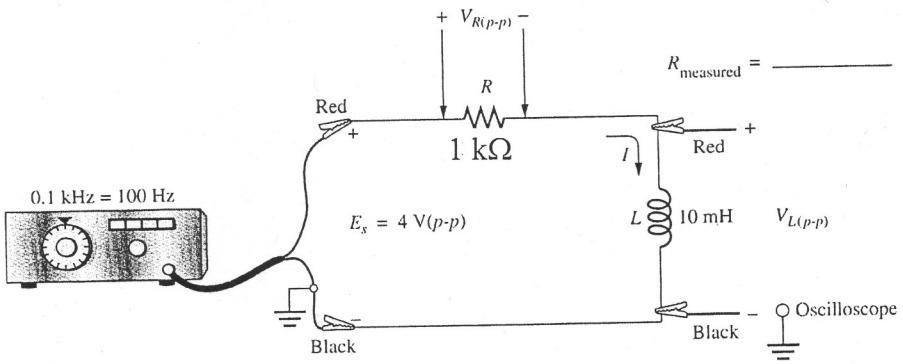
EE 2240 Basic Circuit Laboratory

Final Examination, 6/16/2008 2009

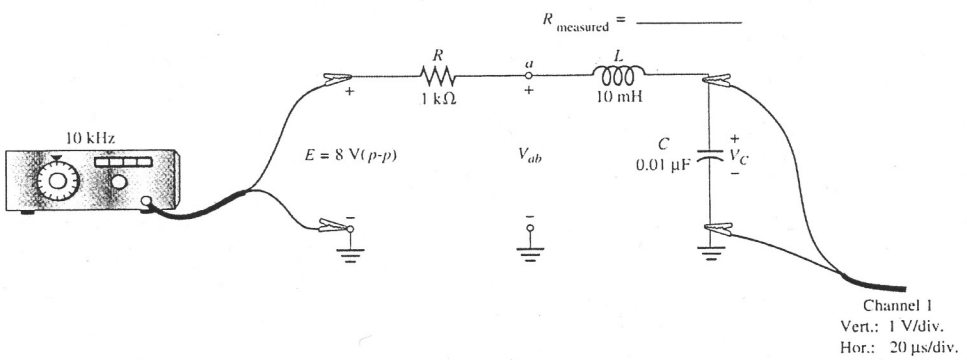
1. (20%)

(1) (5%) Assume you are going to measure the frequency response of a circuit using a function generator and an oscilloscope. To get the frequency response at some frequency, you must show both the input and output voltage waveforms on the oscilloscope. Please describe, **in details** （例如所用到示波器按鈕或旋扭、以及訊號的 **channel 等. Hint: The answer is NOT "Autoset"**）, how you would be able to obtain the waveforms with proper amplitude and frequency on the screen.

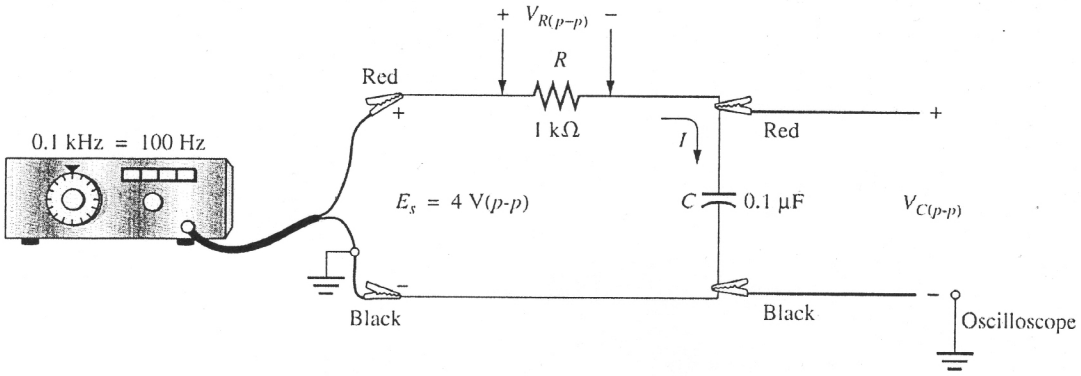
(2) (4%) For the circuit below, please explain how you would measure the total impedance of R and L at some frequency. 只需說明實驗的方法，不用將電壓、電阻及電感的值代入來計算實際值.



(3) (5%) For the circuit below, the input ac voltage magnitude $E_{p\text{-}p}$ is related to the magnitudes of $V_{R(p\text{-}p)}$, $V_{c(p\text{-}p)}$ and $V_{L(p\text{-}p)}$. Please **analyze** and give the expression of $E_{p\text{-}p}$ in terms of $V_{R(p\text{-}p)}$, $V_{c(p\text{-}p)}$ and $V_{L(p\text{-}p)}$. 不需將電壓、電阻、電容及電感的值代入來計算實際值.

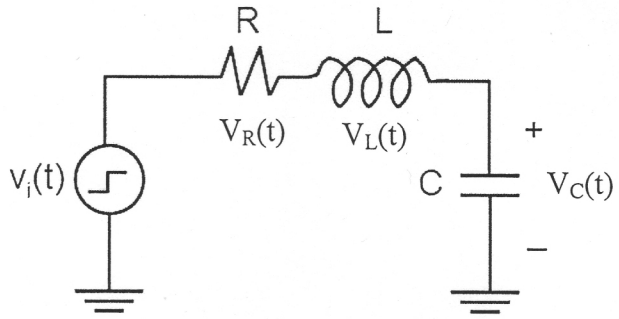


(4) (6%) For the circuit below: Given the sinusoidal input of 4 $V_{p\text{-}p}$ at 100 Hz, please calculate the steady-state response (magnitude and phase) of $V_{c(p\text{-}p)}$. Also, please plot $V_{c(p\text{-}p)}$ and input E_s along the time axis, and clearly indicate the time difference between the two curves.



