ECE-205 : Dynamical Systems

Homework #1

Due : Thursday December 3 at the beginning of class

1) For each of the circuits below:

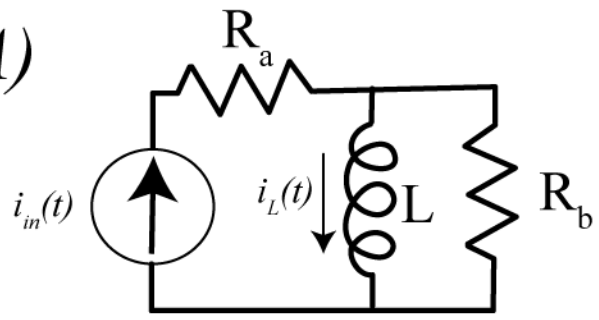
i) Determine the governing differential equation using Kirchhoff's Laws and write it in standard form

ii) Determine the time constant and static gain from the differential equation you derive in (i)

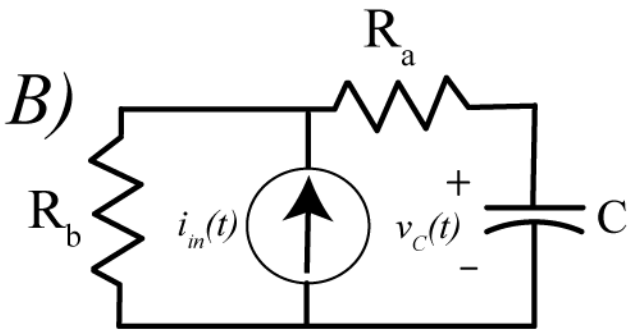
iii) For all circuits except F, determine the Thevenin resistance from the ports of the capactor or inductor and verify the time constants.

iv) For all circuits except F, determine the static gain by determining the DC voltage across the capacitor or the current through and inductor.

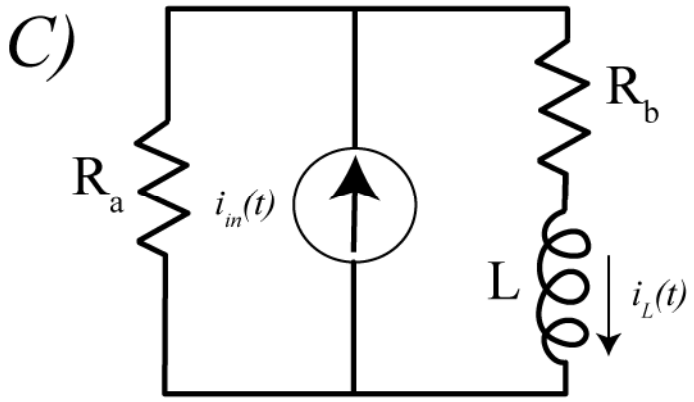
A)



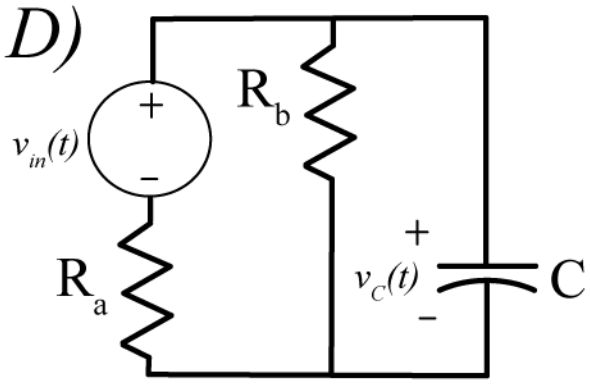
B)



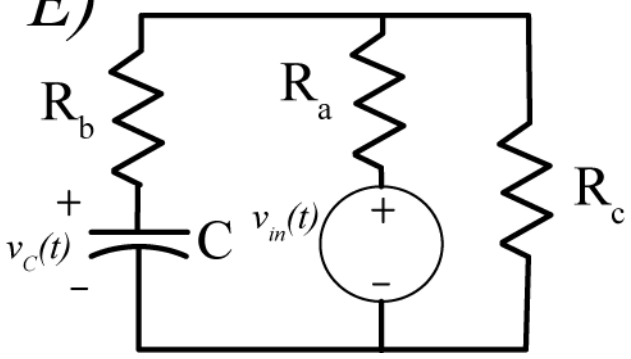
C)



