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Course Outline for MATH 1

CALCULUS I

Effective: Fall 2019

I. CATALOG DESCRIPTION:

MATH 1 — CALCULUS I — 5.00 units

An introduction to single-variable differential and integral calculus including: functions, limits and continuity; techniques and applications of differentiation and integration; the Fundamental Theorem of Calculus; areas and volumes of solids of revolution.

5.00 Units Lecture

Prerequisite

MATH 30 - College Algebra for STEM
with a minimum grade of C

MATH 39 - Trigonometry
with a minimum grade of C

Grading Methods:

Letter Grade

Discipline:

- Mathematics

	MIN
Lecture Hours:	90.00
Expected Outside of Class Hours:	180.00
Total Hours:	270.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

Before entering the course a student should be able to:

A. MATH30

1. Solve rational, linear, polynomial, radical, absolute value, exponential, and logarithmic equations;
2. Solve linear, nonlinear and absolute value inequalities;
3. Explore and apply rational, linear, polynomial, radical, absolute value, exponential, and logarithmic equations in context of applications;
4. Analyze functions graphically and investigate properties of functions;
5. Apply functions and other algebraic techniques to model real world applications in science, technology, engineering and mathematics;
6. Graph linear and nonlinear functions, including functions with radicals, exponential functions, absolute value functions, and logarithmic functions;
7. Apply transformations to the graphs of functions;
8. Synthesize results from the graphs and/or equations of functions;
9. Recognize the relationship between functions and their inverses graphically and algebraically;
10. Determine if a function has an inverse and find the inverse when it exists;
11. Apply techniques for finding real and complex zeros of polynomials and roots of equations.
12. Solve systems of equations and inequalities;
13. Analyze conics algebraically and graphically;
14. Find the terms of a sequence and the partial sums of a series;
15. Use formulas to find sums of finite and infinite series;

B. MATH39

1. Define trigonometric functions in terms of the right triangle, using coordinates of a point and distance from the origin, and using the unit circle;
2. State from memory the values for sine, cosine and tangent functions of common angles given in either degrees or radians;
3. Identify special triangles and their related angle and side measures;
4. State from memory the Pythagorean identities, reciprocal identities, quotient identities, double angle identities, and sum and difference identities for sine and cosine ;
5. Evaluate the trigonometric function of an angle in degree and radian measure;

6. Manipulate and simplify a trigonometric expression;
7. Solve trigonometric equations, including equations with multiple angles over different intervals, and solve triangles and applied problems;
8. Graph the basic trigonometric functions and apply changes in period, phase and amplitude to generate new graphs;
9. Evaluate and graph inverse trigonometric functions;
10. Develop and use trigonometric ratios or other trigonometric formulas to solve problems;
11. Develop and use the law of sines and law of cosines to completely solve an oblique triangle;
12. Convert between polar and rectangular coordinates and equations;
13. Graph polar coordinate equations.
14. Represent a vector (a quantity with magnitude and direction) in the form $\langle a, b \rangle$ and $a\mathbf{i} + b\mathbf{j}$.

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

- A. Evaluate the limit of a function at a real number;
- B. Determine whether a function is continuous at a point or an interval;
- C. Find and interpret average and instantaneous rates of change;
- D. State the definition of the derivative as the limit of a difference quotient and use the definition to find the derivative of a function;
- E. Interpret the derivative as the slope of a tangent line and find the equation of a tangent line to a function;
- F. Explain the definitions of velocity and acceleration and use the derivative to find the velocity and acceleration of an object in motion, given the position function for the object;
- G. State and apply the rules for differentiating algebraic and trigonometric functions.
- H. Utilize the chain rule when differentiating functions;
 - I. Work with differentials and their applications;
- J. Use calculus-based methods to analyze functional behavior;
- K. Sketch the graphs of functions using the methods of calculus;
- L. Find all maxima, minima and points of inflection of a function;
- M. Use implicit differentiation;
- N. Evaluate the limit of a function at infinity;
- O. Apply differentiation to solve related rate and optimization problems;
- P. Apply the Mean Value Theorem;
- Q. Utilize Newton's Method;
- R. Evaluate a definite integral as the limit of a Riemann sum;
- S. Apply the Fundamental Theorem of Integral Calculus;
- T. Evaluate integrals by the method of substitution;
- U. Find areas between curves and volumes of solids of revolution;
- V. Use the precise definition of a limit to prove a limit exists.

