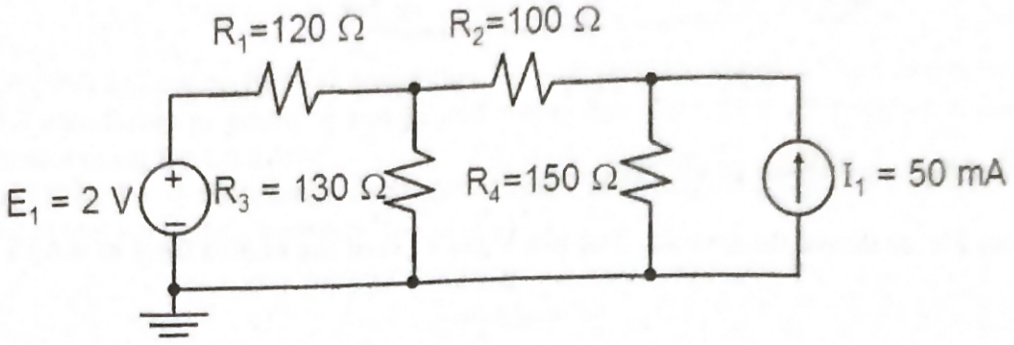
**EE2245 Microelectronics Labs**

**Final Exam**

**Date: January 15, 2016**

**1. DC Circuit (10%)**

Please calculate the voltage $V_1$ and the current $I_1$ across and through $R_1$ and $R_2$.




**2. Time-domain Responses (8%)**

Consider the circuit shown in Fig.1. If the waveform of $v_o$ contains ripples, **which action(s) below** help to suppress or even remove the ripples? **(i) increase R (ii) increase L (iii) increase C**? Please **explain** your answers clearly.

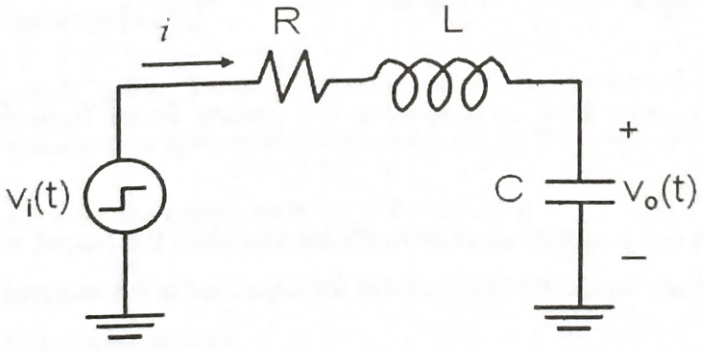



**Fig.1**

**3. Passive filters (18%)**

Consider the circuit shown in Fig. 2.

(a) (6%) Please **derive** the transfer function (in terms of **s**) for $\mathbf{v_o(s)/v_i(s)}$.

(b) (4%) According to the answer in (a), is it a low-pass, or band-pass, or high-pass filter? Please **explain** your answers clearly.

(c) (8%) If we would like to increase the quality factor of the filter, how could **the**

**individual components (i)R (ii)C (iii)L be adjusted**? Please **explain** your answers clearly.

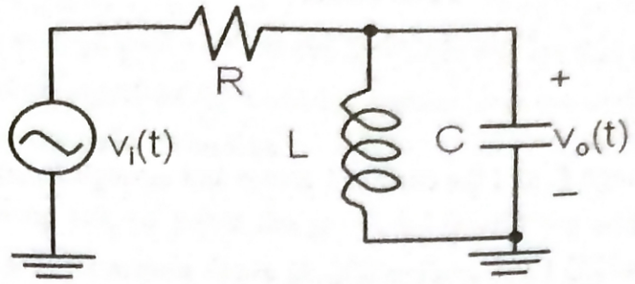
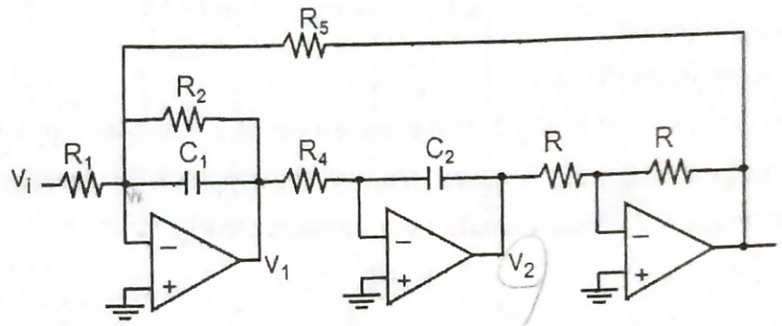



**Fig.2**

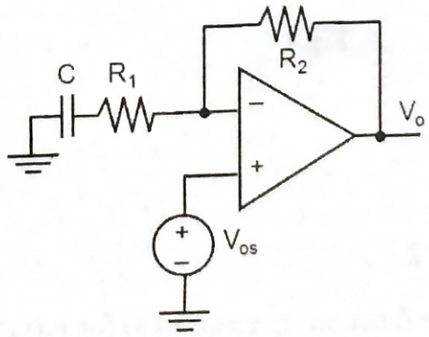
**4. Active filters and Opamps (20%)**

(a) (10%) Please derive the transfer function $V_2(s)/V_i(s)$ of the biquad filter as shown below.



