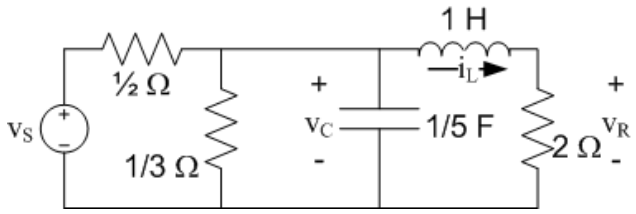
EE 554 Embedded Control Systems
Homework Assignment 2

September 16, 2008

1 State-space description

Find a state-space description of the RLC circuit shown. Recall inductor currents and capacitor voltages are typical variables for which initial conditions will be known, thus they make good choices for state variables. Let the states be $x_1 = v_C$, $x_2 = i_L$, input $u = v_S$, and output $y = v_R$.

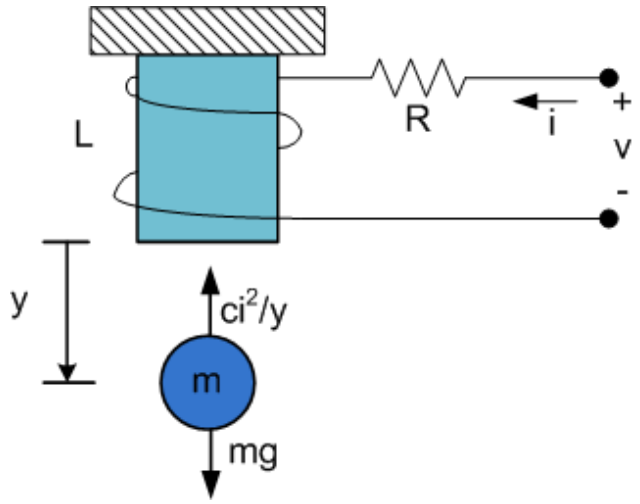


2 Transfer-function description

For the circuit in problem 1, find the transfer function $H(s) = \frac{Y(s)}{U(s)} = \frac{V_R(s)}{V_S(s)}$.

3 Linearization

Consider the magnetic-ball-suspension system shown below where the objective is to vary the input voltage v such that the ball is suspended at a fixed distance y.



The dynamic equations are

$$\begin{aligned} m\frac{d^2y(t)}{dt^2} &= mg - \frac{ci^2(t)}{y(t)} \\ L\frac{di(t)}{dt} &= v(t) - Ri(t) \end{aligned}$$

and the parameters and variables are as follows:

$v(t)$ = input voltage (V)	$y(t)$ = ball position (m)
$i(t)$ = winding current (A)	$c = 1$ = proportionality constant
$R = 1\Omega$ = winding resistance	$L = 0.01$H = winding inductance
$m = 1$kg = mass of ball	$g = 9.81 m/s^2$ = gravitational acceleration

Linearize the system about the (fixed) distance $y = 0.5$m and find the linear, state-space equations. Find the characteristic equation and poles/eigenvalues of the linear system. Comment on stability.