2. (25%)

(1) (14%) For the R-L-C circuit as shown below, $v_i(t)$ is a unit-step input, and the value of R, L, and C are 10 Ω, 1 mH, and 1 μF, respectively. Please calculate the damping ratio, quality factor, and natural frequency of the circuit. Also, please compute the output rise time and overshoot due to a unit-step input.

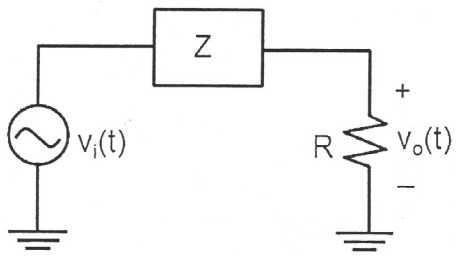


(2) (8%) For the same circuit (but the input is now a sinusoidal waveform from low to high frequencies), please **analyze** and roughly sketch the frequency responses of V_R, V_L, and V_C (magnitude vs. frequency only). Please mark the natural frequency of the circuit and indicate whether the maximum values appear before or after the natural frequency. (Hint: 不需將電壓、電阻、電容及電感的實際值代入作計算)

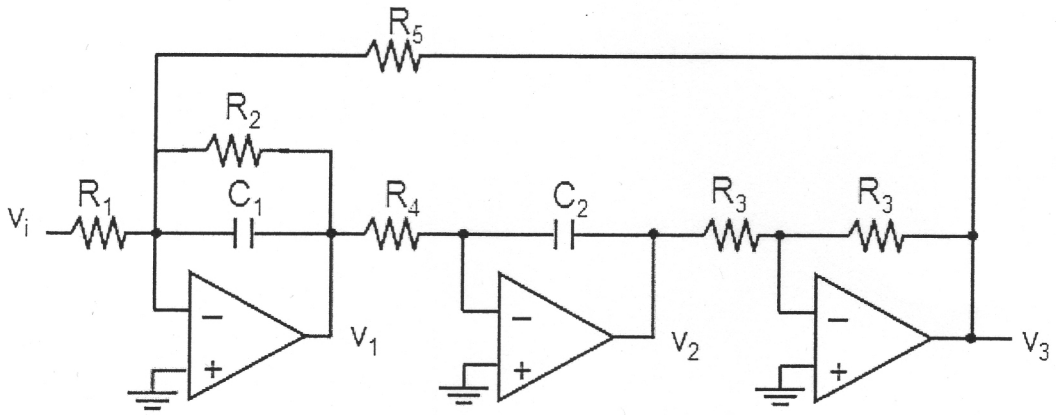
(3) (3%) Suppose you have measured the frequency response of V_c for the circuit above, please describe, in few sentences, how you obtain the quality factor from measured data.

3. (25%)

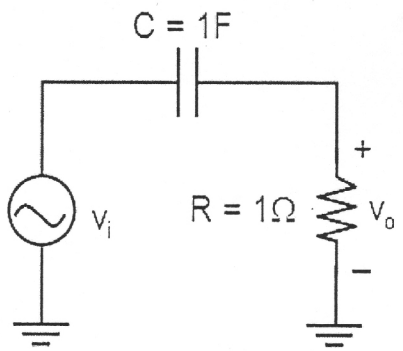
(1) (5%) The circuit below represents a band-pass filter whose transfer function is $v_o(s)/v_i(s)$. The impedance Z consists of a capacitor and an inductor. Please draw the complete circuit and explain your reasoning.



(2) (8%) Find the transfer function $v_2(s)/v_i(s)$ of the filter as shown.



(3) (8%) Please draw the frequency response (magnitude vs. frequency and phase vs. frequency) of the R-C circuit as shown. You should provide the values at $\omega = 0, \infty$, and the 3dB frequency.



(4) (4%) For the R-C circuit above, the input $v_i(t)$ is a unit-step and the initial voltage on the capacitor is zero, please calculate the output voltage $v_o(t)$.

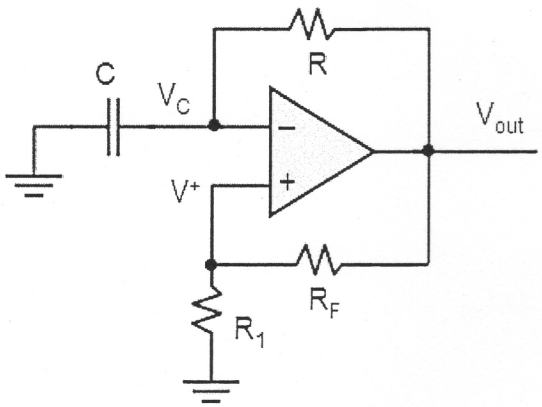
4. (10%)

(1) The low-pass Butterworth filter has the magnitude $|H(j\omega)| = \frac{1}{\sqrt{1+\left(\frac{\omega}{\omega_c}\right)^{2n}}}$. Please determine the order n such that it has a cut-off frequency at 10 kHz, and a gain no more than -40 dB at 50 kHz.

(2) Suppose that a 2nd-order Butterworth low-pass filter has a cut-off frequency at 100 Hz. Please determine the two poles of the filter.

5. (20%)

(1) (10%) Derive the oscillation frequency of the circuit below as a function of resistors and capacitor.



(2) (10%) For the circuit below: $R_1 = 2R_2$, R = 1 kΩ, C = 1 μF, and the output V_o oscillates between ±18 V. Please draw the output waveforms at points A and B, and calculate the oscillation frequency of the circuit.