College of San Mateo
Official Course Outline

1. **COURSE ID:** MATH 251 **TITLE:** Calculus with Analytic Geometry I **C-ID:** MATH 210
   Units: 5.0 units **Hours/Semester:** 80.0-90.0 Lecture hours; 160.0-180.0 Homework hours; 240.0-270.0 Total Student Learning hours
   Method of Grading: Letter Grade Only
   Prerequisite: MATH 222 Or Path to Calculus (Math 225) or placement by other college approved methods.

2. **COURSE DESIGNATION:**
   Degree Credit
   Transfer credit: CSU; UC
   AA/AS Degree Requirements:
   CSM - COMPETENCY REQUIREMENTS: C1 Math/Quantitative Reasoning Basic Competency
   CSM - GENERAL EDUCATION REQUIREMENTS: E2b. Communication and Analytical Thinking
   CSU GE:
   CSU GE Area B: SCIENTIFIC INQUIRY AND QUANTITATIVE REASONING: B4 - Mathematics/Quantitative Reasoning
   IGETC:
   IGETC Area 2: MATHEMATICAL CONCEPTS AND QUANTITATIVE REASONING: A: Math

3. **COURSE DESCRIPTIONS:**
   Catalog Description:
   This course is an introduction to calculus and analytic geometry, including limits and continuity, the derivative, applications of the derivative, the definite integral, and the fundamental theorem of calculus.

4. **STUDENT LEARNING OUTCOME(S) (SLO'S):**
   Upon successful completion of this course, a student will meet the following outcomes:
   1. Calculate limits when they exist; when limits do not exist, give reasons for their non-existence.
   2. Determine where a function is continuous and/or differentiable, and explain why.
   3. Compute derivatives of polynomial, rational, algebraic, exponential, logarithmic, and trigonometric functions.
   4. Use techniques of differentiation, including the product, quotient, and chain rules, and implicit differentiation.
   5. Apply differentiation to the study of functions and their graphs, to optimization and related rate problems, and to applications from science and economics.
   6. Compute anti-derivatives of polynomial, rational, algebraic, exponential, logarithmic, and trigonometric functions.
   7. Interpret Riemann sums as definite integrals, relate definite integrals to areas, and evaluate definite integrals using the Fundamental Theorem of Calculus.

5. **SPECIFIC INSTRUCTIONAL OBJECTIVES:**
   Upon successful completion of this course, a student will be able to:
   1. Calculate limits when they exist, and explain why when they do not.
   2. Determine where a function is continuous and/or differentiable, and explain why.
   3. Compute derivatives of polynomial, rational, algebraic, exponential, logarithmic, and trigonometric functions.
   4. Use techniques of differentiation, including the product, quotient, and chain rules, and implicit differentiation.
   5. Apply differentiation to the study of functions and their graphs, to optimization and related rate problems, and to applications from science and economics.
   6. Compute anti-derivatives of polynomial, rational, algebraic, exponential, logarithmic, and trigonometric functions.
   7. Interpret Riemann sums as definite integrals, relate definite integrals to areas, and evaluate definite integrals using the Fundamental Theorem of Calculus.

6. **COURSE CONTENT:**
   Lecture Content:
   1. Review Topics (as necessary)

A. Analytic Geometry: intervals, absolute value, linear and nonlinear inequalities; distance, slope and midpoint formulas; circles, lines, conics; parametric equations.
B. Functions: definition, notation, domain and range; piecewise defined functions, graphs, symmetry, translation, reflection, stretching; addition of ordinates.
C. Combining functions to create new functions by +, – , x, /, and composition.
D. Types of functions: algebraic (including constant, power, root, polynomial, rational) and transcendental (including trigonometric, exponential and logarithmic); inverse functions

