CORE CURRICULUM COMPONENT APPLICATION
Sam Houston State University

Revised August, 2012

PART I – Course Information

Course Type
☒ Existing/Restructured
☐ New Course Proposed Fall 2013
If new, have you submitted a Form B to the SHSU Curriculum Committee? ☐ Yes ☐ No

Course Prefix & Number: MATH 1420

Texas Common Course Number (TCCN Matrix): MATH 2413

Course Title: Calculus I

Course Catalog Description (Copy and paste from online catalog for existing courses): Topics include limits and continuity, the derivative, techniques for differentiation of algebraic, logarithmic, exponential and trigonometric functions, applications of the derivative and anti-differentiation, definite integral, Fundamental Theorem of Calculus

Course Prerequisites: C or better in MATH 1410, MATH 1316, or high school equivalent

Available Online?
☐ Yes, currently developed in online delivery mode
☐ Anticipated development in online delivery mode (Semester, Year: ☐)
☒ No

Number of Sections to be Offered per Academic Year: 13

Estimated Enrollment per Section: 38

Course Level (freshman, sophomore): freshman

Designated Contact Person (for follow-up communication purposes): Dr. Rebecca Garcia

E-Mail Address: rgarcia@shsu.edu

Phone: 936-294-3520

Approvals

Department Chair: _____ Signature _____ 10-18-12 Date

Academic Dean: _____ Signature _____ 10/22/12 Date

Submit completed, signed form to Core Curriculum Committee - Box 2478 or Fax 4-1271

PART II – THECB Foundational Component Areas

See Appendix for full description of each component area.

Select Component Area: II. Mathematics

In one paragraph, describe how the proposed course will fulfill the core and skill objectives of the component area:

Differential calculus is the study of change and is used in every branch of the physical sciences (e.g., biology, chemistry, physics), computer science, actuarial science, operations research, business, engineering and in those fields where a problem can be mathematically modeled and an optimal solution is desired. In particular, students completing this course will work through a rigorous mathematical approach to further understand the nature of space, time and motion by thoroughly investigating the concepts of velocity, acceleration, slopes, and convexity of a curve, as well as optimization. Implicitly, students successfully completing this course will (1) gain increased quanititative literacy in logic, patterns and relationships, (2) refine their understanding of key mathematical concepts, and (3) learn to apply concepts of differential calculus in appropriate settings.

PART III – Course Objectives & Student Learning Outcomes (SLO)

Insert the applicable course objectives stated as student learning outcomes (e.g., Students completing the course will be able to...) that support the core component area objectives. Please reference the component rubric for additional information on core component area objectives.

Objective/SLO 1:

Students successfully completing this course will gain a greater understanding of the use of mathematical functions in describing natural and physical phenomena, refine pattern recognition skills via generalizations of algebraic techniques, and reformulate real world problems into accurate mathematical expressions. In so doing, students will have increased quantitative literacy in logic patterns and relationships.

How will the objective be addressed (including strategies and techniques)?

Students will be exposed to the relationship between the quantitative properties and uses of a function and those of its derivative. In particular,students will learn the derivatives of all basic real-valued functions and how they relate to standard operations on these basic functions. In addition, they will determine various properties of the original functions through the study of their derivatives. For example, students will use derivatives of a function to determine the intervals over which that function increases/decreases, the points of relative maxima and minima and the intervals of convexity and concavity of a function.

Students will also apply the concept of derivatives to real-world scenarios, such as determining velocity, acceleration and jerk of a moving particle; minimizing cost functions; maximizing profit/benefit functions; modeling population growth, radioactive decay and carbon-dating.

Describe how the objective will be assessed:

This objective will be assessed through embedded problems in quizzes, exams, and/or in-class worksheets. Instructors will incorporate a common subset of problem types in the final exam of each section. As an example, instructors will be asked to include a question that requires the student to determine the intervals on which an unspecified function is increasing (or decreasing) based on the graph of the derivative of this unspecified function.

Objective/SLO 2:

Students successfully completing this course will apply arithmetic, algebraic, and geometric methods to problem solving, in particular the modeling of real-world situations. Emphasis will be placed on accurately representing mathematical information symbolically and graphically, with attention paid to synthesizing the outcomes/solutions both verbally and numerically. In so doing, students will gain a greater understanding of key mathematical concepts.

How will the objective be addressed (including strategies and techniques)?

