where

Where is the mass of the Pendulum, is the mass of the cart

Find .

Sub (1) & (2) into equation.

Substitute in

Sub (3) into Kinetic Co-Energy equation

Find

Find L

Simplify:

Find the State Space using

States:

Subsitute (4), (5) & (6) into the Hamiltonian

Find the 2nd state,

Subsitute in

Now we will expand our state space to contain Velocity as a state, and change our input to Acceleration.

Linearise about the point

Linearise

Linearise

Put the linearized states in matrix form.