2. Limits and Continuity
   A. Limit of a function: Intuitive and ε-δ definitions; one-sided limits; squeeze theorem.
   B. Continuity at a point, on open and closed intervals, discontinuities, continuity of combinations of functions, including composite functions, polynomials, and rational functions; Intermediate Value Theorem.
   C. Slope of tangent line defined as limit of slope of secant lines; average and instantaneous rates of change, velocity and acceleration.
3. Derivatives: Fundamentals
   A. Derivatives: limit definition; derivative as a function; differentiability at a point and on an open interval; notation;
   B. Differentiability implies continuity; interpretations: slope of tangent, velocity, instantaneous rate of change
   C. Differentiation formulas: power rule, linearity, product, quotient and chain rules: statements and proofs
   D. Derivatives of exponential and trigonometric functions
   E. Higher derivatives: definition and notation
   F. Implicit differentiation for first and higher derivatives, and for differentiation log and inverse trig functions
   G. Applications such as motion on a line, linear density, marginal cost, revenue, and profit
4. Derivatives: Further Topics
   A. Mean Value Theorem and Rolle's Theorem (statements and proofs).
   B. Differentials: linear approximations and error estimates.
   C. Indeterminate forms, l'Hôpital's rule
   D. Logarithmic differentiation, related rates, Newton's Method
5. Optimization and Curve Sketching
   A. Relative and absolute extrema; Extreme Value and Fermat's Theorem; first derivative test
   B. Concavity on an interval; points of inflection; second derivative test for classifying local extrema
   C. Limits at infinity and horizontal asymptotes; limits at infinity of rational and algebraic functions.
   D. Infinite limits and vertical asymptotes.
   E. Curve sketching
      a. Plotting points; domain and range; intercepts; symmetry and periodicity
      b. Asymptotes (horizontal, vertical, and slant); end behavior as $x \to \pm$ Intervals of increase, decrease, monotonicity, upward and downward concavity
      c. Local extrema, flex points, discontinuities
   F. Optimization: analyze and solve problems from a variety of areas, e.g. geometry, physics, and economics.
6. Introduction to Integration
   A. Antiderivatives: definition, examples, linearity.
   B. Riemann sum definition of the definite integral: statement, notation, examples
   C. Fundamental Theorem of Calculus: statement and proof and applications.
   D. Substitution: relationship to the chain rule; finding and using substitutions.

7. **REPRESENTATIVE METHODS OF INSTRUCTION:**

Typical methods of instruction may include:
A. Lecture
B. Discussion
C. Other (Specify): A. Instructional methods that are focused on inquiry-based learning (for example, using case studies). B. Instructional methods focused on active learning (Collaboration in small and large groups). C. Instructional methods that trigger student thinking (Building Thinking Classroom activities with emphasis on creative and critical thinking). D. Instructional methods with the use of technology (Desmos classroom, Google Docs, Google Spreadsheets, etc.).

8. **REPRESENTATIVE ASSIGNMENTS**

Representative assignments in this course may include, but are not limited to the following:

Writing Assignments:

Students may be assigned papers and/or projects on the subject matter. (Example: Students will write a short paper on how Archimedes solved Quadrature of the Parabola (found the area between the line and the parabola) in the 3rd century BC and then show how the same problem can be solved with the modern Calculus).

Reading Assignments:

Instructor will assign readings for discussion.

Other Outside Assignments:

The instructor selects problems, projects, and modeling assignments to supplement student learning.

9. **REPRESENTATIVE METHODS OF EVALUATION**

Representative methods of evaluation may include:

A. Class Participation
B. Exams/Tests
C. Group Projects
D. Quizzes
E. Written examination
F. A. Written individual assignments and/or journal- to demonstrate individual student progress toward objectives. B. Small group presentations - to demonstrate student participation in problem solving process C. Written exams/quizzes - to reflect student knowledge of vocabulary, concepts, and application of concepts to problem solving as presented in lectures and discussion, small group sessions, and text readings; to include calculation of measures and models, but also interpretation of results in the context of the data being analyzed. D. Directed questions in quizzes and exams as to the meaning of various parts of formulas. E. A comprehensive and cumulative Final Examination - to reflect and demonstrate student knowledge of vocabulary, concepts, and applications of concepts to problem solving as presented in lectures and discussions, small group sessions, and text readings. F. Participation - to reflect student involvement in class discussions, small group sessions and presentations.

10. **REPRESENTATIVE TEXT(S):**

Possible textbooks include:

A. Stewart, James.. *Calculus: Early Transcendentals*, 9th ed. Cengage, 2020
B. Strang, Gilbert. *Calculus, Volume 1*, ed. OpenStax, 2024
C. Matthew Boelkins. *Active Calculus*, ed. http://activecalculus.org, 2019
D. Stewart, James. *Calculus, Early Transcendentals*, 8th ed. Belmont, CA: Thomson Higher Ed/Brooks/Cole, 2016

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