Newton-Euler Equations

System of Particles

Rigid Body

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Newton's Equations of Motion for a Single Particle of mass *m*

$$\mathbf{F} = m\mathbf{a}$$

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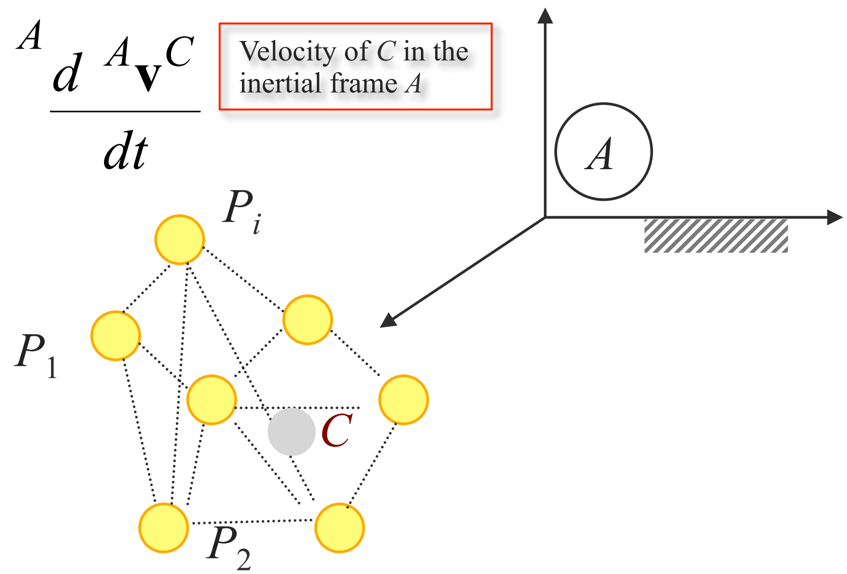
Newton's Second Law for a System of Particles

The center of mass for a system of particles, *S*, accelerates in an inertial frame (*A*) as if it were a single particle with mass *m* (equal to the total mass of the system) acted upon by a force equal to the net external force.

$$\mathbf{F} = \sum_{i=1}^{N} \mathbf{F}_i = m \frac{{}^{A}d\; {}^{A}\mathbf{v}^{C}}{dt}$$

Velocity of *C* in the inertial frame *A*



Center of mass

$$\mathbf{r}_c = \frac{1}{m} \sum_{i=1,N} m_i \mathbf{p}_i$$

Rate of Change of Linear Momentum

Derivative in the inertial frame *A*

$$\mathbf{F} = \frac{{}^{A}d\,\mathbf{L}}{dt}$$

Linear momentum of the system of particles in the inertial frame *A*

Also true for a rigid body

Rotational equations of motion for a rigid body

The rate of change of angular momentum of the rigid body *B* relative to *C* in *A* is equal to the resultant moment of all external forces acting on the body relative to *C*

Angular momentum of the rigid body *B* with the origin *C* in the inertial frame *A*

Derivative in the inertial frame *A*

$$\frac{{}^{A}d\ {}^{A}\mathbf{H}_{C}^{S}}{dt} = \mathbf{M}_{C}^{S}$$

Net moment from all external forces and torques about the reference C

angular velocity of B in A

Angular momentum

$$\boxed{{}^{A}\mathbf{H}_{C}^{S} = \mathbf{I}_{C} \cdot {}^{A}\omega^{B}}$$

inertia tensor with C as the origin