The fundamental concept underlying calculus is that of limits, which leads to the main topic of the class: derivatives. Students will explore both topics through various approaches; heuristically, numerically, graphically, algebraically and rigorously using logic and precisely stated definitions. For example, students are first introduced to the concept of derivative via the natural notion of the rate of change of a moving body's position over time, i.e. velocity. Students will then explore the notion of the average rate of change of a function in general and how it relates geometrically to the slope of secant lines of the graphical representation of a function. Students will then apply the concept of a mathematical limit to refine the concept of the average rate of change of a function to the instantaneous rate of change of a function (i.e., the derivative at a point). Students will also develop this refinement visually, using the slope of secant lines to approach the slope of the tangent line at a point. In addition to the general concept of derivatives, students will uncover algebraic techniques of computing derivatives of all basic mathematical functions.

Describe how the objective will be assessed:

This objective will be assessed is through embedded problems in quizzes, exams and/or in-class worksheets. Instructors will incorporate a common subset of problem types in final exam of each section. As an example, instructors will be asked to include a question that requires the student to compute the derivative of a basic function using only the definition (involvng a mathematical limit) of the derivative.

Objective/SLO 3:

Students successfully completing this course will use appropriate technology to enhance mathematical thinking and understanding, solve problems using mathematical concepts, and judge the level of reasonability of the results. Students will learn to interpret mathematical

formulas, graphs and tables and will expand their mathematical reasoning skills to develop sound mathematical arguments.

How will the objective be addressed (including strategies and techniques)?

Applications are an important part of understanding the key concepts in differential calculus. In particular, the applications have implicit conditions wherein these concepts make sense (e.g., non-negative distances). Significant time will be spent on developing principle ideas arising from biology, chemistry, physics, and economics and how concepts of differential calculus are applied to further understanding these ideas. Of course, knowing when the principles of calculus can be applied to a scientific process is almost as challenging as knowing how to apply these principles. Significant time will be spent not only convincing students of the vast uses of differential calculus, but also on developing the methods with which industry applies these tools.

For example, optimization problems naturally arise in economics, where one is required to find values that would maximize profits or minimize costs. As another example, population growth, especially at the cellular level, is modeled exponentially and is a natural topic in biology with obvious constraints. Dedicated sections of the class time will be used to develop the knowledge required to understand when and how to apply calculus to these models.

Describe how the objective will be assessed:

This objective will be assessed is through embedded problems in quizzes, exams and/or in-class worksheets. Instructors will incorporate a common subset of problem types in final exams of each section. As an example, instructors will include a question that requires the student to determine the solution to a problem of applied optimization: Design a cylindrical can that can hold 900 cubic centimeters which uses the least amount of metal.

Objective/SLO 4:

How will the objective be addressed (including strategies and techniques)?

Describe how the objective will be assessed:

Objective/SLO 5:

How will the objective be addressed (including strategies and techniques)?

Describe how the objective will be assessed:

PART IV – THECB Skill Objectives

Address each of the THECB skill objectives required within the component area. Explain how the skill is addressed, including specific strategies to address the skill(s), and how each skill will be assessed. *Address ALL skill objectives associated with the selected Component Area. (See Appendix)*

1. Critical Thinking Skills: to include creative thinking, innovation, inquiry, and analysis, evaluation and synthesis of information

How will the skill be addressed (including strategies and techniques)?

Calculus is one of the greatest achievements of the human intellect. Inspired by problems in astronomy, the major ideas of calculus were developed over 300 years ago and yet they still remain a fundamental course in the mathematics curriculum. The endurance of calculus in any core curriculum is due to its extraordinary power in reducing complicated problems to simple rules and procedures. Students' conceptual understanding of the key ideas of differential calculus is often accomplished by actively working on assigned problems that illustrate the topic graphically, numerically, symbolically and verbally. This process requires students to think critically about the problems and to evaluate, analyze and sythesize the given information.

The first stage in the development of mathematical and critical thinking is the acquisition of a clear, intuitive picture of the central ideas of a given problem. Next, the student learns to reason with her intuition and explain the reasoning clearly, in plain language. Once this foundation has been laid, students advance their understanding of theoretical constructs and applications applied to other disciplines. Each stage develops the students' skills from symbolic algebraic manipulation through logic and reasoning, pattern recognition and formulating accurate generalizations of observable phenomena.

Describe how the skill will be assessed:

This objective will be assessed through embedded problems in quizzes, exams and/or in-class worksheets. Instructors will incorporate a common subset of problem types in the final exam of each section. As an example, instructors will include questions that test the graphical, numerical and symbolic comprehension of the limit of a function at a point.

2. Communication Skills: to include effective development, interpretation and expression of ideas through written, oral and visual communication

How will the skill be addressed (including strategies and techniques)?

