5-8

☒ Undergraduate

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REQUEST FOR

ADDITION OF COURSE TO
CORE CURRICULUM

College/School: Arts & Sciences
Department: Mathematics

Subject Prefix: MATH Course Number: 1610 Semester Credit Hours: 3

TCCNS Number (if applicable) MATH 2312 (common course number)

Hours Per Week: 3 Lecture; ___ Lab; ___ Recitation; ___ Other

Title Functions, Graphs, and Applications
Short Course Title : FUNCTIONS AND GRAPHS
(maximum 22 characters including spaces)

Category of Core Curriculum course is to be added: Mathematics

Catalog Description:

A preparatory course for calculus: algebra and graphs of functions; properties and graphs of polynomials and rational functions; graphs and applications of exponential and logarithmic functions; applications of trigonometric functions and graphs; sequences, series and their applications. MATH 1600 and 1610 together cover approximately the same material as MATH 1650. Students who already have credit for Math 1650 may not receive credit for Math 1610.

Prerequisite(s):

MATH 1600.

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 course begins with a review of the algebra and geometry of lines, but putting more emphasis on the meaning and interpretation of familiar concepts like slope and intercept to the modeling of real-world situations. The statistical method of least squqares regression lines is used to further reinforce the students' algebra skills associated to lines. The algebra and arithmetic of exponential functions and logarithms is used to model real-world phenomena such as population growth, radioactive decay, compound interest, and the Richter and decibel scales for recording earthquake and sound magnitute. The arithmetic and geometry of trigonometric functions are used to model periodic phenomena such as tides, vibrations of springs, phases of the moon, seasonal variations in temperature, and so forth. Sequences and series are used to model problems in personal finance such as annuities and installment loans.

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

Each new class of functions is introduced from all four perspectives. For example, a linear or proportionality relationship will be described in words and the students will beasked to write the relationship symbolically and sketch a graph. Alternatively, a graph of a trigonometric function will be given, and the students will be asked to find a symbolic formula for the graph and use their formula to interpolate between given numerical values. Students could also be given a table of data and asked to determine if a linear or exponential model seems more appropriate for the given data and then asked to fit a line or exponential curve to the given data.

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 tabular features on the calculator help the students look at numerical results in a less tedious fashion. Students work with examples where using a mathematical model to extrapolate results far out into the future can lead to unreasonable results.

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

Much of the course focuses on correctly choosing a function to model a real-world situation. The function is then used to make predictions about the future, or to draw some other conclusion. For example, students are taught how to model building a fence with three sides along a river and then to use the model to conclude what configuration of a fixed amount of fence will enclose the most area.

Over-arching Objectives

1. explore math

During the course, students explore different types of functions. They learn in detail how the graphs of common functions look. They learn how to recognize patterns in numerical tables that tend to indicate certain types of functions. They learn what types of physical and business situations are best modeled by the various types of functions studied in the course. Toward the end of the course, students also start to explore the concept of infinity: what happens as a pattern repeats indefinitely or when infinitely many smaller and smaller terms are added together. This exploration prepares them for calculus, where they will explore the infinite and the infinitely in much greater depth.

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

Students make connections between abstract mathematical concepts, like the algebraic laws of exponents and logarithms, and real-life manifestations of those laws, like half-life in radioactive decay or doubling time for a population or investment. They also use mathematical reasoning to challenge and ultimately improve their common sense. For example, the students may be asked to explore whether doubling a monthly mortgage payment halves the time needed to pay off the mortgage.

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 series that takes place toward the end of the course requires critical and creative thought.

5. develop problem solving skills

Problem solving skills are developed throughout the course. The text book discusses general problem solving strategy, adapted from the famous mathematician George Polya's book *How to Solve It,* as follows. Students are first taught to understand the problem. They are asked to organize the given information and to ascertain what needs to be found out. They are expected to identify any constraints or conditions specified by the problem and to draw a diagram representing the given information. Students are next taught to develop a plan of attack for the problem, based on the following general principles. The students are asked to look for something familiar. Does the problem resemble an example they have seen in class or a previous exercise? If not, are there familiar elements within it? Students are taught to search for patterns in the given data. In Math 1610, there is a focus on recognizing graphical or numerical patterns that indicate a certain type of function should be used to model the situation. Students are taught to think of a strategy for solving a more complex problem by first considering analogies to simpler or smaller problems. Students are taught they may need to add an extra variable or parameter to what was given in the problem to give them enough flexibility to find a solution. Finally, students are taught to establish the validity of solutions from both ends. In addition to beginning from the given information and working forward toward a solution, students are taught to work backwards as well. Given a guess as what the solution might be, they are taught how to check if the guess is a valid solution. Or, they are asked to think about what else they would know if they knew a solution as a way to establish intermediate sub-goals toward finding the ultimate solution.

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 polynomials, exponentials, logarithms, trigonometric functions, sequences, and series, all the essential mathematical tools necessary for basic mathematical analysis in the sciences and engineering. This is essential for students to be able to consult mathematical references later in life. 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.

