Jacobian

$$\mathbf{J} = \begin{bmatrix} \frac{\partial \mathbf{f}}{\partial x_1} & \cdots & \frac{\partial \mathbf{f}}{\partial x_n} \end{bmatrix} = \begin{bmatrix} \nabla f_1 \\ \vdots \\ \nabla f_m \end{bmatrix} = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \cdots & \frac{\partial f_1}{\partial x_n} \\ \vdots & \ddots & \vdots \\ \frac{\partial f_m}{\partial x_1} & \cdots & \frac{\partial f_m}{\partial x_n} \end{bmatrix}$$

Equilibrium point

$\dot{x}_0 = F(x_0) = 0$

Linearization

$\dot{x} \approx F(x_0) + J(x_0)(x - x_0)$

Newtons Method

$\mathbf{x}_{n+1} = \mathbf{x}_n - J_F(\mathbf{x}_n)^{-1} F(\mathbf{x}_n)$

Polar coordinates

$$x = r\cos\theta \qquad r = \sqrt{x^2 + y^2}$$

$$y = r\sin\theta \qquad \theta = \arctan\left(\frac{y}{x}\right) + k\pi, \quad x \neq 0$$

Spherical coordinates

$$x = R\sin\phi\cos\theta$$
$$y = R\sin\phi\sin\theta$$
$$z = R\cos\phi$$
$$R^2 = x^2 + y^2 + x^2 = r^2 + z^2$$
$$r = \sqrt{x^2 + y^2} = R * sin(\phi)$$

$$tan(\phi) = \frac{r}{z} = \frac{\sqrt{x^2 + y^2}}{z}$$
$$tan(\theta) = \frac{y}{x}$$

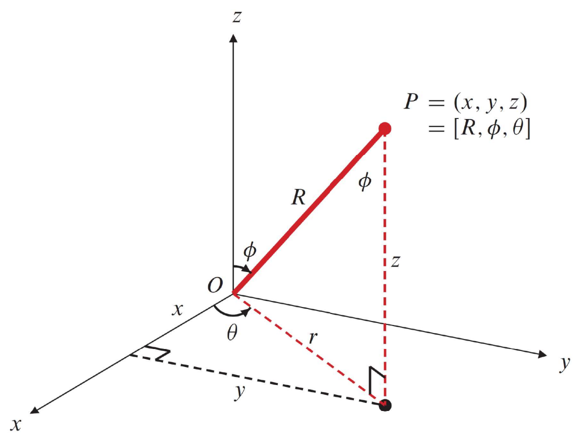

Figure 1: Spherical coordinates as explained in Adams, R. A. & Essex, C. *Calculus* - Ninth Edition.

Trigonometrics

$$\tan x = \frac{\sin x}{\cos x}$$
$$\csc x = \frac{1}{\sin x}$$
$$\sec x = \frac{1}{\cos x}$$
$$\cot x = \frac{1}{\tan x}$$
$$\sinh x = \frac{e^x - e^{-x}}{2}$$
$$\cosh x = \frac{e^x + e^{-x}}{2}$$

$$\sin' x = \cos x$$
$$\cos' x = -\sin x$$
$$\tan' x = \sec^2 x$$
$$\cot' x = -\csc^2 x$$
$$\sec' x = \tan x \sec x$$
$$\csc' x = -\cot x \csc x$$
$$\sinh' x = \cosh x$$
$$\cosh' x = \sinh x$$
$$\tanh' x = \frac{1}{cosh^2 x} = 1 - tanh^2 x$$