Students will develop their written, oral and visual communication skills as a natural part of the learning process of differential calculus. Obtaining a true understanding the content of differential calculus requires each students working closely with graphical representations of mathematical functions and using such visual representations to communicate information about the function and its behavior through writing and speech. Students are routinely asked to explore and explain a variety of calculus concepts and applications in writing exercises that challenge students to discuss important calculus concepts with precision. In addition, many of the exercises task the student with translating plain language into symbolic mathematical expressions, resolving the problems algebraically, and communicating the results in plain language, either verbally or written

Improving communication skills could be addressed in one of two ways, either in the form of class presentations or within group work. In those classrooms which implement student presentations, students will be expected to present solutions to several problems to the rest of the class on a regular basis. Solutions will be presented in both written form (on the board, in front of the room) and orally (explaining methods used and conclusions drawn). Students presenting solutions will receive immediate feedback from those students listening to the presentation.

Those classrooms not having students present their work to their classmates will use group work to address communication skills. On a regular basis (such as during weekly quizzes) the class will be partitioned into small groups of three or four students, and each group will work on either a lengthy problem or on a sequence of problems to be solved using differential calculus. The groups will either be assigned by the instructor or formed by the students. Typically each student turns in her own set of solutions, requiring communication among group members, ensuring complete, correct solutions.

Describe how the skill will be assessed:

Regardless of method used (group work or class presentations), the instructor of each section of differential calculus will be asked to maintain a record of each student's communication skills in the following way. Each student will earn a score from 1 to 4, determined by whether the student has communication skills that (1) need great improvement, (2) need some improvement, (3) are satisfactory, or (4) are superior. Each semester, instructors of this course will report the number of students in their section who have obtained a score of (3) or (4).

3. Empirical and Quantitative Skills: to include the manipulation and analysis of numerical data or observable facts resulting in informed conclusions

How will the skill be addressed (including strategies and techniques)?

As a natural part of the curriculum for differential calculus, students must develop skills to manipulate and simplify complex mathematical expressions, analyze numerical data or observable facts to provide accurate and informed conclusions. Early on, multiple representations of the basic functions are stressed: verbal, visual, algebraic and numeric; this is

true for the function as it is for their derivatives. Students will learn to generate and interpret graphs and symbolic formulae as tools for understanding both the quantitative and empirical real-world relationships of functions. A main focus of differential calculus is the complete analysis of standard mathematical functions: intervals on which a function increases/decreases, the concavity and convexity of a function, its asymptotic and long-term behavior.

Describe how the skill will be assessed:

This objective will be assessed through embedded problems in quizzes, exams and/or in-class worksheets. Instructors will incorporate a common subset of problem types in the final exam of each section. As an example, instructors will include questions that would require the student to analyze completely the behavior of a specified function over its domain: determine the intervals on which the function increases/decreases, find intervals of concavity and convexity, determine points of inflection, asympotes, asympotic behavior, or relative maxima and minima.

4. Teamwork: to include the ability to consider different points of view and to work effectively with others to support a shared purpose or goal

How will the skill be addressed (including strategies and techniques)?
This skill will not be addressed.

Describe how the skill will be assessed:

5. Personal Responsibility: to include the ability to connect choices, actions and consequences to ethical decision-making

How will the skill be addressed (including strategies and techniques)?
This skill will not be addressed.

Describe how the skill will be assessed:

6. Social Responsibility: to include intercultural competence, knowledge of civic responsibility, and the ability to engage effectively in regional, national, and global communities

How will the skill be addressed (including strategies and techniques)?
This skill will not be addressed.

Describe how the skill will be assessed:

PART V – SHSU Core Curriculum Committee Requirements

1. Using a 15-week class schedule, identify the topics to be covered during each week of the semester. Provide sufficient detail to allow readers to understand the scope and sequence of topics covered.

Week 1	Review of precalculus topics; the concept of average rate of change.
Week 2	The derivative at a point; the intuitive definition of a mathematical limit.
Week 3	Algebraic computation of limits; existence vs nonexistence of limits; the Squeeze Theorem.
Week 4	Limits at infinity; the formal definition of the existence of a limit.
Week 5	The derivative as a function; continuity.
Week 6	The derivative of trigonometric functions; the Product Rule.
Week 7	The Quotient and Chain Rules.
Week 8	The derivative of exponential functions.
Week 9	The derivative of inverse functions; differentiating logarithmic functions.
Week 10	Related rates problems; implicit differentiation.
Week 11	Optimization problems, curve sketching.
Week 12	The Mean Value Theorem; L'Hospital's Rule.
Week 13	Antiderivatives; solving initial value problems; Riemann sums.
Week 14	The Fundamental Theorem of Calculus, Parts I and II.
Week 15	(Time permitting) Computation of area between curves.

