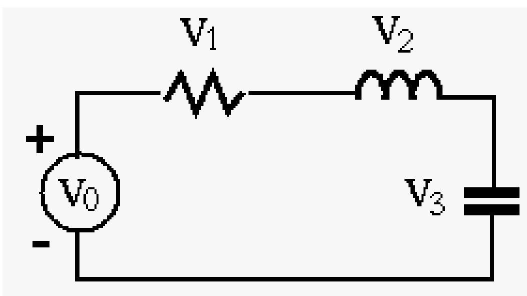
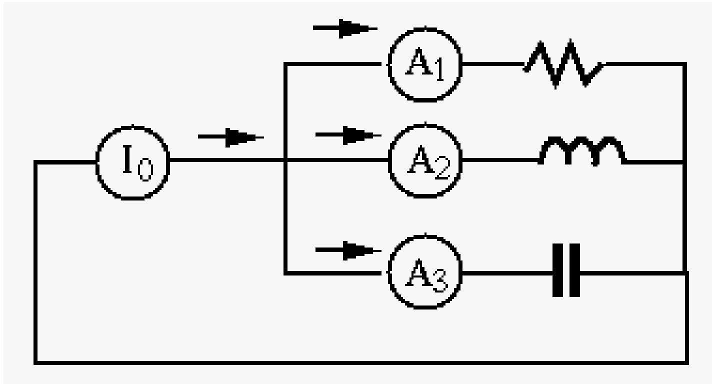
Next: About this document ... **Up:** final16s **Previous:** Instruction (read this before

The Final Exam (don't click until you are ready to take the exam)

1. Answer the following questions:
    - (**10 pts**) The RMS values of the three AC voltages across R, L, and C are known to be $V_1=4\,V$, $V_2=5\,V$, and $V_3=2\,V$, respectively. Find the RMS voltage V_0 of the source. If the AC voltage source is replaced by a DC voltage source $V_0=10\,V$, find the three voltages V_1, V_2, and V_3.

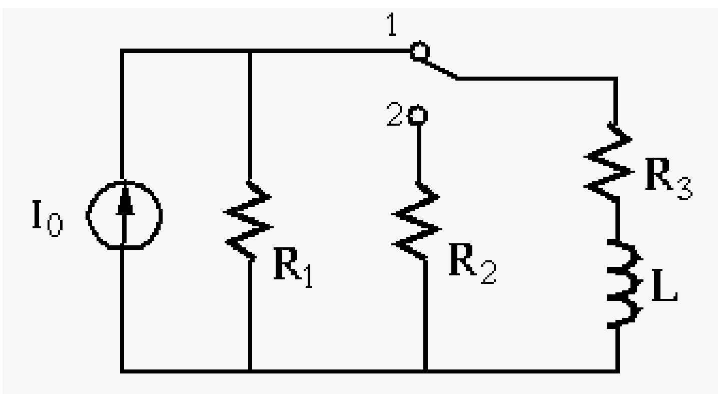


    - (**10 pts**) In the figure above, it is know that $R=10\Omega$, $L=100\,mH$, and $C=500\,\mu F$, and the current through the loop is known to be $\underline{i(t)=\cos(100\,t)\,A}$, find all four voltages $\underline{v_0(t)}$, $\underline{v_1(t)}$, $\underline{v_2(t)}$, and $\underline{v_3(t)}$.
    - (**10 pts**) The RMS values of the three AC currents through R, L, and C measured by the three ammeters A_1, A_2, and A_3 are $I_1=4\,A$, $I_2=5\,A$, and $I_3=2\,A$, respectively. Find the RMS value of the source current I_0. If the AC voltage source is replaced by a DC current source $I_0=1\,A$, find the three currents I_1, I_2, and I_3 measured respectively by ammeters A_1, A_2, and A_3.

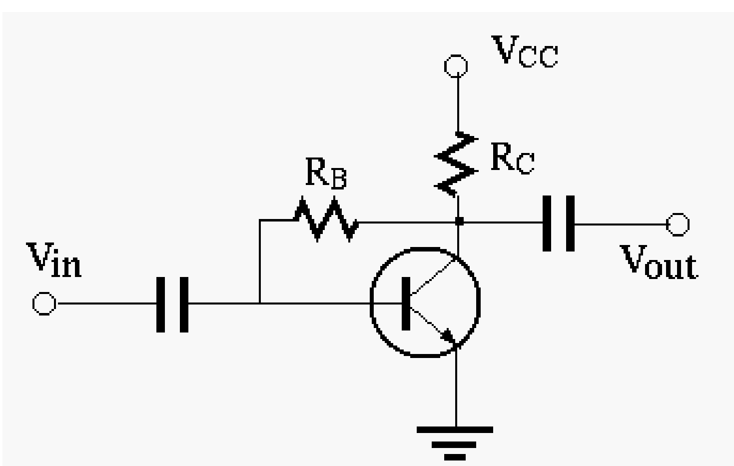


2. (**23 pts**) In the circuit below, $R_1 = 20\Omega$, $R_2 = 10\Omega$, $R_3 = 30\Omega$, $L = 10\,mH$, $I_0 = 5A$.

   The circuit is at steady state before the switch is turned from position 1 to position 2 at $t = 0$. Find the three voltages $v_1(t)$, $v_2(t)$ and $v_L(t)$ across R_1, R_2 and L, respectively, for $t > 0$ (the bottom wire is treated as ground).



3. (**23 pts**) The circuit below shows a simple means for obtaining improved bias stability of the DC operating point of the transistor. As always, assume $V_{BE} = 0.7V$ when answering the following questions.



   - Complete the event chain below (in terms of V_C, V_B, I_B, etc.) to show qualitatively that R_B connected to the collector C (instead of V_{CC}) introduces a negative feedback by which the DC operating point tends to be stabilized:

$$I_C \uparrow \Longrightarrow \cdots\cdots\cdots \Longrightarrow I_C \downarrow$$

- Derive an expression for I_C in terms of R_B, R_C, V_{CC} and β.
- Assuming $\beta=100$, $V_{BE}=0.7$, and $V_{CC}=10V$, find R_C and R_B so that $V_{CE}=5V$ and $I_C=2mA$.
- Confirm your design does put the DC operating point in the middle of the linear region.

4. (**24 pts**) Determine qualitatively what kind of filter the following op-amp circuit is. Is it a first or second order? a low-pass, high-pass, or band-pass?

   Find the frequency response function (FRF) of the circuit, and find the cut-off frequency ω_c of the filter in terms of the given circuit parameters R_1, R_2, R and C, so that $|H(j\omega_c)|=|H(j\omega_p)|/\sqrt{2}$, where ω_p is the frequency at which $|H(j\omega_p)|$ reaches maximum.