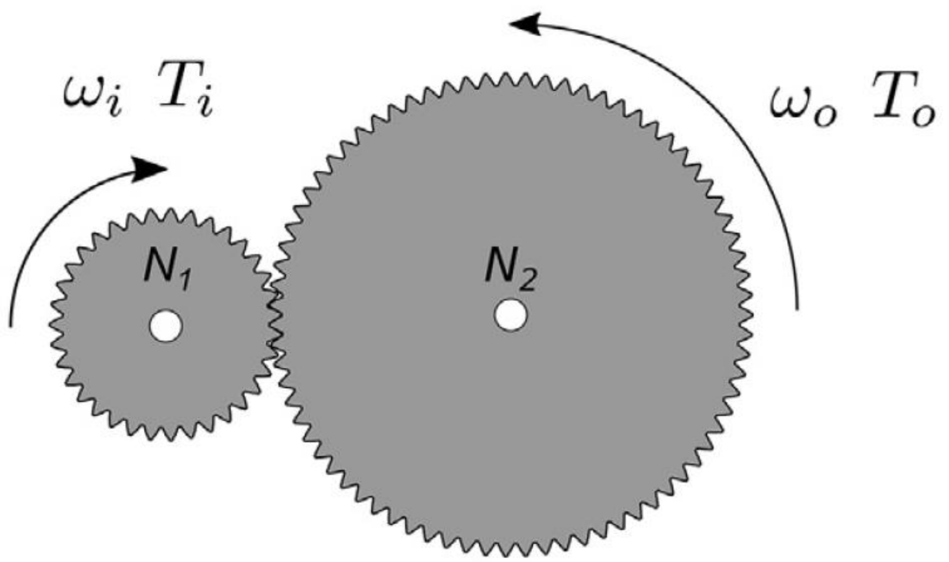
Mechatronic Actuators

Lecture 7a

Mechanical drives

Gear ratio



$$n = \frac{N_2}{N_1}$$

$$P_o = P_i$$

$$T_o \omega_o = T_i \omega_i$$

$$T_o = \pm n T_i$$

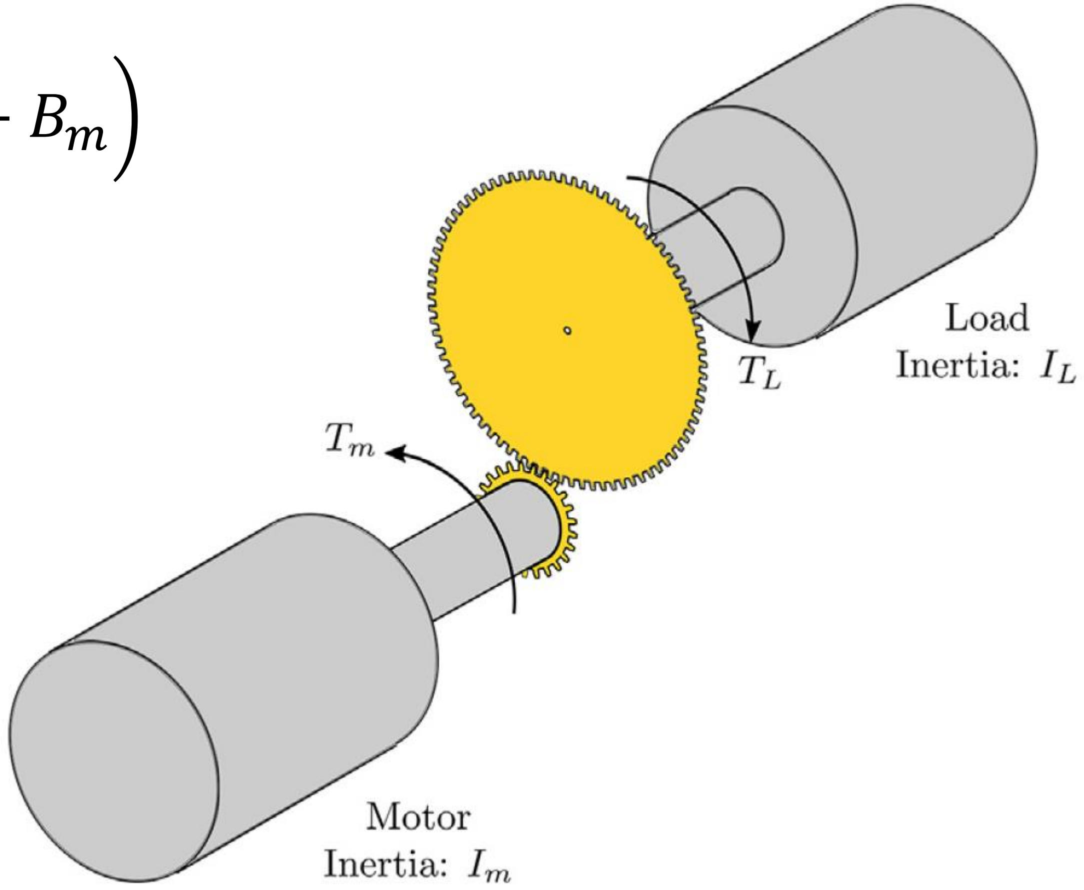
$$\omega_o = \pm \frac{1}{n} \omega_i$$

The influence of the gear ratio on the moment of inertia

$$I_m = \frac{I_L}{n^2}$$

The equation of motion

$$T_m - \frac{T_L}{n} = T_{diff} = \alpha_L n \left(\frac{I_L}{n^2} + I_m\right) + \omega_m \left(\frac{B_L}{n^2} + B_m\right)$$



Acceleration without load moment and friction

