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Course Outline for MATH 1

CALCULUS I

Effective: Fall 2018

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
and

MATH 39 - Trigonometry
with a minimum grade of C
or

MATH 38 - Trigonometry with Geometry
with a minimum grade of C

Grading Methods:
Letter Grade

Discipline:
- Mathematics

	MIN
Lecture Hours:	90.00
Total Hours:	90.00

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 <a,b> and ai+bj.

C. MATH38
1. Solve problems using definitions, postulates, and theorems concerning:
2. Congruent and similar triangles;
3. Perimeters, circumferences, and areas of 2-dimensional geometric figures;
4. Volumes and surface areas of 3-dimensional geometric figures.
5. Identify and use trigonometric ratios in problem solving;
6. Define trigonometric functions in terms of the right triangle and the unit circle;
7. Memorize the values for sine, cosine and tangent functions for common angles, both in degrees and radians;
8. Memorize the Pythagorean identities, reciprocal identities, double angle and half-angle formulas for sine and cosine and sum and difference formulas for sine and cosine;
9. Develop and use trigonometric formulas to solve problems;
10. Solve trigonometric equations including equations with multiple angles over different intervals;
11. Graph trigonometric and inverse trigonometric functions;
12. Develop and use the law of sines and law of cosines to completely solve an oblique triangle;
13. Convert between polar coordinate system and rectangular coordinate system;
14. Graph basic polar coordinate equations.

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 that 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:

A. **Methods**

1. Exams/Tests
2. Quizzes
3. Home Work
4. Other:
    a. Collaborative Group Activities
    b. Cumulative final exam

B. **Frequency**

1. Exams/Tests
    a. Recommend minimum of four exams
    b. Comprehensive final examination
2. Quizzes
    a. Announced or unannounced, in-class or take home at the discretion of the instructor
3. Homework
    a. Assigned for each section covered
4. 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