2. Attachments (Syllabus Required)

Syllabus Attached? ☒ Yes ☐ No

Other Attached? ☐ Yes ☒ No If yes, specify:

Appendix: THECB Component Area Descriptions and Skill Requirements

I. Communication (Courses in this category focus on developing ideas and expressing them clearly, considering the effect of the message, fostering understanding, and building the skills needed to communicate persuasively. Courses involve the command of oral, aural, written, and visual literacy skills that enable people to exchange messages appropriate to the subject, occasion, and audience.)

II. Mathematics (Courses in this category focus on quantitative literacy in logic, patterns, and relationships. Courses involve the understanding of key mathematical concepts and the application of appropriate quantitative tools to everyday experience.)

III. Life and Physical Sciences (Courses in this category focus on describing, explaining, and predicting natural phenomena using the scientific method. Courses involve the understanding of interactions among natural phenomena and the implications of scientific principles on the physical world and on human experiences.)

IV. Language, Philosophy, and Culture (Courses in this category focus on how ideas, values, beliefs, and other aspects of culture express and affect human experience. Courses involve the exploration of ideas that foster aesthetic and intellectual creation in order to understand the human condition across cultures.)

V. Creative Arts (Courses in this category focus on the appreciation and analysis of creative artifacts and works of the human imagination. Courses involve the synthesis and interpretation of artistic expression and enable critical, creative, and innovative communication about works of art.)

VI. American History (Courses in this category focus on the consideration of past events and ideas relative to the United States, with the option of including Texas History for a portion of this component area. Courses involve the interaction among individuals, communities, states, the nation, and the world, considering how these interactions have contributed to the development of the United States and its global role.)

VII. Government/ Political Science (Courses in this category focus on consideration of the Constitution of the United States and the constitutions of the states, with special emphasis on that of Texas. Courses involve the analysis of governmental institutions, political behavior, civic engagement, and their political and philosophical foundations.)

VIII. Social and Behavioral Sciences (Courses in this category focus on the application of empirical and scientific methods that contribute to the understanding of what makes us human.
Courses involve the exploration of behavior and interactions among individuals, groups, institutions, and events, examining their impact on the individual, society, and culture.)

Required Skill Objectives

Foundational Component Areas	Skill Objectives					
	Critical Thinking	Communication	Empirical & Quantitative	Team Work	Social Responsibility	Personal Responsibility
Communication	✓	✓		✓		✓
Mathematics	✓	✓	✓			
Life and Physical Sciences	✓	✓	✓	✓		
Language, Philosophy & Culture	✓	✓			✓	✓
Creative Arts	✓	✓		✓	✓	
American History	✓	✓			✓	✓
Government/Political Science	✓	✓			✓	✓
Social and Behavioral Sciences	✓	✓	✓		✓	

Submit completed, signed form to Core Curriculum Committee - Box 2478 or Fax 4-1271

Math 1420
Differential Calculus
Fall 2014
4 undergraduate credits

- **Class meeting information:**

- **Professor:** **e-mail:**
  Office: **Office Phone:** 294-xxxx

  All course materials will be available via **Google+**

- **Office Hours:**

- **Course Description:**
  A study of the applications and properties of differential calculus in the context of polynomial, rational, exponential and trigonometric functions.

  Prerequisites include a grade of C or better in MATH 1410 or equivalent.

- **Topics covered:**
  Students completing this course should have mastery of the following major concepts. Other techniques and ideas will also be covered.
  - The definition and properties of the derivative.
  - Both a rigorous and intuitive definition of the existence of limits on the real number line.
  - Calculation of derivatives on rational, exponential, logarithmic and trig. functions.
  - Applications of the derivative including related rates and optimization.
  - The mean value theorem and its uses.
  - Antiderivatives and the Fundamental Theorem of Calculus.
  - Signed area under a curve, volumes of surfaces of revolution (time permitting).

- **Course Objectives:**

  - Students successfully completing this course will gain a greater understanding of the use of mathematical functions in describing natural and physical phenomena, refine pattern recognition skills via generalizations of algebraic techniques, and reformulate real world problems into accurate mathematical expressions. In so doing, students will have increased quantitative literacy in logic patterns and relationships.
  - Students successfully completing this course will apply arithmetic, algebraic, and geometric methods to problem solving, in particular the modeling of real-world situations. Emphasis will be placed on accurately representing mathematical information symbolically and graphically, with attention paid to synthesizing the outcomes/solutions both verbally and numerically. In so doing, students will gain a greater understanding of key mathematical concepts.

