In the voltage reference circuit of Figure 5, the device parameters are as follows:
\[ \mu_n C_{ox} \approx 100 \mu A/V^2, V_m \approx 1V, \gamma \approx 0, \lambda_n \approx 0 \]
\[ \mu_p C_{ox} \approx 50 \mu A/V^2, V_p \approx 1V, \gamma \approx 0, \lambda_p \approx 0 \]

**Thermal Voltage:** 
\[ V_T = 25.9 mV, \frac{\partial V_T}{\partial T} = 86 \mu V/°C \]

**Emitter–base:** 
\[ V_{eb} \approx 660 mV, \frac{\partial V_{eb}}{\partial T} = -2 mV/°C \]

**Resistors:** 
\[ TC(R) = \frac{\partial R}{R \partial T} = -1200 \text{ppm/°C} = -1.2 \cdot 10^{-3}/°C \]

The MOS device aspect ratios \( W/L \) in \( \mu m/\mu m \) and relative scale factors \( m \) for the bipolar devices are shown. The op-amp can be assumed to be ideal. Complete the following parts and show all work.

(a) Label the inverting and non-inverting inputs of the op-amp such that the bias circuit will operate properly.
(b) Write an expression for the bias current \( I_b \) in terms of the resistance \( R \) and process parameters. Solve for the resistance \( R \) that gives a bias current: \( I_b = 10 \mu A \).
(c) Write an expression for the output voltage \( V_o \) in terms of the resistive scale factor \( x \) and process parameters.
(d) Solve for the resistive scale factor \( x \) such that the temperature coefficient of the output voltage is approximately zero.

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