Consultation with University Curriculum Assessment Committee member:
Department: Mathematics Contact: William Cherry Date: 03/19/2009

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: S. Matthew [signature] Date: 4/24/09
College/School Curriculum Committee Chair: [signature] Date: 5/7/09
Dean of College/School: [signature] Date: 5/7/09
Core Oversight Committee Chair: ____________ Date: ________
University Curriculum Committee (VPAA): ____________ Date: ________

Math 1610 (Functions, Graphs, and Applications) 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.

The following table shows the number of fingerling salmon that survive the trip from their spawning ground in a certain British Columbia creek to the Strait of Georgia in the Pacific Ocean:

Year	1985	1986	1987	1988	1989	1990	1991	1992
1000s of Salmon	43	36	27	23	26	33	43	50
Year	1993	1994	1995	1996	1997	1998	1999	2000
1000s of Salmon	56	63	57	50	44	38	30	22

The data above appears to be approximately periodic.
(i) Estimate the period.
(ii) Estimate the amplitude.
(iii) Sketch a graph of the number of salmon as a function of time.
(iv) Find a formula approximating the data in the table above.

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

The drag force F on a boat is jointly proportional to the wetted surface area A on the hull and the square of the speed s of the boat. Suppose that a boat with a wetted sruface area of 40 ft^2 travellig at 5 mi/hr experiences a drag force of 220 lbs.

(i) Express the above symbolically.

(ii) Which of the graphs drawn below could be the graph of the drag force F as a function of speed s, assuming the wetted area A remains 40 ft^2?

(iii) Which of the graphs drawn below could be the graph of the drag force F as a function of wetted surface area A, assuming the speed s remains constant at 5 mi/hr?

Graphs omitted here.

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

Water in an industrial water treatment plant can be passed through a filtration stage multiple times. The following table shows the amount of pollutant left in the water after passing through the filtration process.

# of times through filtration	0	1	2	3	4	5
Pollutant (parts per million)	150	90	54	32	19	12

Enter the above data into your graphing calculator and fit a linear regression line to the data.

(i) Give a rough sketch of the scatter plot and regression line

(ii) If you use your regression line to predict how much pollutant remains in the water after passing through the filtration system 10 times, what do you get?

(iii) Is this a reasonable answer? Explain.

(iv) From the shape of the scatter plot, can you suggest a better type of function than a linear function to model the above data?

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

A boy stands on a cliff above a beach and throws a ball up into the air. The height of the ball H above the beach, measured in feet, t seconds after the boy throws the ball is given by

$$H = 120 + 40t - 16t^2$$

(i) About how high is the cliff above the beach?
(ii) What is the maximum height above the beach that the ball reached?
(iii) How many seconds after the boy threw the ball did it land on the beach below?

Examples of possible final exam questions targeting Over-Arching Objectives

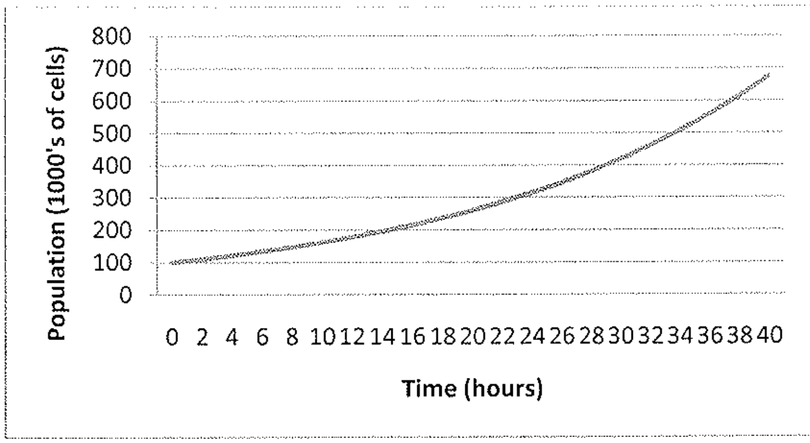
1. explore math

Consider the function $f(x) = \frac{e^{-x^2/2\sigma}}{\sqrt{\pi\sigma}}$. With the help of your graphing calculator, sketch graphs for a couple of different values of σ=1, 2, 3, 4. What affect does σ have on the shape of the graph? Can you explain this in terms of "shifting and stretching"? Be as precise as you can.

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

(i) The population P of a particular bacterial culture measured in 1000's of cells after t hours is given by the formula $P=(1.05)^{t/2}$. Compute the doubling time of the population. Show work demonstrating an algebraic solution.

(ii) Use the following population graph of the bacteria culture to estimate the population's doubling time:



Mark on the graph above how you can see the doubling time in the graph.

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

A scientist doing a memory study asks volunteers to memorize a list of 100 words. The scientist then asks the volunteers to recall the words at various times in the future and records the percentage of words the volunteers correctly remembered. The following data shows the percentage of words remembered correctly *y* after *t* hours.

[Data table omitted here]

Consider the following scatter plots of the above data generated with a graphing calculator.

[Plots omitted here. One is *y* versus *t*, another is log *y* versus *t*, and the third is log *y* versus log *t*]

Do the above graphs indicate a power model or exponential model is most appropriate for the data? Why?

