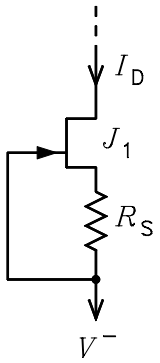
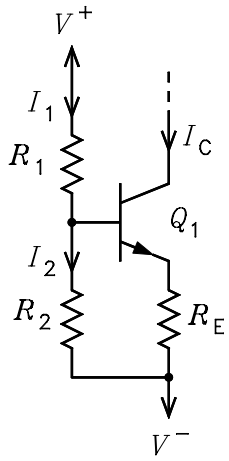
ECE3050 – Assignment 15

1. The figure shows a JFET current source used as the tail supply for a diff amp. It is given that $V^- = -15\,\text{V}$, $\beta = 0.004\,\text{A/V}^2$, 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 β (it is greater than β_0), r_0, and r_{id}. Note that $R_Q = r_{id}$ for the diff amp tail supply. Answers: $r_0 = 30.9\,\text{k}\Omega$, $r_{id} = 254\,\text{k}\Omega$.