- Students successfully completing this course will use appropriate technology to enhance mathematical thinking and understanding, solve problems using mathematical concepts, and judge the level of reasonability of the results. Students will learn to interpret mathematical formulas, graphs and tables and will expand their mathematical reasoning skills to develop sound mathematical arguments.

- **Structure of course:**

  There is no textbook and there will be no lectures. Course notes will be distributed periodically. These notes will include definitions, remarks, examples, problems, questions, and theorems.

  Each student should read and understand all of the definitions, remarks and examples followed by an *attempt* to answer **all** of the questions, solve **all** of the problems, and prove **all** of the theorems.

  Each attempted answer, solution, or proof should be written up neatly, completely and concisely. It may be useful to have each on its own sheet (or sheets) of paper. **All submitted work must be legible and consist of complete sentences.** (Note: an equation is considered a complete sentence.)

- *Components:* There are four integrated components within this course. A description of each and its weight is below.

  1. **Class presentations – 20 points** – Each day I will call on several students (or ask for volunteers) to present their work on the board. Student progress will be determined by two factors: (1) performance at the board presenting complete, correct work and answering questions from the class pertaining to this presentation and (2) performance when others are at the board, i.e. paying close attention to their presentation and, if necessary, politely questioning their work.

  2. **Written work – 30 points** – Each day written work will be collected. Every time a student goes to the front of the room to present her work on a particular problem, written solutions to that problem will be collected from the rest of the class. I will read these and return them the next day, marked either as "correct" or "rework." You are permitted to rework any solutions until they are deemed correct. Your written work grade will be determined by the number of points earned on "correct" solutions.

     If a correct solution is turned in *before* that problem is presented, **6 points** will be earned. If turned in after the presentation, **2 points** will be earned.

  3. **Class participation – 10 points** – Each student will be expected to attend each class and participate in a professional manner. Polite questions and comments are expected on a regular basis.

  4. **Exams – 20 pts each** – A midterm and a final exam on Wed., May 9, 8:00 - 10:00.

- *Important Rules:*

  1. **Academic Honesty:** I assume that all work handed in to me or presented in class by you is **entirely** your own work. ***You must hand in your own original work.*** There

are **no** accepted references for this class. You **may not** consult other people who are not in this class for help. You **may not** consult any textbooks for help. Doing so will be considered the worst possible form of plagiarism.

2. **Attendance:** Since a significant part of your grade is class participation, and since you cannot participate if you are not present, it will be impossible to succeed (*i.e.* not fail the course) if class is missed.

3. **Focus:** Since this class is almost entirely driven by the students, it is vitally important that during class time we stay focused on the presentations at the board. If you need to read the newspaper or notes from other classes, send a text message, or have a conversation on your phone or with a classmate do so outside of this class.

4. **Etiquette:** To do well in this course, you will spend a large portion of time in front of the class. When a student is presenting a proof that observers politely question, it is important that each member of the class *ask a question* about the proof, rather than offer a correction. And remember the most important rule: **Be Polite.**

- **Academic Dishonesty:** Students are expected to maintain honesty and integrity in the academic experiences both in and out of the classroom. See Student Syllabus Guidelines.

- **Classroom Rules of Conduct:** Students are expected to assist in maintaining a classroom environment that is conducive to learning. Students are to treat faculty and students with respect. Students are to turn off all cell phones while in the classroom. Under no circumstances are cell phones or any electronic devices to be used or seen during times of examination. Students may tape record lectures provided they do not disturb other students in the process.

- **Visitors in the Classroom:** Only registered students may attend class. Exceptions can be made on a case-by-case basis by the professor. In all cases, visitors must not present a disruption to the class by their attendance. Students wishing to audit a class must apply to do so through the Registrars Office.

- **Student Absences on Religious Holy Days Policy:** Students are allowed to miss class and other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. Students remain responsible for all work. See Student Syllabus Guidelines.

- **Disabled Student Policy:** It is the policy of Sam Houston State University that individuals otherwise qualified shall not be excluded, solely by reason of their disability, from participation in any academic program of the university. Further, they shall not be denied the benefits of these programs nor shall they be subjected to discrimination. Students with disabilities that might affect their academic performance should visit with the Office of Services for Students with Disabilities located in the Counseling Center. See Student Syllabus Guidelines.

For more information on these policies, please visit the site

`http://www.shsu.edu/syllabus/`