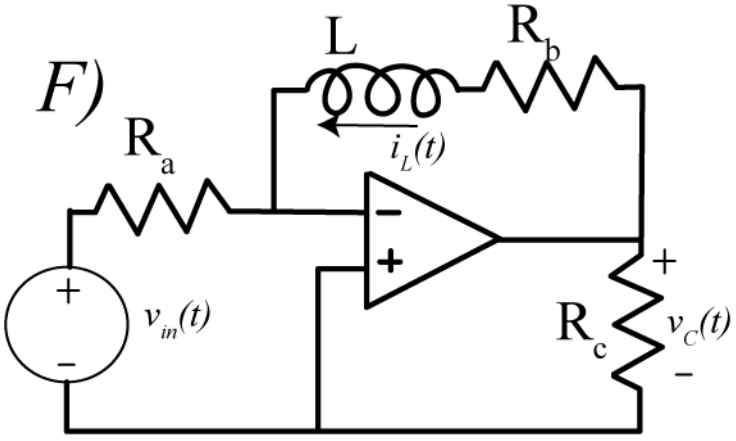
D)



E)



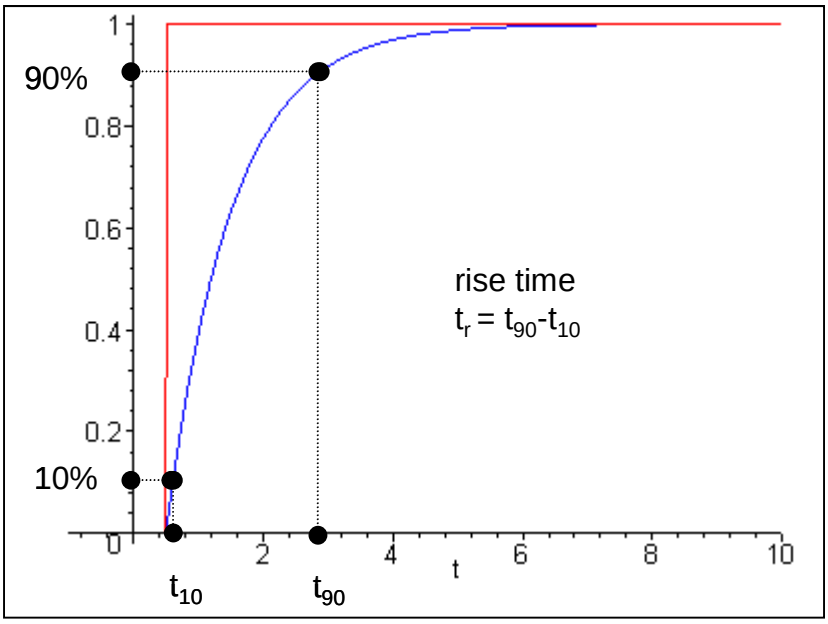
F)



2) For a simple series RC circuit the response of the system when the input is a unit step is

$$y(t) = 1 - e^{-t/RC} = 1 - e^{-t/\tau}$$

The 10-90% rise time, t_r, as shown below. The rise time is simply the amount of time necessary for the output to rise from 10% to 90% of its final value. Show that for this system the rise time is given by $t_r = \tau \ln(9)$



Answers:

$$\left(\frac{L}{R_b}\right)\frac{di_L(t)}{dt} + i_L(t) = i_{in}(t)$$

$$C(R_a + R_b)\frac{dv_C(t)}{dt} + v_C(t) = R_b i_{in}(t)$$

$$\left(\frac{L}{R_a + R_b}\right)\frac{di_L(t)}{dt} + i_L(t) = \left(\frac{R_a}{R_a + R_b}\right) i_{in}(t)$$

$$C\left(\frac{R_a R_b}{R_a + R_b}\right)\frac{dv_C(t)}{dt} + v_C(t) = \left(\frac{R_b}{R_a + R_b}\right) v_{in}(t)$$

$$C\left(\frac{R_a R_b + R_c R_b + R_a R_c}{R_a + R_c}\right)\frac{dv_C(t)}{dt} + v_C(t) = \left(\frac{R_c}{R_a + R_c}\right) v_{in}(t)$$

$$\left(\frac{L}{R_b}\right)\frac{dv_{in}(t)}{dt} + v_{in}(t) = -\left(\frac{R_a}{R_b}\right) v_C(t)$$