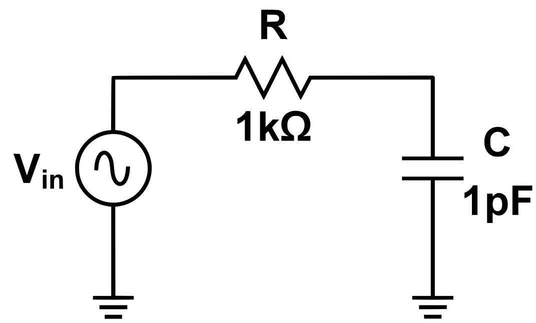
Assignment: #1

Due Date and Time: Feb. 10, 2020, 11:59 PM

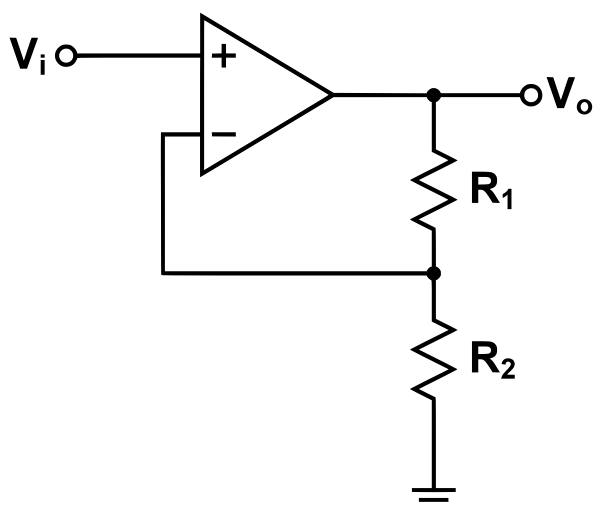
PROBLEM 1. Process Variations



(a) In the low pass filter shown above, due to process variations, the resistor R has ±25% variation and capacitor C has ±20% variation across corners. Taking three process corners (MAX, MIN and TYP where TYP is 0%) each for R and C, find the percentage variation of the -3dB cut-off frequency w.r.t its typical value for all corners. Identify the critical corners. Suggest a method to correct the error in the -3dB cut-off frequency on-chip.

(b) If the temperature coefficient(k) of R is -1000ppm/°C, find the percentage variation of the cut-off frequency across temperature (-40°C to 125°C) w.r.t to its value at 27°C assuming ideal capacitor. Given: $R(T) = R(T_0)\ [1 + k\ (T-T_0)]$, where $T_0 = 27°C$.

PROBLEM 2. Resistor Mismatch

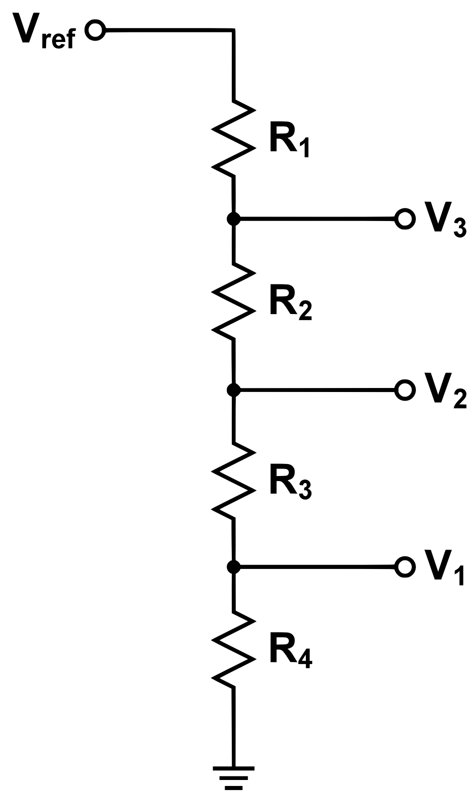


(a) Assuming the above Opamp to be ideal, find R1 and R2 such that voltage gain, $A_v = V_o/V_i = 2$ and $R_1+R_2 = 20k\Omega$.

(b) The resistor value is calculated as $R = R_{sh}(L/W)$, where L, W and R_{sh} are the length, width and sheet resistance of the resistor. If R_1 and R_2 are of the same type and the resistor mismatch is modelled using Gaussian distribution with σ value given, choose W and L of R_1 and R_2 such that 3σ variation in A_v is $\leq 1\%$. Given: $R_{sh} = 200\Omega/\Box$. Minimum L and W that can be used are $L_{min} = W_{min} = 500$nm. Sigma variation of R w.r.t. its mean is given by $\sigma(\Delta R/R) = 0.03/\sqrt{(WL)}$, where W and L are in μm.

PROBLEM 3. Mismatch in Resistive Divider

Given: V_{ref} = 400mV; $V_1 = V_{ref}/4$; $V_2 = V_{ref}/2$; $V_3 = 3V_{ref}/4$; $R_1+R_2+R_3+R_4$ = 40kΩ; Minimum L and W of resistors, L_{min}=W_{min}=500nm; Sigma variation of R w.r.t. its mean is given by $\sigma(\Delta R/R) = 0.03/\sqrt{(WL)}$, where W and L are in μm.



(a) For the resistive divider shown above, find the 3σ variation in the absolute value of output voltages V_1, V_2 and V_3 due to resistor mismatch in terms of $\sigma(\Delta R/R)$. Which voltage has the highest 3σ variation? Choose W and L of the resistors such that for $3\sigma(V_i) \leq$ 1mV for all values of i.

(b) If the resistive divider is extended to say eight equal resistors, which voltage is expected to have the highest 3σ variation?