

Preliminary Notes

1. The mathematics department recently adopted as the text for this course, *Calculus* (3rd Edition), by Hughes-Hallet, Gleason, McCallum, et al. In content and pedagogical direction this text is considered to be a compromise between reform and traditional approaches.
2. This outline conforms to the structure of the Chapters 2, 3, and 4 in *Calculus* by Hughes-Hallet, Gleason, McCallum, et al. We heartily recommend that you refer to this text, even if your students do not have access to it.
3. In the spirit of calculus reform, the Hughes-Hallet text relegates traditionally more difficult problems to the standard homework exercises, while eschewing repetitious exercises. Also, the text relies heavily on graphical and numerical approaches to conceptualization. Depending on the needs of your students, we suggest that you augment your lessons so that they cover the requisite content and pedagogical approaches.
4. The prescribed content closely conforms to the chapter organization of the Hughes-Hallet text, and in what follows the chapter numbers are left for reference.
5. Note the optional content in Chapter 4.

Learner Outcomes

Using the **Rule of Three**, i.e., symbolically, graphically, and numerically, the learner will demonstrate the following.

Chapter 2: The derivative of a function, including

1. Average Velocity (Rates of Change)
2. Instantaneous Velocity
3. Limits and instances where limits do not exist
4. The derivative at a point
5. The derivative of a function
6. Interpretations of the first derivative
7. Higher order derivatives and their interpretations
8. Continuity
 - a. Instances where continuity cannot exist
 - b. Continuity of sums, products, and quotients, and composites of functions
9. Differentiability or Smoothness of a function (local and global)
 - a. A smooth function is continuous
 - b. Power Rule for derivatives of polynomials
 - b. Derivatives of sums, products, quotients, and composite functions

Chapter 3 Short-cuts to Differentiation, including

1. Derivative of cf , where c is constant
2. The power rule for polynomials
3. Derivatives of sums and differences of functions
4. Derivatives of exponential functions
5. Derivatives of products and quotients of functions
6. The chain rule: derivatives of composites of functions
7. Derivatives of trigonometric functions
8. Derivatives of implicit functions
9. Parametric equation models and their derivatives
10. Local linearity and its applications
 - a. Error approximation
 - b. Finding limits (L'Hopital's Rule)

Chapter 4: Using the Derivative in applications, including

1. Determining the behavior of functions to
 - a. Locate extrema (maxima and minima) using first and second derivatives
 - b. Locate inflection points
 - c. Locate regions of concavity
 - d. Locate regions of functional increase or decrease
2. Determining global maxima and minima
3. Determining marginality in cost, revenue, and profit models
4. Determining important features of well-known functions in applications (Optional)
 - a. $y = -16t^2 + v_0t + x_0$
 - b. $y = A\sin(ax + b)$
 - c. $y = e^{-(x-a)^2}$
 - d. $y = a(1 - e^{-bx})$
5. Optimization and Modeling

Note: This section emphasizes the typical applications for optimization using local maxima and minima in physical settings.
6. Hyperbolic trigonometric functions and some applications (Important but Optional)
7. Theorems About Continuous and Differentiable Functions (Important but Optional)
 - a. The extreme value theorem
 - b. The mean value theorem
 - c. The increasing function theorem
 - d. The constant function theorem
 - e. The "Racetrack Principle"