MATH 1BH: HONORS CALCULUS II

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2022
Units:	5
Hours:	5 lecture per week (60 total per quarter)
Prerequisite:	MATH 1A or 1AH.
Corequisite:	MATH 1BHP.
Advisory:	Demonstrated proficiency in English by placement via multiple measures OR through an equivalent placement process OR completion of ESLL 125 & ESLL 249; not open to students with credit in MATH 1B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Area V: Communication & Analytical Thinking
Transferable:	CSU/UC
Grade Type:	Letter Grade Only
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students will solve problems involving applications of integration of functions of a single variable.
- Students will develop conceptual understanding of integration of functions of a single variable. They will learn to demonstrate and communicate this understanding in a variety of ways, such as: reasoning with definitions and theorems, connecting concepts, and connecting multiple representations, as appropriate.
- Students will demonstrate the ability to compute and approximate integrals of functions of a single variable.
- Students will use formal definitions with theorems and mathematical proof techniques to prove indefinite, definite, and improper integrals, properties of integrals, and relevant theorems.

Description

Introduction to integral calculus, including Riemann sums, definite, indefinite, and improper integrals, the first and second fundamental theorems of calculus and their applications to geometry, physics, and solutions to elementary differential equations. Honors work emphasizes more in-depth analysis of real-world problems and the theory through proofs using analysis techniques.

Course Objectives

The student will be able to:

1. Demonstrate an understanding of and evaluate and approximate definite integrals.
2. Find antiderivatives graphically, and analytically.
3. Use the first and second fundamental theorems of calculus to evaluate definite integrals and construct antiderivatives.
4. Evaluate a definite integral as a limit.
5. Apply integration to find area.
6. Evaluate definite and indefinite integrals using a variety of integration formulas and techniques.
7. Apply integration to areas and volumes, and other applications such as work or length of a curve.
8. Evaluate improper integrals.
9. Graph, differentiate, and integrate functions in polar and parametric forms.
10. Solve and interpret solutions to elementary differential equations.
11. Use technology, such as graphing calculators and/or computer software to assist in solving problems involving any of the topics in (1) through (10) above.
12. Discuss mathematical problems and write solutions in accurate mathematical language and notation.
13. Interpret mathematical solutions.
14. Prove indefinite, definite, and improper integrals, properties of integrals, and relevant theorems.

Course Content

1. Demonstrate an understanding of and evaluate and approximate definite integrals
    a. Signed area under a curve and the net change of a function F from f
    b. Properties of integrals
    c. Approximating definite integrals
    d. Interpretations of the definite integral
    e. Average value of a function
    f. Numerical approximations to definite integrals using rectangular, trapezoidal and Simpson's approximation and estimation of errors
    g. Formal definition of the definite integral
2. Find antiderivatives graphically, and analytically
    a. The graphical relationship between a function and its antiderivatives
    b. Construction of antiderivatives analytically
3. Use the first and second fundamental theorems of calculus to evaluate definite integrals and construct antiderivatives
    a. Fundamental theorem of calculus I for evaluating definite integrals
    b. Fundamental theorem of calculus II for constructing antiderivatives
    c. Fundamental theorem of calculus for evaluating improper integrals
4. Evaluate a definite integral as a limit
    a. Riemann sum
5. Apply integration to find area
    a. Signed area under a curve
6. Evaluate definite and indefinite integrals using a variety of integration formulas and techniques
    a. Integration by substitution
    b. Integration by parts
    c. Integration by partial fraction expansion
    d. Integration using trigonometric substitutions
    e. Integrals of inverse functions
    f. Integrals of trigonometric, exponential and logarithmic functions

7. Apply integration to areas and volumes, and other applications, such as work or length of a curve
   a. Applications of integration to general problems from geometry involving areas, volumes and arc length
   b. Surfaces of revolution
   c. Applications of definite integrals to problems from physics such as work, moments and centers of mass
   d. Applications of integrals to solve simple differential equations of motion
8. Evaluate improper integrals
   a. Find improper integrals
   b. Interpret improper integrals
   c. Find improper integrals by using the formal definition
9. Graph, differentiate, and integrate functions in polar and parametric forms
   a. Parametric curves
   b. Polar curves
10. Solve and interpret solutions to elementary differential equations
    a. Verification of solutions to elementary differential equations
    b. Use of slope fields to get qualitative information about solutions to differential equations
    c. Solutions to elementary first order differential equations by separation of variables
    d. Applications of differential equations to growth and decay problems
11. Use technology, such as graphing calculators and/or computer software to assist in solving problems involving any of the topics in (1) through (10) above
    a. Calculator/computer utilities for evaluating definite integrals
    b. Calculator/computer utilities for constructing graphs of antiderivatives
    c. Calculator/computer programs for approximating definite integrals
12. Discuss mathematical problems and write solutions in accurate mathematical language and notation
    a. Application problems from other disciplines
    b. Proper notation
    c. Correct mathematical proofs of certain integrals, properties of integrals, and theorems
13. Interpret mathematical solutions
    a. Explain the significance of solutions to application problems
14. In addition to all material covered in MATH 1B, the honors student in this course will do the following: Prove indefinite, definite, and improper integrals, properties of integrals, and relevant theorems
    a. The Reimann integral
    b. Definite integrals using the formal epsilon-delta definition
    c. Proofs of properties of the Riemann integral
    d. Riemann integrable functions
    e. Formal partitions of sets
    f. Proofs of theorems
       i. Fundamental theorem of calculus I
       ii. Fundamental theorem of calculus II
    g. Applying the fundamental theorems to find antiderivatives formally
    h. Finding improper integrals using the formal definition

Lab Content

Not applicable.

Special Facilities and/or Equipment

1. Access to graphing technology, such as a graphing calculator or graphing software.
2. Access to a mathematical typesetting software.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Written homework
Quizzes and tests
Proctored comprehensive final examination
Typed solutions to special applied projects with detailed explanations

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture
Discussion
Cooperative learning exercises

Representative Text(s) and Other Materials

Briggs, W., L. Cochran, and B. Gillett. Calculus Early Transcendentals, 3rd ed.. 2018.

Alternative textbook: Calculus Volumes 1 & 2, OpenStax, 2021. https://openstax.org/subjects/math

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Homework problems covering subject matter from text and related material ranging from 30-60 problems per week. Students will need to employ critical thinking in order to complete assignments. Honors students will be assigned some of the more challenging problems from the textbook.
2. Six hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials and notes.
3. Students will submit a typed report solving at least one applied, real-world problem. Typed solutions should be generated using a mathematical typesetting software. These special applied projects will require students to discuss mathematical problems, write solutions using accurate mathematical language and notation, and interpret mathematical solutions. Projects may require the use of a computer algebra system, such as Mathematica or MATLAB.
4. Worksheets: Problems and activities covering the subject matter. Such problems and activities will require students to think critically. These worksheets may be completed inside or outside of class.

Discipline(s)

Mathematics