- Acceleration without load moment and friction $\alpha_L = \frac{T_{peak}}{n\left(I_d + \frac{I_L}{n^2}\right)}$

- Optimal gear ratio $n^* = \sqrt{\frac{I_L}{I_d}}$

- Acceleration expressed in another way $\alpha_L = \frac{T_{peak}}{2I_d n^*}$

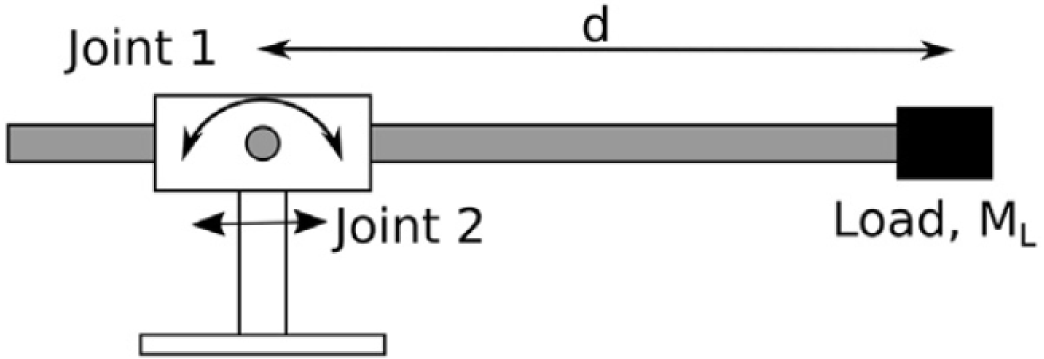
Acceleration with load

- Acceleration $\alpha_L = \frac{T_{peak} - T_L/n}{n\left(I_d + \frac{I_L}{n^2}\right)}$

- Optimal gear ratio $n^* = \sqrt{\frac{I_L \alpha_L - T_L}{I_d \alpha_L}}$

- Acceleration expressed in another way $\alpha_L = \frac{T_{peak} - T_L/n^*}{2 I_d n^*}$