V. CONTENT:

- A. Limits
 1. Left-hand limits and right-hand limits
 2. Computing limits
 - a. Numerically
 - b. Graphically
 - c. Algebraically
 3. Limits of trigonometric functions
 4. Limits at infinity
 5. Precise definition of a limit
- B. Average and instantaneous rates of change
- C. Continuity
 1. Definition of continuity
 2. Continuity at a real number
 3. Continuity on an interval
 4. Discontinuous functions
 - a. Types of discontinuities
 - b. Removable discontinuities
- D. Intermediate Value Theorem
- E. Secant and tangent lines
- F. Average and instantaneous rates of change; velocity and acceleration
- G. Definition of the derivative as the limit of a difference quotient
- H. Interpretation of the derivative
 1. Slope of a tangent line
 2. Rate of change
 3. Derivative as a function
- I. Differentiation formulas and techniques
 1. Differentiation of constant-valued function
 2. Power rule
 3. Product rule
 4. Quotient rule
 5. Trigonometric functions
 6. Chain rule
 7. Implicit derivative
 8. Higher-order derivatives
- J. Applications of differentiation
 1. Rate of change
 2. Related rates
 3. Optimization
- K. Functional analysis
 1. Mean Value Theorem
 2. Critical numbers
 3. Maximum and minimum values (absolute and local)
- L. Curve sketching: algebraic, rational and trigonometric functions
 1. First Derivative Test
 2. Second Derivative Test
 3. Test for Concavity and Points of Inflection
 4. Extrema
 5. Asymptotic behavior
 - a. Limits at infinity
 - b. Horizontal and vertical asymptotes

- M. Differentials and their applications
- N. Newton's Method
- O. Antiderivatives
- P. Definite integral
 - 1. Interpretation as area under a curve
 - 2. Defined as limit of a Riemann Sum
 - 3. Evaluation of a definite integral as the limit of a Riemann Sum
- Q. Indefinite integrals
- R. Properties of definite and indefinite integrals
- S. Fundamental Theorem of Calculus
- T. Integration
 - 1. As antidifferentiation
 - 2. Method of substitution
- U. Applications of integration
 - 1. Area under a curve
 - 2. Area between curves
 - 3. Volume of a solid of revolution
- V. Inverse functions
 - 1. Differentiation of inverse functions

VI. METHODS OF INSTRUCTION:

- A. **Discussion** -
- B. **Lecture** -
- C. Web- or CD-Rom-based tutorials
- D. Student presentations
- E. Collaborative learning

VII. TYPICAL ASSIGNMENTS:

- A. Homework
 - 1. Homework should be assigned from the text and should include a sufficient number and variety of problems to develop both skill and conceptual understanding. A typical assignment should take an average student 1 to 2 hours for each hour in class.
- B. Collaborative learning
 - 1. Collaborative learning, done in small groups of 2-4 students, can be used to introduce new concepts, build skills, or teach problem solving. Students may be asked to present their results on the board.
 - 2. Example collaborative learning assignment: Have each group solve a curve-sketching problem and then present their work to the rest of the class, explaining the process they used and their results.

VIII. EVALUATION:

Methods/Frequency

- A. Exams/Tests
 - minimum 4 exams and a comprehensive final exam
- B. Quizzes
 - Announced or unannounced, in-class or take home at the discretion of the instructor
- C. Home Work
 - Assigned for each section covered
- D. Other
 - 1. Collaborative Group Activities
 - a. At the discretion of the instructor

IX. TYPICAL TEXTS:

1. Hass, J.R., Heil, C.D., & Weir, M.D. (2017). *Thomas' Calculus: Early Transcendentals* (14th ed.). Boston, MA: Pearson.
2. Stewart, J. (2016). *Calculus* (8th ed.). Boston, MA: Cengage.
3. Briggs, W.L., Cochran, L., & Gillett, B. (2015). *Calculus: Early Transcendentals* (2nd ed.). New York, NY: Pearson.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

- A. Graphing calculator may be required