AP Calculus AB Syllabus

Course Overview

AP Calculus is a college level, introductory course in differential and integral calculus. The primary focus of this course is to prepare students to take, and successfully pass, the AP Calculus AB Exam that will be administered in May of this upcoming Spring. The course will move at a quick pace with a workload consistent with that of a collegiate course. Homework problems, quizzes, and tests will reflect problems in three general areas: basic mastery, mastery, and AP mastery. It is the aim of the course to have students work from basic mastery to AP mastery throughout each topic explored. All tests and quizzes will be comprehensive. Homework will be assigned daily and expected to be completed by each assigned due date. A graphing calculator is required for this course. A calculator will be provided for use if you cannot get your own calculator. The course will include such topics as limits, continuity, functions, derivatives, definite integrals, and applications of such topics. A complete listing of topics may be found in the AP ® Calculus AB Course Description.

Course Topics and Outline

Chapter 1: Prerequisites for Calculus — Approximately 11 days

- 1.1 Lines
  - Increments, slope of a line, parallel and perpendicular lines, equations of lines, lines of regression, applications.
- 1.2 Functions and Graphs
  - Functions, domain, range, viewing and interpreting, even/odd functions and symmetry, piecewise, absolute value functions, and composite.
- 1.3 Exponential Functions
  - Exponential growth, exponential decay, lines of regression, applications, the number e.
- 1.4 Parametric Equations
  - Relations, circles, ellipses, lines and other curves.
- 1.5 Functions and Logarithms
  - One-to-one functions, inverses, finding inverses, logarithmic functions, properties of logarithms, applications.
- 1.6 Trigonometric Functions
  - Radian measure, graphs of trigonometric functions, periodicity, even/odd trigonometric graphs, applications, inverse trigonometric functions.
- Chapter 1 Review and Assessment

Chapter 2: Limits and Continuity — Approximately 10 days

- 2.1 Rates of Change and Limits
  - Average and instantaneous speed, definition of a limit, properties of limits, one-sided and two-sided limits, sandwich theorem.
- 2.2 Limits Involving Infinity
  - Finite limits as $x \to \pm\infty$, sandwich theorem, Infinite limits as $x \to a$, end behavior models, "se eing" limits as $x \to \pm\infty$.
- 2.3 Continuity

    - Continuity at a point, continuous functions, algebraic combinations, composites, intermediate value theorem for continuous functions.
- 2.4 Rates of Change and Tangent Lines
    - Average rates of change, tangent to a curve, slope of a curve, normal to a curve, speed revisited.
- Chapter 2 Review and Assessment

Chapter 3: Derivatives Approximately 30 days

- 3.1 Derivatives of a Function
    - Definition of a derivative, notation, relationships between the graphs of f and f', graphing the derivative from data, one-sided derivatives.
- 3.2 Differentiability
    - How f'(a) might fail to exist, differentiability implies local linearity, derivatives of a calculator, differentiability implies continuity, intermediate value theorem for derivatives.
- 3.3 Rules of Differentiation
    - Derivative of a constant functions, power rule, constant multiple rule, sum and difference rule, product rule, quotient rule, applications.
- 3.4 Velocity and Other Rates of Change
    - Instantaneous rates of change, motion along a line, sensitivity to change, derivatives in economics.
- 3.5 Derivatives of Trigonometric Functions
    - Derivative of the Sine function, derivative of the Cosine function, simple harmonic motion, jerk, derivatives of other basic trigonometric functions.
- 3.6 Chain Rule
    - Derivative of a composite function, "outside-inside" rule, repeated use of the chain rule, slopes of parameterized curves, power chain rule.
- 3.7 Implicit Differentiation
    - Implicitly defined functions, lenses, tangents, and normal lines, derivatives of higher order, rational powers of differentiable functions.
- 3.8 Derivatives of Inverse Trigonometric Functions
    - Derivatives of inverse functions, derivative of the arcsine, derivative of the arctangent, derivative of the arcsecant, derivatives of the other three.
- 3.9 Derivatives of Exponential and Logarithmic Functions
    Derivative of e^x, derivative of a^x, derivative of ln x, derivative of $\log_a x$, power rule for arbitrary real powers.
- Chapter 3 Review and Assessment

Chapter 4: Applications of Derivatives Approximately 25 days

- 4.1 Extreme Values of Functions
    - Absolute (global) extreme values, Local (relative) extreme values, finding extreme values.
- 4.2 Mean Value Theorem
    - Mean value theorem, physical interpretation, increasing and decreasing functions, other consequences.
- 4.3 Connecting f ' and f " with the Graph of f
    - First derivative test for local extrema, concavity, points of inflection, second derivative test for local extrema, learning about functions from derivatives.

