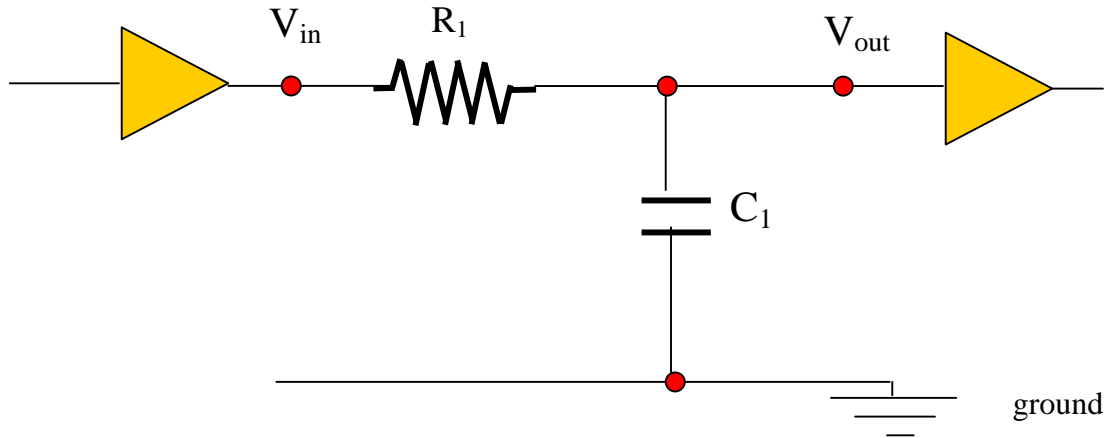


Review Material

You do not have to hand these in. Note that your exam problems may not necessarily be similar to these. These are just to help reinforce some of the concepts you have learned.

1. Read everything including particle dynamics, mechanical systems, and electrical systems!

2. RC-filter:



(2.i) Systematically obtain the first-order system equation for the above circuit, using V_{out} as the state variable.

(2.ii) Obtain the no-source solution for this system.

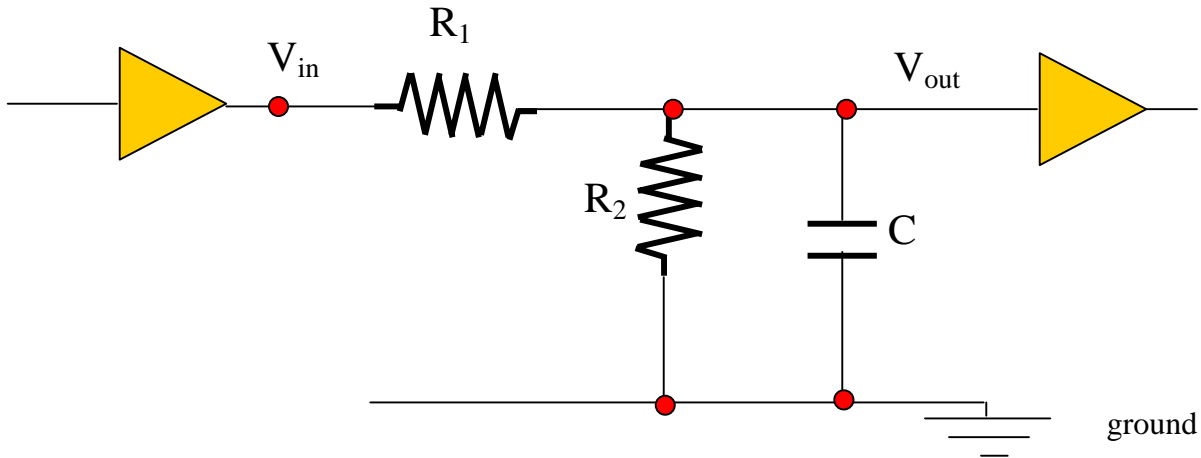
(2.iii) If the input is a harmonic voltage source: $V_{in}(t) = V_o \sin \omega_f t$, obtain the appropriate source solution.

(2.iv) Therefore obtain the total solution for the output voltage $V_{out}(t)$ in terms of V_o , ω_f , and the parameters R_1 and C_1 , given that at time $t=0$ the capacitor is uncharged.

3. A ball is placed at the bottom of an empty frictionless bowl. The ball is moved up the side of the bowl and gently let go. What kind of motion do you expect for the ball assuming gravity is acting downwards and there is no friction between the ball and the bowl? What would be a suitable analog electrical system for this? If the bowl is filled with a liquid, it is observed that there is viscous damping from the water as the ball moves. How would you modify your equivalent electrical system to model this system?

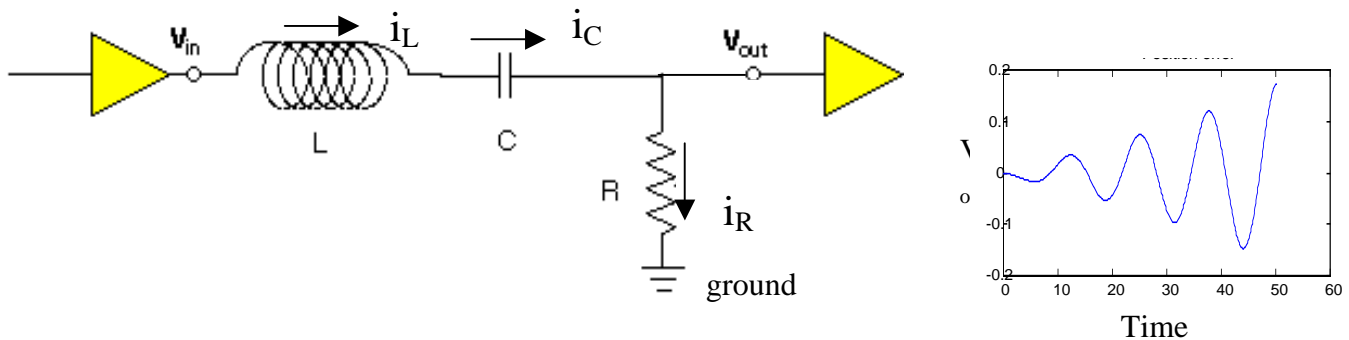
4. Another RC-circuit

Consider the circuit below.



- (4.i) Systematically obtain the first-order state equation for the output voltage V_{out} .
 (4.ii) Solve the state equation for V_{out} given that the input V_{in} is a constant V_0 for $t > 0$ and the capacitor is initially uncharged. What kind of system response is this? Let $R_1 = R_2 = 1\text{k}\Omega$, and $C = 0.1\mu\text{F}$. Schematically plot $V_{out}(t)$ specifying either the time constant (if exponential) or the angular frequency (if oscillatory), whichever is appropriate.

5. A junior engineer is asked to calculate the output voltage V_{out} of the following circuit given that the input voltage $V_{in}(t) = V_0 \sin \omega t$;



He brings you a plot for $V_{out}(t)$ that looks like the one shown above right. Do you think the engineer is correct? If not, suggest where he might have made a mistake?