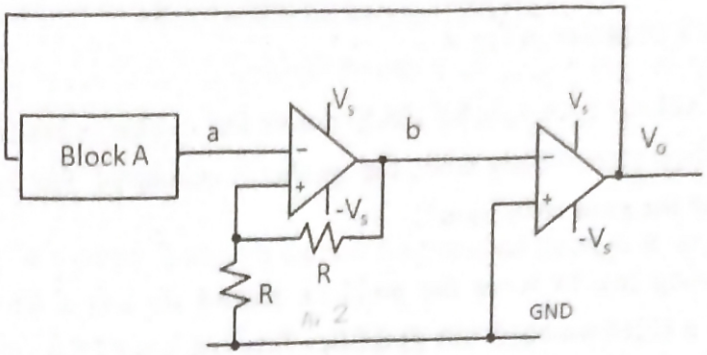

(b) (5%) Please describe how to determine the quality factor from the measured frequency response.

(c) (5%) For the op-amp circuit as shown, please calculate the output voltage due to the dc offset $V_{os}$. What would be the output if the capacitor is not inserted?



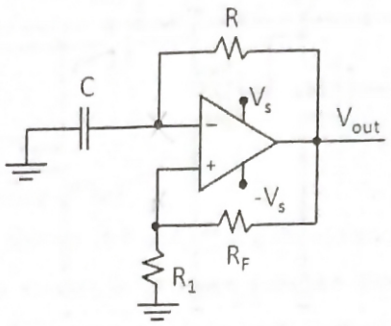

**5. Oscillators (20%)**

(a) (5%) Below is an incomplete schematic of the triangular, square-wave oscillator circuit used in our lab. Please draw the circuit diagram represented by Block A.




(b) (5%) Following part (a), given that $V_s$ = 10 V, please draw at least one period for the waveforms at points *a* and *b*, and make sure the relationship between them is correct along the time axis.

(c) (10%) For the relaxation oscillator as shown below, please derive the frequency of the output oscillating between $V_{max}$ and $-V_{max}$.




## 6. MOS Transistors (12%)

Consider the circuit in Fig. 3. Let $g_m$ represent the transconductance of the transistor and assume the channel-length modulation effect of the transistor is negligible.

(a) (4%) Please derive **the expression for the voltage gain $v_o/v_i$.**

(b) (8%) If we increase $V_G$ but find the voltage gain $v_o/v_i$ reduces, **what is the likely reason** for this phenomenon?

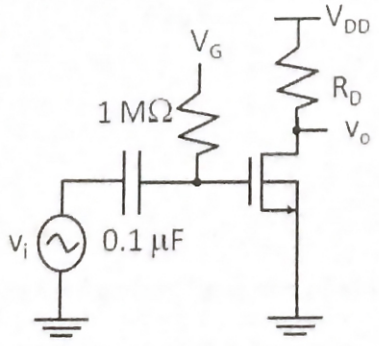



**Fig.3**

## 7. MOS Amplifiers (12%)

Consider the MOS amplifier in Fig. 4.

(a) (4%) Let the voltage gain $v_o/v_i$ be 100dB before the speaker is connected. But the voltage gain drop significantly when the speaker is connected. Would you **explain the reason for the gain reduction**?

(b) (8%) Following (a), to solve the problem, should we add a **(i)common-gate amplifier or a (ii)common-drain amplifier** between $v_o$ and the speaker? Please **explain** your answer clearly.

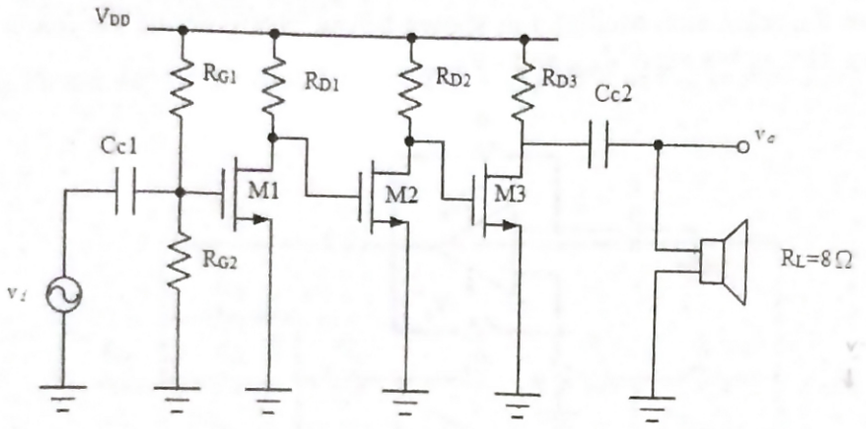



**Fig.4**