- 4.4 Modeling and Optimization
    - Examples from business and industry, example from mathematics, examples from economics, modeling discrete phenomena with differentiable functions.
- 4.5 Linearization
    - Linear approximation.
- 4.6 Related Rates
    - Related rate equations, solution strategy, simulating related motion.
- Chapter 4 Review and Assessment

Chapter 5: The Definite Integral Approximately 26 days

- 5.1 Estimating with Finite Sums
    - Distance traveled, rectangular approximation methods, volume of a sphere, cardiac output.
- 5.2 Definite Integrals
    - Riemann sums, terminology and notation of integration, definite integral and area, constant functions, integrals on a calculator, discontinuous integrable functions.
- 5.3 Definite Integrals and Antiderivatives
    - Properties of definite integrals, average value of a function, mean value theorem from definite integrals, connecting differentiable and integral calculus together.
- 5.4 Fundamental Theorem of Calculus
    - Fundamental Theorem of Calculus part I, Fundamental Theorem of Calculus part II, area connection, applications.
- 5.5 Trapezoidal Rule
    - Trapezoidal approximations, other algorithms, error analysis.
- Chapter 5 Review and Assessment

Chapter 6: Differential Equations & Mathematical Modeling Approximately 22 days

- 6.1 Antiderivatives and Slope Fields
    - Solving initial value problems, antiderivatives and indefinite integrals, slope fields, properties of indefinite integrals, applications.
- 6.2 Integration by Substitution
    - Power rule in integral form, trigonometric integrands, substitution in indefinite integrals, substitution in definite integrals, separable differential equations.
- 6.4 Exponential Growth and Decay
    - Law of exponential change, continuously compounded interest, radioactivity, Newton's law of cooling, resistance proportional to velocity.
- 6.5 Population Growth
    - Exponential model, logistic growth model, logistic regression.
- 6.6 Numerical Methods
    - Euler's method, numerical solutions, graphical solutions, improved Euler's method.
- Chapter 6 Review and Assessment

Chapter 7: Applications of Definite Integrals Approximately 21 days

- 7.1 Integral as Net Change
    - Linear motion revisited, general strategy, consumption over time, net change from data, work.

- 7.2 Areas in the Plane
    - Areas between curves, area enclosed by intersecting curves, boundaries with changing functions, integrating with respect to y, saving time with geometry formulas.
- 7.3 Volumes
    - Volumes as an integral, square cross sections, circular cross sections, cylindrical shells, other cross sections.
- 7.4 Applications from Science and Statistics
    - Work revisited, fluid force and fluid pressure, normal probabilities.
- Chapter 7 Review and Assessment

Review For Calculus AB Exam Approximately 15 days

- Review of "ma jor" themes central ideas.
- Practice free response questions
- Practice multiple choice questions
- Test taking tips
    - Four functions of calculator
    - Three decimal rule
    - Guessing only when answered narrowed to three or less
    - Free response part c credit when not able to do a or b
- General strategy and game-planning.

Teaching Strategies

I teach my students to learn and interpret the material in four ways: analytically, graphically, numerically and verbally. I begin lectures and discussions from each perspective and strive to have students find connections between the algebra, graphs, tables, and words that they speak. This has proven to be an extremely powerful method of teaching, and consequently, a powerful method of learning. Students are assigned problem sets from each section of the book. The homework is collected, graded, and returned with insights and questions to further the students' development of the central ideas. I often use the explorations, that are given in each section, to preview or solidify main ideas. Students often work in groups to foster collaborative conversations that challenge one's own ideas and further the development and comprehension of all in the group. The group is then asked to report back to the class about their findings and offer adequate and correct justification for their conjectures. Tests and quizzes are used to assess a student's ability at the middle and end of each chapter.

