- $\dfrac{d}{dx}\left[cf(x)\right] = cf'(x)$
- $\dfrac{d}{dx}\left[f(x) \pm g(x)\right] = f'(x) \pm g'(x)$
- $\dfrac{d}{dx}\left[x^n\right] = nx^{n-1}$
- $\dfrac{d}{dx}\left[e^{f(x)}\right] = f'(x)e^{f(x)}$
- $\dfrac{d}{dx}\left[a^x\right] = (\ln a)\, a^x$
- $\dfrac{d}{dx}\left[\log_c x\right] = \dfrac{1}{x \ln c}$
- $\dfrac{d}{dx}\left[\ln\left(f(x)\right)\right] = \dfrac{f'(x)}{f(x)}$
- $\dfrac{d}{dx}\left[\sin x\right] = \cos x$
- $\dfrac{d}{dx}\left[\cos x\right] = -\sin x$
- $\dfrac{d}{dx}\left[\tan x\right] = \sec^2 x$
- $\dfrac{d}{dx}\left[\sin^{-1} x\right] = \dfrac{1}{\sqrt{1-x^2}}$
- $\dfrac{d}{dx}\left[\cos^{-1} x\right] = -\dfrac{1}{\sqrt{1-x^2}}$
- $\dfrac{d}{dx}\left[\tan^{-1} x\right] = \dfrac{1}{1+x^2}$
- Product rule: $\dfrac{d}{dx}\left[f(x)g(x)\right] = f'(x)g(x) + g'(x)f(x)$
- Quotient rule: $\dfrac{d}{dx}\left[\dfrac{f(x)}{g(x)}\right] = \dfrac{f'(x)g(x) - g'(x)f(x)}{(g(x))^2}$.
- Chain rule: $\dfrac{d}{dx}\left[f(g(x))\right] = f'(g(x))g'(x)$
- Marginal cost: $c'(x)$
- Average cost: $\dfrac{\Delta c}{\Delta x} = \dfrac{c(x_2) - c(x_1)}{x_2 - x_1}$

- Area between curves (ch 6.1)

  (provided that on the interval $[a, b]$, $f(u) \geq g(u)$

$$A = \int_a^b [f(u) - g(u)] \ du$$

  Essentially, $f(u) - g(u)$ needs to be {right function} − {left function} if the functions are in terms of y and you have dy.

  Otherwise, $f(u) - g(u)$ needs to be {upper function} − {lower function} if the functions are in terms of x and you have dx.

- Volume (ch 6.2, 6.3)
  - General:

$$V(u) = \int_{u=a}^{u=b} A(u) \ du$$

  - Disk Method

$$\text{rotation about x-axis: } V(x) = \int_{x=a}^{x=b} \pi \left(f(x)\right)^2 \ dx$$

$$\text{rotation about y-axis: } V(y) = \int_{y=a}^{y=b} \pi \left(g(y)\right)^2 \ dy$$

  - Cylindrical shells

$$\text{rotation about y-axis: } V(x) = \int_{x=a}^{x=b} (2\pi x)\left(f(x)\right) \ dx$$

$$\text{rotation about x-axis: } V(y) = \int_{y=a}^{y=b} (2\pi y)\left(g(y)\right) \ dy$$

- Arc Length (ch 6.4)
  - If $x = f(t)$ and $y = g(t)$

$$L = \int_{t=a}^{t=b} \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2} \ dt$$

  - If $x = x$ and $y = g(x)$

$$L = \int_{x=a}^{x=b} \sqrt{1 + \left(\frac{dy}{dx}\right)^2} \ dx$$

  - If $x = f(y)$ and $y = y$

$$L = \int_{y=a}^{y=b} \sqrt{\left(\frac{dx}{dy}\right)^2 + 1} \ dy$$

- Average Value (ch 6.5)

$$f_{avg} = \frac{1}{b-a} \int_a^b f(x) \ dx$$

- Work (ch 6.6)

$$W = \int_a^b f_{orce}(x) \ dx$$

- Center of Mass (ch 6.6)
  - Moments

$$M_y = \rho \int_a^b x f(x) \ dx$$

$$M_x = \rho \int_a^b \frac{1}{2} \left[f(x)\right]^2 \ dx$$

  - Centroid

$$\bar{x} = M_y / \left(\rho \int_a^b f(x) \ dx\right)$$

$$= \frac{1}{A} \int_a^b x f(x) \ dx$$

$$\bar{y} = M_x / \left(\rho \int_a^b f(x) \ dx\right)$$

$$= \frac{1}{A} \int_a^b \frac{1}{2} \left[f(x)\right]^2 \ dx$$

- Economic Surplus (ch 6.7)
  - Consumer Surplus

    Given a "Production Level" of C, then $P = p(C)$ and Consumer Surplus is

$$\int_0^C [p(x) - P] \ dx$$

  - Producer Surplus

    Given a "Production Level" of C, then $P = p(C)$ and Producer Surplus is

$$\int_0^C [P - p(x)] \ dx$$

- Probability (ch 6.8)
  - Probability Density Function

    $f(x)$ is a probability density function if both of the following are true:

    * $f(x) \geq 0$ for all x
    * $1 = \int_{-\infty}^{\infty} f(x) \ dx$
  - Probability of an event

    If $f(x)$ is a probability density function, then

$$\mathbb{P}\left(a \leq X \leq b\right) = \int_a^b f(x) \ dx$$

  - Average Value (Mean)

    if $f(x)$ is a probability density function, then the mean or average value is given by

$$\mu = \int_{-\infty}^{\infty} x f(x) \ dx$$