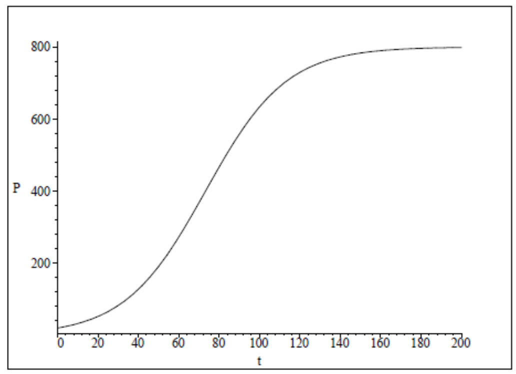
Math 111 - Calculus I (Differential Calculus)

What is differential calculus?

Calculus is the language that science and technology use to talk about change. What kind of change? A few of many possible examples:

- How fast is a comet moving? (How is its distance from the sun *changing*?) (Physics)
- At what rate is the salmon population *decreasing*? (Biology/Ecology)
- How does *changing* the temperature of a liquid affect the *rate* at which it evaporates? (Chemistry)
- At what *rate* does a rumour spread through a population? (Sociology)
- How does the amount of information already memorized affect the *rate* at which new information can be memorized? (Psychology)

Differential calculus can take these real-world situations and construct *mathematical models* of them, which describe the situations precisely, and may be used to better understand them.



Example:
As an illustration, in the case of the rumour-spread example above, a calculus student learns to construct a model like the *differential equation*

$$\frac{dP}{dt} = 0.05P\left(1 - \frac{P}{800}\right)$$

(where P is the number of people who have heard a rumour, in a total population of 800 individuals). The differential equation predicts the relationship between P and time t shown in the graph. The mathematical object on the left, $\frac{dP}{dt}$, is a "derivative", the central idea developed in Calculus I and one of the most commonly occurring tools in science and mathematics.

First-year calculus courses also serve as the entry-point to university level mathematics. Ideas developed there are central to major areas of modern mathematics, and taking the courses is the first step in exploring those worlds, and an interesting intellectual journey in its own right.

Prerequisites:
One of the following: (B or better in one of Principles of Mathematics 12, Pre-calculus 12, MATH 095, or MATH 096) or (B or better in both MATH 092 and MATH 093) or (C+ or better in MATH 110) or (at least 70% on the MDPT).

See over for content

Content:

- Preliminaries:
  1. brief review of functions, functional notation, and graphs
  2. review of special functions and their graphs: power, polynomial, exponential, inverse, logarithmic, trigonometric

- The Derivative:
  1. introduction to derivatives and limits
  2. interpretation of the derivative as a rate of change
  3. geometric interpretation of first and second derivatives
  4. definition of derivatives using numerical methods
  5. formal definition of the derivative
  6. limits and continuity
  7. local linearity

- Differentiation of Special Functions:
  1. power functions
  2. exponential functions
  3. product, quotient, chain rules
  4. trigonometric functions, inverse trigonometric functions
  5. implicitly-defined functions
  6. logarithmic differentiation

- Applications of the Derivative:
  1. curve sketching and analysis of function behaviour; Mean Value Theorem
  2. analysis of families of curves
  3. optimisation problems from various disciplines, which may include physics, chemistry, biology, population studies, economics
  4. related rates problems from various disciplines
  5. Newton’s method
  6. L’Hopital’s rule

- Antiderivatives

- Polar Curves and Parametric Functions
  1. polar coordinates and curves, with applications
  2. differentiation of polar curves
  3. parametric functions and applications
  4. differentiation of parametric functions