Electronics II, Exam-2, Spring 2021

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April 30, 2021, Prof. Dah-Chung Chang (E1-311)

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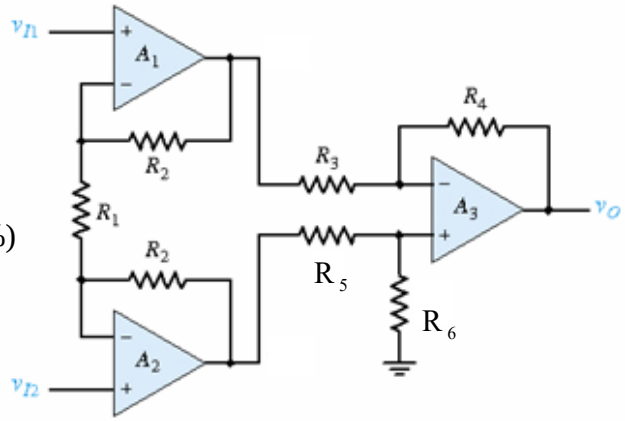
1. (30%) Consider the following instrumentation amplifier.

   (a) Assume that $R_4 / R_3 = R_6 / R_5$. Find v_O in relation of v_{I1} and v_{I2}. (10%)

   (b) Assume that $R_2 / R_1 = 2$, $R_4 / R_3 = 10$, and $R_6 / R_5 = 11$. Determine CMRR(dB). (20%)

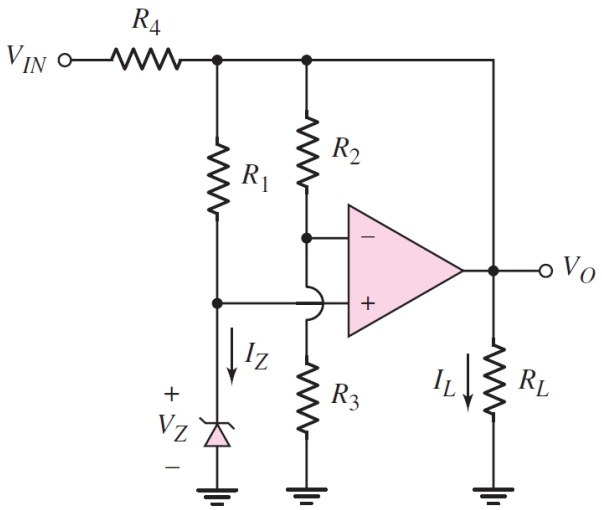


2. (15%) Consider the voltage reference circuit, using a Zener diode with a breakdown voltage of 5.6V. We design the circuit to produce an output voltage of 12.0 V with the input voltage of 15.0V and the Zener diode current $I_Z = 2mA$.

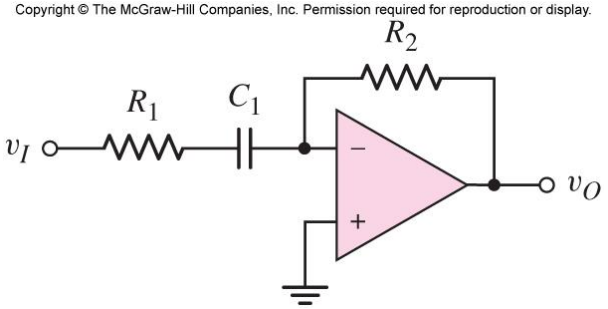
   (a) Find R_1. (5%)

   (b) Let the current of R_2 be $2mA$. Find R_2 and R_3. (5%)

   (c) If $R_L = 6\text{K}\Omega$, find R_4 such that the op-amp has no output current. (5%)



3. (30%) The following circuit is a first-order high-pass active filter. Let ω be the frequency of the input signal.
   (a) What is the voltage transfer function expressed in terms of ω? (10%)
   (b) What is the voltage gain as the frequency becomes extremely large? (5%)
   (c) At what frequency is the magnitude of the gain a factor of $\sqrt{2}$ less than the maximum voltage gain as obtained in (b)? (15%)



4. (25%) The parameters are $V_{DD} = 10V$ and $R_L = 20\Omega$. The transistors are matched, and the transistor parameters are $K = 0.20A/V^2$ and $|V_T| = 1V$. The quiescent drain current is to be 20% of the load current when $v_O = 5V$.
   (a) Find the voltage value of V_{BB}. (10%)
   (b) Find the value of v_{SGp} when $v_O = 5V$. (10%)
   (c) Find the input voltage when $v_O = 5V$. (5%)