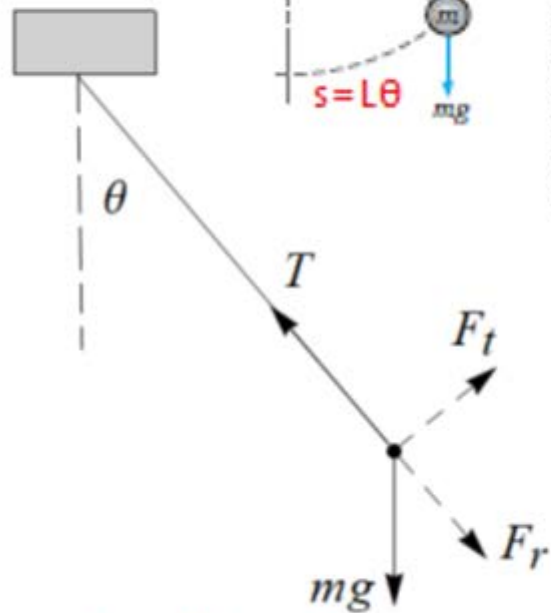
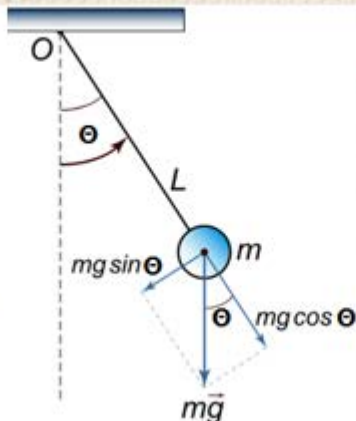
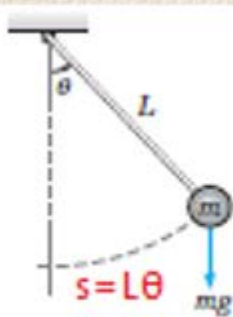




مثالی از مدل سازی غیر خطی: حرکت نوسانی آونگ ساده

$$s(t) = L \cdot \theta(t) \quad v = \frac{ds}{dt} = L \frac{d\theta}{dt}$$

$$a_t(t) = \frac{dv}{dt} = \frac{d^2 s}{dt^2} = L \frac{d^2 \theta}{dt^2}$$

$$\sum F_t = m a_t$$

$$-mg \sin \theta = mL \frac{d^2 \theta}{dt^2} \quad -\frac{g}{L} \sin \theta = \frac{d^2 \theta}{dt^2}$$

$$\frac{d^2 \theta}{dt^2} + \frac{g}{L} \sin \theta = 0$$

$$\sin \theta \cong \theta \quad \frac{d^2 \theta}{dt^2} + \frac{g}{L} \theta = 0$$

توجه: $-T + mg \cos \theta = m a_r = m \frac{v^2}{L} = mL \left(\frac{d\theta}{dt} \right)^2$