The Derivative as a Rate of Change
- 3.4 Derivatives of Trigonometric Functions
- 3.5 The Chain Rule and Parametric Equations
- 3.6 Implicit Differentiation
- 3.7 Related Rates
- 3.8 Linearization and Differentials

Chapter 4: Applications of Derivatives
- 4.1 Extreme Values of Functions
- 4.2 The Mean Value Theorem
- 4.3 Monotonic Functions and the First Derivative Test
- 4.4 Concavity and Curve Sketching
- 4.5 Applied Optimization Problems
- 4.6 Indeterminate Forms and L'Hôpital's Rule
- 4.7 Newton's Method
- 4.8 Antiderivatives

Chapter 5 Integration
- 5.1 Estimating with Finite Sums
- 5.2 Sigma Notation and Limits of Finite Sums
- 5.3 The Definite Integral
- 5.4 The Fundamental Theorem of Calculus
- 5.5 Indefinite Integrals and the Substitution Rule
- 5.6 Substitution and Area Between Curves

Chapter 6 Application of Definite Integrals
- 6.1 Volumes by Slicing and Rotation about an Axis
- 6.2 Volumes by Cylindrical Shells
- 6.3 Lengths of Plane Curves
- 6.4 Moments and Centers of Mass
- 6.5 Areas of Surfaces of Revolution and the Theorems of Pappus
- 6.6 Work
- 6.7 Fluid Pressure and Forces

UNT Mathematics Core Component

After completing Math 1710, students will have learned:

1. to apply arithmetic, algebraic, geometric, higher-order thinking, and statistical methods to modeling and solving real-world situations;
2. to represent and evaluate basic mathematical information verbally, numerically, graphically, and symbolically;
3. to use appropriate technology to enhance mathematical thinking and understanding and to solve mathematical problems and judge the reasonableness of the results; and
4. to interpret mathematical models such as formulas, graphs, tables and schematics, and draw inferences from them.

While taking Math 1710, students will participate in the following over-arching objectives of UNT's core curriculum. Math 1710 students will:

- explore math
- make connections between different areas of knowledge and different ways of knowing
- be able to locate, evaluate and organize information including the use of information technologies
- think critically and creatively, learning to apply different systems of analysis
- develop problem solving skills
- cultivate self-responsibility, building a foundation for life-long learning