5.3, 5.4: FTC

I. \[ \frac{d}{dx} \int_a^x f(t) \, dt = f(x) \]

II. \[ \int_a^b F'(x) \, dx = F(b) - F(a) \]

Warm-up Problems

1. **Clicker** Find the derivative

   \[ \frac{d}{dx} \int_{-x^2}^{e^x} \sin(t^2) \, dt \]

   (a) \[ e^x \sin(e^{2x}) - 2x \sin(x^4) \]
   (b) \[ e^x \sin(e^{2x}) + 2x \sin(x^4) \]
   (c) \[ \sin(e^{2x}) - \sin(x^4) \]
   (d) \[ e^x \sin(e^{2x}) \]
   (e) I have no idea

2. Explain the MVT:

   ![Graph of MVT](image)

   **Tangent Line**
   **Secant Line**

   - Tangent Line
   - Secant Line
   - a
   - e
   - b

Class Problems

3. Find the following indefinite integrals using FTC part 2.

   (a) \[ \int_{-4}^{12} dx = \]
   (b) \[ \int_1^9 -2 \, dx = \]
   (c) \[ \int_1^4 x \, dx = \]
   (d) \[ \int_{-1}^{1} x^2 \, dx = \]
   (e) \[ \int_0^\pi \sin x \, dx = \]
   (f) \[ \int_1^{10} \frac{1}{x} \, dx = \]
   (g) \[ \int_0^{\pi/4} \sec^2 x \, dx = \]
   (h) \[ \int_1^4 x \, dx = \]
4. **Clicker**  
(True/False) Any derivative formula gives a corresponding indefinite integral formula?  
(a) True (b) False (c) Neither True or False

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**Review Problems**

5. Suppose \( \int_{3}^{1} f(x) \, dx = 6 \) and \( \int_{1}^{3} g(x) \, dx = 2 \). What is \( \int_{1}^{3} (2f(x) - 3g(x)) \, dx \)?

6. Suppose \( \int_{1}^{4} f(x) = 8 \), \( \int_{1}^{2} f(x) = 4 \), \( \int_{3}^{4} f(x) = 2 \), what is \( \int_{2}^{3} f(x) = 8 \)?

7. Find \( \int_{0}^{1} x (\sqrt{x} + \sqrt[3]{x}) \, dx \)

8. If \( g(x) = \int_{1}^{x^2} \sin(t^2) \, dt \), find \( g'(x) \).

9. **Clicker** Let \( g(x) = \int_{0}^{x} f(t) \, dt \) where \( f(t) \) is the graph below. Determine which of the statements are true:

   (a) \( g \) attains an absolute maximum at \( x = 2 \)

   (b) \( g \) has a local maximum at \( x = 5 \)

   (c) \( g \) has a local minimum at \( x = 4 \)

   (d) \( g \) is concave down on \([0, 2]\)