Technology and Calculator

Each student has access and uses a TI-83, TI-84, or TI-89. The use of the calculator is limited to the four uses that are acceptable for credit on the AP calculus AB exam. The uses are: calculating a numerical derivative, calculating a numerical integral, creating a graph of a function, and to solve equations. All other uses of the calculator are then said to be supportive to ideas and conjectures that students make, but may not be the central process to completing tasks and prompts given from the curriculum. Other technologies used in this class have been the inclusion of the AP College Board website and other websites found by the instructor that are used to practice skills. Often times, these websites offer short tutorials on topics covered in class and then present a short set of practice problems for students to try. The teacher also has access to a TI-84 overhead calculator.

Teacher Resources

Primary Text

Finney, Ross L., Franklin D. Demana, Bert K. Waits, and Daniel Kennedy. *Calculus: Graphical, Numerical, Algebraic.* Prentice Hall. 1999. 2nd edition.

Supplemental Materials

Ancillary materials from primary text including technology resources, AP concepts workbooks, assessment pieces, teacher's guide, pacing guide, solutions manual.

Finney, Ross L., Franklin D. Demana, Bert K. Waits, and Daniel Kennedy. *Calculus: Graphical, Numerical, Algebraic.* Prentice Hall. 2006. 3rd edition.

Stewart. *Calculus Concepts and Contexts*. International Thompson Publishing Inc. 1998.

Student Evaluation

Students are assessed in four ways. The first assessment is through their written communication and thoughts about the material that we are covering. I implement the use of the explorations in each section to have students think logically about "why" things are happening and have them explain them to me. Often times, they are in groups and must discuss their thoughts, and formulate a group conjecture in written form. They are then asked to present their findings to the class and defend their conjectures with proper justification.

The second way students are assessed is through the evaluation of assigned problem sets. The problems chosen by the instructor are meant to have students work on problems that range from basic mastery to mastery to AP mastery. This progression allows students to learn the material on a graduated scale and build confidence around the material they are learning. Homework is collected frequently and then graded and returned to the student. The instructor evaluates their work, conjectures, and explanations at an AP level. The homework is then returned with comments to further the development of the ideas of the content and to have students reflect upon their work and their justifications. The homework set of problems also includes "extending the idea" problems and "writing to learn" problems. The instructor gives students AP mastery practice problems using the "extending the idea" problems. The "writing to learn" problems are used to have students communicate their thoughts and answers in a written expression.

The third way that students are assessed is with tests and quizzes. The tests and quizzes are comprehensive and are modeled after AP style questions. As the year progresses the tests are gradually molded to the format of the AP exam. This includes offering multiple choice and free response questions, as well as, taking partial points off for incorrect answers. The tests are rigorous and problems are consistent with an AP level of difficultly.

Finally, students are asked to review and reflect on their tests after they have been graded and returned. Then an individual meeting is scheduled to review the test with the instructor. The student leads the meeting and explains their method of thinking when they were completing the test and their corrected method of thinking. This offers the teacher the chance to have students verbally convey

the ideas and concepts of the content of the current chapter they are discussing. This has been extremely useful for the student and the teacher.

Calculus Labs

Calculus Labs have been implemented to introduce new topics and also to solidify connections between the algebra involved and what is happening in the graphs. Labs are used with topics such as limits, derivatives, the Fundamental Theorem of Calculus, differential equations and indefinite/definite integrals. In these labs, students are required to make initial hypotheses and then investigate their hypotheses using their graphing calculators to generate relevant data and information. Then, students are asked to make conjectures about the topic they are investigating and support their claims. Students are then grouped together to share/defend their conjectures and must come up with a group conjecture that will be presented to the class.

Student Activities

1. Daily homework sets
2. Explorations embedded within section notes
3. Extending the Idea problems worked out in groups
4. Math labs (derivative, limits, continuity, Fundamental Theorem of Calculus, integrals, slope fields)
5. Lecture Notes
6. Writing to Learn problems
7. Small class presentations
8. Quizzes
9. Tests
10. Calculator activities
11. Timed AP simulated experiences (Free Response/Multiple Choice)
12. Website interaction in computer lab
13. Past material warm-ups