Newton Euler

$$\sum \overrightarrow{F} = ma_g$$
$$\sum \overrightarrow{M}_A = I\overrightarrow{\alpha}$$

A is a fixed point or center of gravity

Power Equation

$$T + U = T_o + U_o + W^{(nc)}$$
$$Power = \frac{dW^(nc)}{dt} = \frac{dT}{dt} + \frac{dU}{dt}$$

Lagrange's Equations

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_i}\right) - \frac{\partial T}{\partial \dot{q}_i} + \frac{\partial U}{\partial q_i} = Q_i$$

Linearized Lagrange's Equations

$$[M]\ddot{\overrightarrow{z}} + [C]\dot{\overrightarrow{z}} + [K]\overrightarrow{z} = \overrightarrow{0}$$

$$\overrightarrow{z}(t) = \overrightarrow{q}(t) - \overrightarrow{q}_0$$
$$M_{ik} = (m_{ik})_{\overrightarrow{q}_0} = M_{ki}$$
$$C_{ik} = \left(\frac{\partial^2 R}{\partial q_i \partial q_k}\right)_{\overrightarrow{q}_0} = C_{ki}$$
$$K_{ik} = \left(\frac{\partial^2 U}{\partial q_i \partial q_k}\right)_{\overrightarrow{q}_0} = K_{ki}$$

Log Decrement

$$\delta = \ln\left(\frac{x_j}{x_{j+1}}\right)$$
$$\zeta = \frac{\delta/2\pi}{\sqrt{1 + (\delta/2\pi)^2}}$$
$$\zeta << 1 \rightarrow \zeta = \frac{\delta}{2\pi}$$