1. The figure shows a JFET current source used as the tail supply for a diff amp. It is given that $V^- = -15\, \text{V}$, $\beta = 0.004 \, \text{A}/\text{V}^2$, and $V_{TO} = -3\, \text{V}$. Use the equations $I_D = \beta (V_{GS} - V_{TO})^2$ and $V_{GS} = -I_D R_S$ to solve for the drain current $I_D$.

2. The figure shows a BJT current source. It is given that $V^+ = 24\, \text{V}$, $V^- = -24\, \text{V}$, $V_T = 25\, \text{mV}$, $I_S = 7.5 \times 10^{-15} \, \text{A}$, and $\beta = 49$. (Note that $\beta = 49$ is a low current gain, but it forces you to consider the base current.)

(a) Solve for $V_{BE}$ for $I_C = 3 \, \text{mA}$. Answer: $V_{BE} = 0.668 \, \text{V}$.
(b) Solve for $R_E$ such that the voltage across $R_E$ is $V_{BE}$. Answer: $R_E = 218\, \Omega$.
(c) If $I_2 = 10 I_B$, solve for $R_2$. Answer: $R_2 = 2.18\, \text{k}\Omega$.
(d) Solve for $R_1$. Answer: $R_1 = 69.3\, \text{k}\Omega$.
(e) If $V_A = 70\, \text{V}$, $V_C = -1\, \text{V}$, and $r_x = 40\, \Omega$, solve for $r'_e$, $r_0$, and $r_{ic}$. Answers: $r'_e = 51.3\, \Omega$, $r_0 = 30.8\, \text{k}\Omega$, $r_{ic} = 149\, \text{k}\Omega$.
(f) If the Early effect is neglected, i.e. assume that $\lambda = 0$ so that $\beta = \beta_0$, solve for $R_S$ for $I_D = 2\, \text{mA}$. Note that $I_Q = I_D$ for the diff amp tail supply. Answer: $R_S = 1.15\, \text{k}\Omega$.
(g) If $\lambda = 0.02\, \text{V}^{-1}$ and the voltage at the JFET drain is $V_D = -1\, \text{V}$, solve for the value of $\beta$ (it is greater than $\beta_0$), $r_0$, and $r_{id}$. Note that $R_Q = r_{id}$ for the diff amp tail supply. Answers: $r_0 = 30.9\, \text{k}\Omega$, $r_{id} = 254\, \text{k}\Omega$. 