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

Consider the following proof by induction that all cats are black. Let *P*(*n*) denote the statement: In any group of *n* cats, if one is black, then they are all black.

Base Step: The statement is clearly true for groups of one cat. Namely in a group consisting of only one cat, if the cat is black, then because there is only one cat, all the cats in the group are black.

Induction Step: Consider a group of *k*+1 cats, at least one of which is black. Number the cats so that cat #1 is black. Take cat #2 out of the group. Then, we are left with a group of k cats, which contains the black cat #1. By the induction hypothesis, we then know that all the cats in this smaller group must be black. Now put back cat #2 and take out cat #1. We again have a group of k cats. Because we saw that all the cats, except maybe cat #2 were black, this group again has a black cat, and so by induction all the cats are black, including cat #2.

The above induction "proof" shows that if there is at least one black cat in the world, then all cats are black. We have all seen one black cat, and therefore the above proof seems to suggest that all cats are black. What is wrong with the above argument? You must find the flaw in the logic and cannot simply say that something must be wrong since not all cats are black.

5. develop problem solving skills

A very large pile of logs is stacked so that the bottom row contains 150 logs, the second row contains 147 logs, the third row contains 144 logs, and so on with the number of logs in each row decreasing by 3 each time. If there are 3255 logs total in the pile, how many rows of logs are there?

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 projects asking the students to gather data, such as height versus shoe-size, and analyze the data to find an appropriate formula relating the data. Other projects could involve the students studying "fractal" shapes and using geometric series to calculate their lengths or areas. Still other projects might involve Descarte's Rule of Signs or other aspects of finding zeros of polynomials in greater detail than might be emphasized as part of the main content of the course.

The department will collect and retain a random sample of the projects completed in Math 1610 each semester. Every fourth year the Undergraduate Affairs Committee will review these portfolios and assess how well Math 1610 is cultivating self-responsibility and building a foundation for life-long learning in the students.

MATH 1610

Semester Year/Dates

COURSE/Section # `MATH 1610`	COURSE TITLE: Functions, Graphs and Applications
INSTRUCTOR:	**OFFICE:** **OFFICE PHONE:**
OFFICE HOURS: Four (4) hours/wk and also by appt.	**CLASS MEETS:** Three (3) hours/wk.
EMAIL:	**WEB ACCESS:**

COURSE DESCRIPTION: 3 hours. A preparatory course for calculus: algebra and graphs of functions; properties and graphs of polynomials and rational functions; graphs and applications of exponential and logarithmic functions; applications of trigonometric functions and graphs; sequences, series and their applications. MATH 1600 and 1610 together cover approximately the same material as MATH 1650. Students who already have credit for Math 1650 may not receive credit for Math 1610. Prerequisite: Math 1600. Satisfies the Mathematics requirement of the University Core Curriculum.

Prerequisite(s): Math 1600

TEXT: *Precalculus*, 5th edition, by J. Stewart, L. Redlin and S. Watson

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 1: Fundamentals
- 1-10 Lines
- 1-11 Modeling Variation

Chapter 2: Functions
- 2-1 What is a Function?
- 2-2 Graphs of Functions
- 2-3 Increasing and Decreasing Functions.
- 2-4 Average Rate of Change
- 2-5 Transformations of Functions
- 2-6 Quadratic Functions: Maxima and Minima
- 2-7 Modeling with Functions
- 2-8 Combining Functions
- Focus on Modeling: Fitting Lines to Data

Chapter 3: Polynomial and Rational Functions
- 3-1 Polynomial Functions and Their Graphs
- 3-2 Dividing Polynomials
- 3-3 Real Zeros of Polynomials
- 3-4 Complex Numbers
- 3-5 Complex Zeroes and the Fundamental Theorem of Algebra
- 3-6 Rational Functions

Chapter 4: Exponential and Logarithmic Functions
- 4-1 Exponential Functions
- 4-2 Logarithmic Functions
- 4-3 Laws of Logarithms
- 4-4 Exponential and Logarithmic Equations
- 4-5 Modeling with Exponential and Logarithmic Functions

Chapter 5: Trigonometric Functions of Angles
- 5-1 The Unit Circle
- 5-2 Trigonometric Functions of Real Numbers
- 5-3 Trigonometric Graphs
- 5-4 More Trigonometric Graphs
- 5-5 Modeling Harmonic Motion

Chapter 11: Sequences and Series
- 11-1 Sequences and Summation Notation
- 11-2 Arithmetic Sequences
- 11-3 Geometric Sequences
- 11-4 Mathematical Finance*
- 11-5 Mathematical Induction*
- 11-6 The Binomial Theorem*

Chapter 12: Limits: A Preview of Calculus
- 12-1 Finding Limits Numerically and Graphically*
- 12-2 Finding Limits Algebraically*
- 12-3 Tangent Lines and Derivatives*

12-4 Limits at Infinity; Limits of Sequences*
12-5 Areas*

* Are optional sections

UNT Mathematics Core Component

After completing Math 1610, 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 1610, students will participate in the following over-arching objectives of UNT's core curriculum. Math 1610 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