

UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
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Homework #1

EECS 140

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Note: Use the device parameters given in the class handout “Device Parameters & SPICE Models” and also available on the EECS 140 website, <http://kowloon.eecs.berkeley.edu/~courses/140>. Assume $\beta \rightarrow \infty$ and $V_A \rightarrow \infty$ for all BJTs and $\lambda \rightarrow 0$ for all MOSFETs.

- 1) Given is the self-biasing V_{BE} reference circuit in Fig.1. The devices are sized such that $(W/L)_1 = (W/L)_2 = (W/L)_3$ and $(W/L)_4 = (W/L)_5$.
 - a) Find the value for R, so that $I_{OUT} = 100\mu A$.
 - b) Find the Sensitivity of I_{OUT} to fractional changes in the saturation current $\Delta I_S/I_S$ of Q1. Calculate the percent change $\Delta I_{OUT}/I_{OUT}$ for a 10% change of I_S .
 - c) Find the Fractional Temperature Coefficient, TC_F , of I_{OUT} . The resistor R has a temperature coefficient of 1200ppm/ $^{\circ}C$. Assume $dV_{BE}/dT = -2mV/^{\circ}C$ for Q1.

- 2) Given is the self-biasing V_t reference circuit in Fig.2 with the following parameters: $(W/L)_1 = (W/L)_2 = 200$; $(W/L)_3 = (W/L)_4 = (W/L)_5$.
 - a) Find the value for R, so that $I_{OUT} = 100\mu A$.
 - b) Find the Sensitivity of I_{OUT} to changes in the threshold voltage V_t . Calculate the percent change $\Delta I_{OUT}/I_{OUT}$ for a 100mV change of V_t . Note: to first order, only changes of the threshold voltage of M1 are significant.
 - c) Find the Fractional Temperature Coefficient, TC_F , of I_{OUT} . The resistor R has a temperature coefficient of 1200ppm/ $^{\circ}C$. Assume $dV_t/dT = -2mV/^{\circ}C$ and neglect the temperature dependence of the mobility, \square .