Acceleration of loads with variable moment of inertia

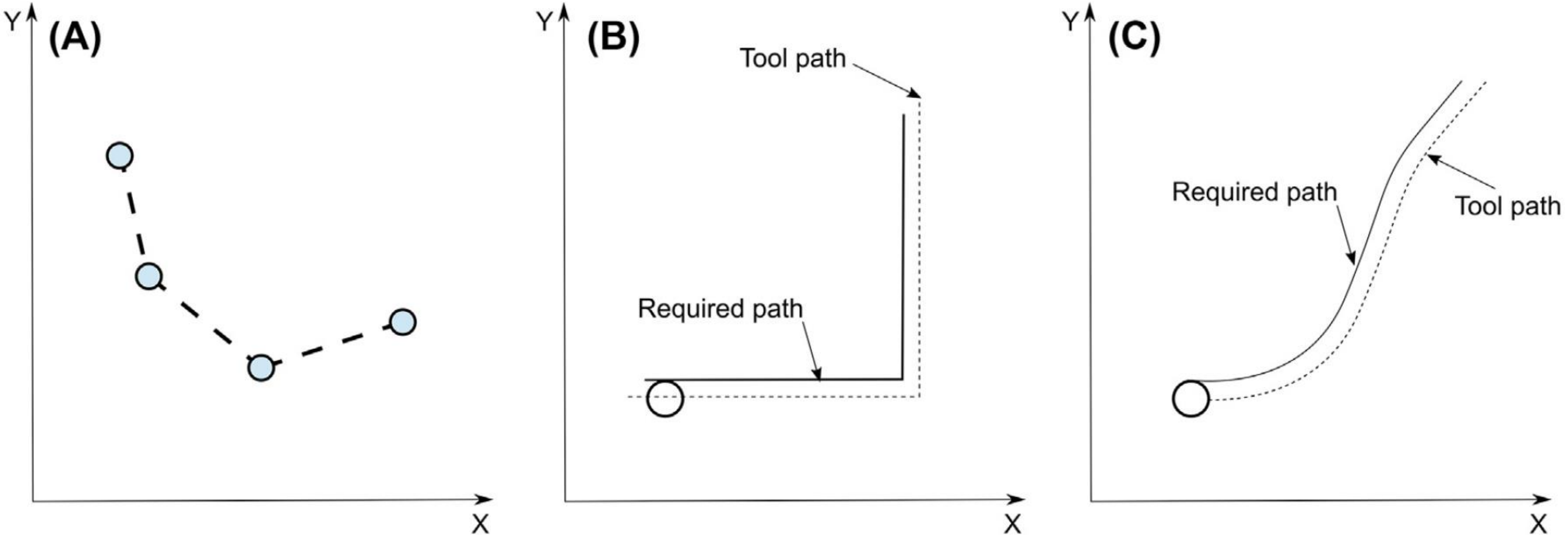


- Steiner's theorem $I_{Load} = I_a + d^2 M_L$

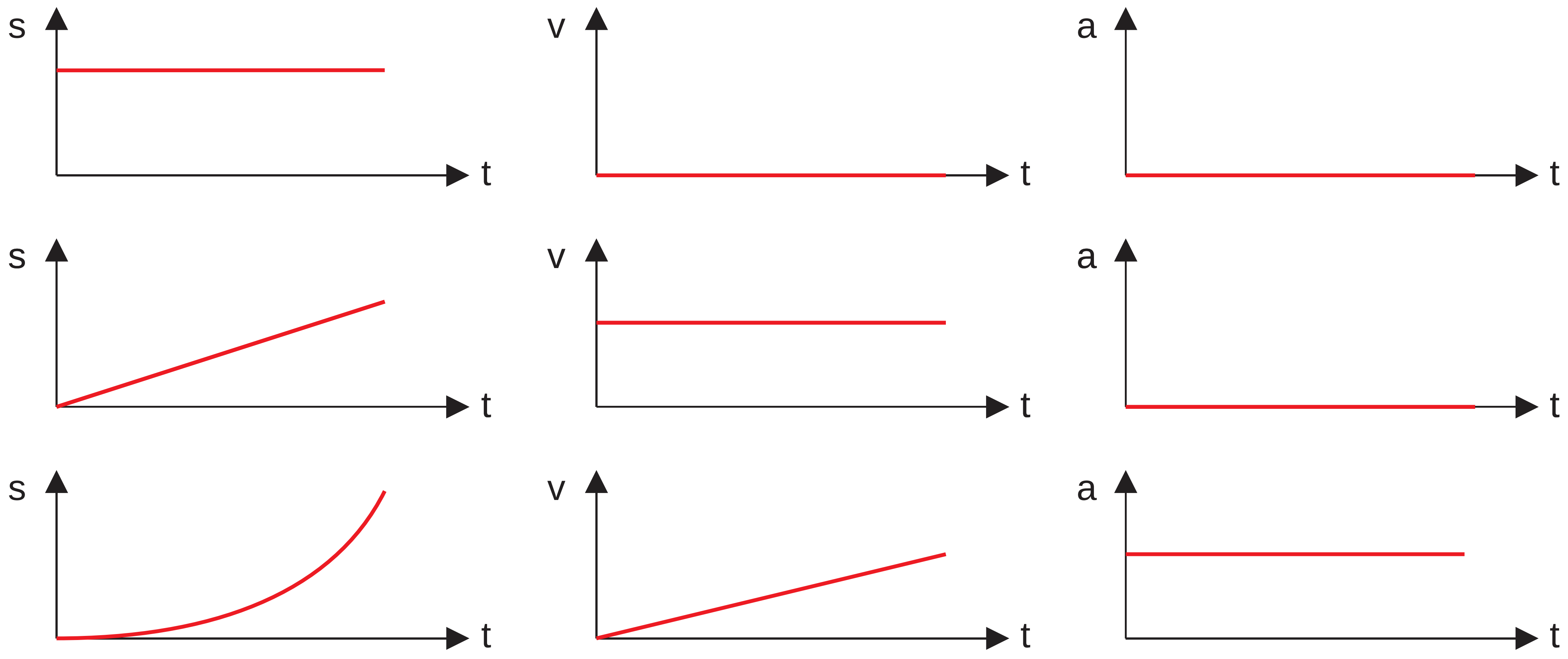
Linear systems

- Acceleration : $\ddot{x} = \frac{F}{m}$
