A summary of what we have looked at so far. (Hopefully piecing it all together and seeing connections from one section to another)

3.1

- How the first derivative can be used to find extrema (relative min/max's) of a function (*important)*
- Relative Extrema occur only at critical points (found by differentiating a function…finding the derivative…and finding where $f'(x) = 0 \; or \; f'(x) \; does \; not \; exist$
- Finding absolute extrema on a closed interval. We found the critical points and compared their y-coordinates with the endpoints y-coordinates. Highest was the max…lowest was the min. (this is of limited use until we get to OPTIMAZATION problems…section 3.7 (on Friday).

3.2

- **Rolles Theorem**—If a function is on a closed interval where the endpoint's x-coordinates have the same y-coordinate and the function is differentiable between the two x-coordinates, there will be one point in between the two x-coordinates where the derivative is equal to zero.
  (official fancy language can be found on page 170…very worth reading and comparing to my non-rigorous definition here)
- **Mean Value Theorem**—If a function is continuous on a closed interval and differentiable between the two endpoints, there will be one point in between the two endpoints where the slope of the tangent line will equal the slope of line connecting the two endpoints.
  (official fancy language can be found on page 172…very worth reading and comparing to my non-rigorous definition here)

3.3

- Using the first derivative…f'(x)…to determine when a function is increasing or decreasing.
  $f'(x) > 0 \;\rightarrow increasing \qquad f'(x) < 0 \rightarrow decreasing \qquad f'(x) = 0 \;\; or \; f'(x) \; does \; not \; exist \rightarrow critical \; point$
- Steps:
  - Find the critical points
  - set up intervals between $-\infty$, the critical points and ∞.
  - Select values in each interval…find each selected values f'(x) value …i.e.—is graph increasing or decreasing?
  - **First derivative Test…**Determine whether the critical point is a minimum or maximum or neither

3.4

- Using the second derivative…f''(x)…to determine the concavity of a function in an interval.
  $f"(\text{x})>0 \rightarrow \text{concave up} \qquad f"(\text{x}) < 0 \rightarrow concave \;\; down \qquad f"(\text{x})=0 \;\text{ or f"}(x) \; does \; not \; exist \rightarrow possible \; point \; of \; inflection$
- Steps:
  - Find the points of inflection
  - set up intervals between $-\infty$, the possible points of inflection and ∞.
  - Select values in each interval…find each selected values f''(x) value
  - State whether graph is concave up or concave down
  - **Second derivative Test**
    - First find the first derivative
    - Find the critical points
    - Find the second derivative
    - Test the concavity of the critical points using the second derivative.
    - Use results to state whether it is a minimum of maximum or neither

3.5

- Limits at infinity
  - As x approaches infinity from either direction, the y-coordinate (or limit) will approach the horizontal asymptote.
  - If equation is 'bottom heavy, horizontal asymptote will be y=0
  - If equation is 'same degree', the horizontal asymptote will be the quotient of the leading coefficients.

3.5

- Curve Matching
- Matching the graph of a function to the graph of its derivative and to the graph of its second derivative.

3.8

- Applications of first derivative and second derivative