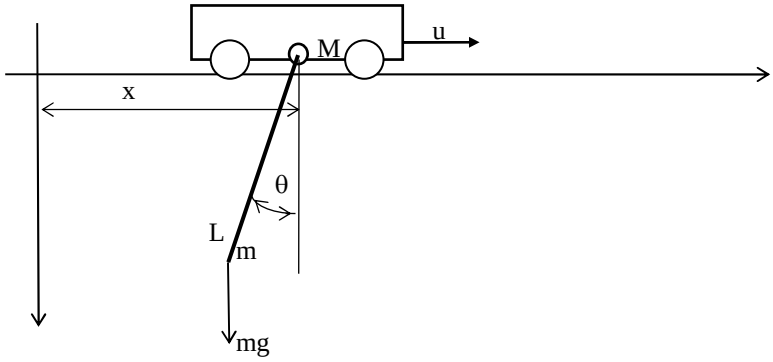
# Overhead crane




**State-space model (L = const):**

θ - angle of rope [rad]
x - position of trolley [m]
m - Mass of load [kg], M – mass of trolley [kg]
L - Length of rope [m]
g - acceleration of gravity [m/s$^2$]
u – Fx – force [kgm/s$^2$ ] (model input)

$$\begin{cases} \dot{X} = A \cdot X + B \cdot U \\ Y = C \cdot X \end{cases} \quad X = \begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix}$$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{mg}{M} & 0 & 0 \\ 0 & -\frac{(M+m)g}{ML} & 0 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ \frac{1}{M} \\ -\frac{1}{ML} \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix}$$

or C = [ 1 L 0 0]  $x_L$ =  x + L sinθ ≈ x + Lθ

Model limitations: from linearization ( sinθ ≈ θ & cosθ ≈ 1) ⇒ **θ ≤ 0.2rad** ⇔ error < 1%

L = (0,4+0,05*nr)  [m] (nt. 1m, M=2.5 kg, m=1 kg)

$X_{2max}$ = 0,2 rad

($X_{3max}$ = 0,6 m/s)

$U_{max}$ = 10 kgm/s$^2$