- Motor power : $F_m = F_L + m_{tot}\ddot{x} + B_L\dot{x}$
- Change in kinetic energy : $\Delta E_k = \frac{m_{tot}(\dot{x}_2^2 - \dot{x}_1^2)}{2}$

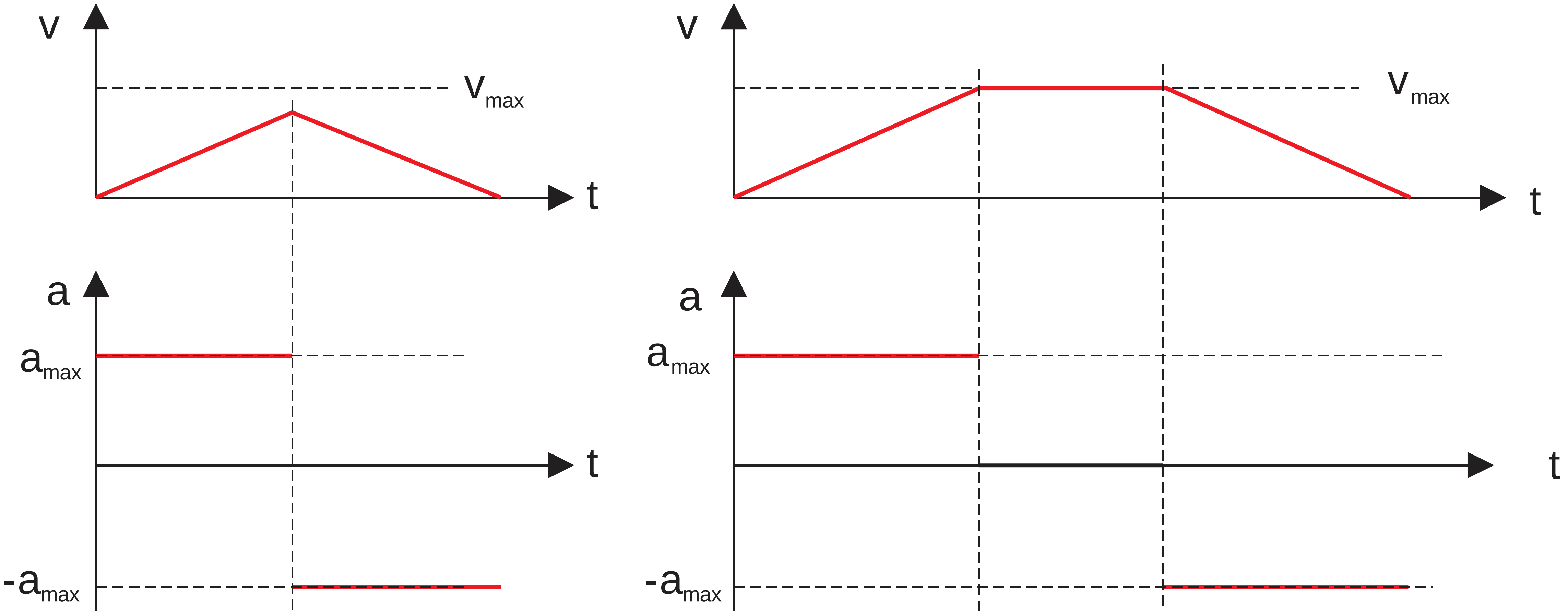
Movement trajectories



Speed profiles



Triangular and trapezoidal profile



Jerk