### Derivatives

$$\frac{d}{dx}[c] = 0$$
$$\frac{d}{dx}[x^c] = cx^{c-1}$$
$$\frac{d}{dx}[cf(x)] = cf'(x)$$
$$\frac{d}{dx}[f(x) \pm g(x)] = f'(x) \pm g'(x)$$
$$\frac{d}{dx}[f(x)g(x)] = f(x)g'(x) + f'(x)g(x)$$
$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - g'(x)f(x)}{[g(x)]^2}$$
$$\frac{d}{dx}[f(u(x))] = f'(u)u'(x)$$
$$\frac{d}{dx}\left[\frac{1}{x}\right] = -\frac{1}{x^2}$$
$$\frac{d}{dx}[e^x] = e^x$$
$$\frac{d}{dx}\left[e^{u(x)}\right] = e^{u(x)}u'(x)$$
$$\frac{d}{dx}[a^x] = a^x \ln(a)$$
$$\frac{d}{dx}\left[a^{u(x)}\right] = a^{u(x)}u'(x)\ln(a)$$
$$\frac{d}{dx}[\ln(x)] = \frac{1}{x}$$
$$\frac{d}{dx}[\ln(u(x))] = \frac{u'(x)}{u(x)}$$
$$\frac{d}{dx}[\log_a(x)] = \frac{1}{\ln(a)} \cdot \frac{1}{x}$$
$$\frac{d}{dx}[\log_a(u(x))] = \frac{1}{\ln(a)} \cdot \frac{u'(x)}{u(x)}$$

## Probability

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

68–95–99.7 rule

### First/Second Derivative Tests

| | $< 0$ | $> 0$ |
|---|---|---|
| $f'(x)$ | decreasing | increasing |
| $f''(x)$ | concave down | concave up |

### Second Partial Derivative Test

$f_x = 0$ and $f_y = 0$

$$d = f_{xx}f_{yy} - [f_{xy}]^2$$

| $d$ | $f_{xx}$ | result |
|---|---|---|
| $> 0$ | $> 0$ | relative minimum |
| $> 0$ | $< 0$ | relative maximum |
| $< 0$ | | saddle point |
| $= 0$ | | inconclusive |

### Lagrange Multiplier

$$f_x = \lambda g_x$$
$$f_y = \lambda g_y$$
$$\vdots$$
$$g(x, y, \ldots) = 0$$

### Interest

| | |
|---|---|
| Compound Interest | $A = P\left(1 + \frac{r}{n}\right)^{nt}$ |
| Population Growth | $P(t) = P(0)e^{rt}$ |
| Radioactive Decay | $m(t) = m(0)e^{-\frac{t\ln(2)}{h_0}}$ |

### Logarithms

$$\ln(1) = 0$$
$$\ln(e) = 1$$
$$e^{\ln(x)} = x$$
$$\ln(e^x) = x$$
$$e^x = e^y \iff x = y$$
$$\ln(x) = \ln(y) \iff x = y$$
$$\ln(xy) = \ln(x) + \ln(y)$$
$$\ln\left(\frac{x}{y}\right) = \ln(x) - \ln(y)$$
$$\ln\left(x^y\right) = y\ln(x)$$