Math 112
Approximating Integrals Numerically

Summary of Results. Consider the definite integral

$$I = \int_a^b f(x)\,dx.$$

For any integer n, use the following notation:

- L_n denotes the left rectangular sum approximation using n rectangles.
- R_n denotes the right rectangular sum approximation using n rectangles.
- M_n denotes the midpoint rectangular sum approximation using n rectangles.
- T_n denotes the trapezoid approximation using n trapezoids.

1. Suppose $f(x)$ is **increasing** on $[a, b]$. Then for any integers m and n, the following bounding (or trapping) inequality is true:

2. Suppose $f(x)$ is **decreasing** on $[a, b]$. Then for any integers m and n, the following bounding (or trapping) inequality is true:

3. Suppose $f(x)$ is **concave up** on $[a, b]$. Then for any integers m and n, the following bounding (or trapping) inequality is true:

4. Suppose $f(x)$ is **concave down** on $[a, b]$. Then for any integers m and n, the following bounding (or trapping) inequality is true:

5. For any n, the following relationship holds among T_n, L_n, and R_n.