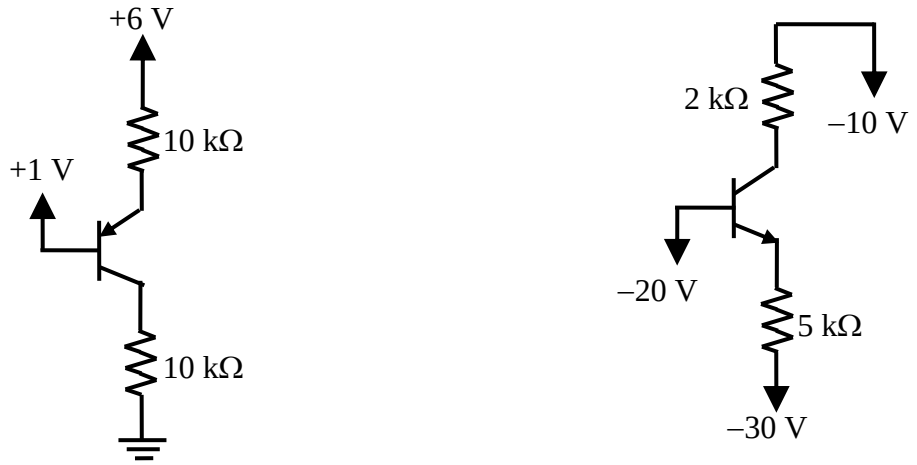
Nanyang Technological University
School of Electrical & Electronic Engineering
E2002 Analog Electronics – Tutorial 5

1. Identify the region of operation for the following circuits. What is the $V_{C,}$ V_E, I_B, I_C and I_E in each case. If active, what is the collector voltage? Assume $|V_{BE}| = 0.7$ V and $\beta = 100$.

   (Ans: (a) Saturation, $V_C = 1.4$ V, $V_E = 1.7$ V, $I_B = 0.29$ mA, $I_C = 0.14$ mA, $I_E = 0.43$ mA; (b) Active, $V_C = -13.68$ V, $V_E = -20.7$ V, $I_B = 18.4$ μA, $I_C = 1.86$ mA, $I_E = 1.86$ mA)

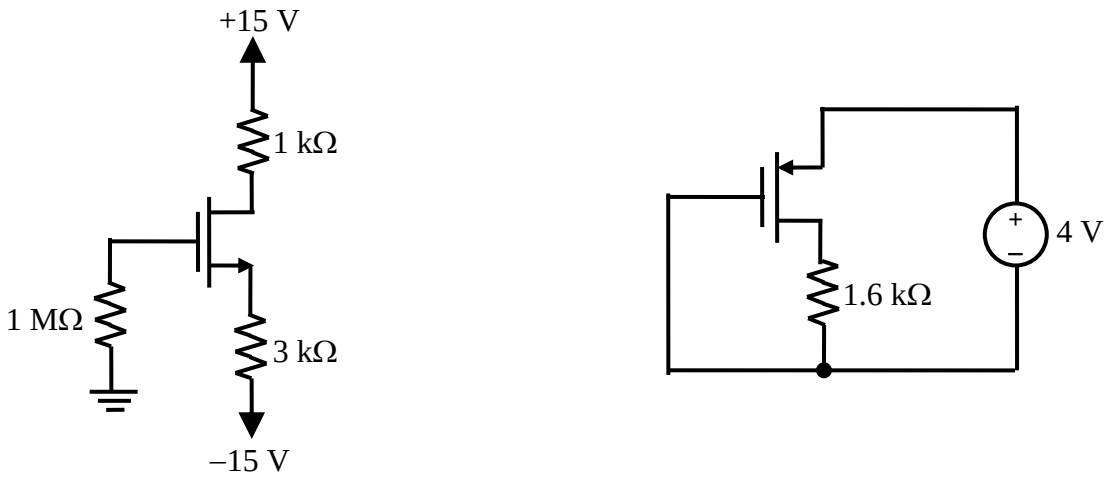


(a) (b)

Figure 1

2. Check if the region of operation for the following circuits. Determine the operating point if it is in saturation. Assume $\lambda = 0$. $V_{TN} = 1$ V and $K_n = 0.5$ mA/V^{-1} for NMOS and $V_{TP} = -1$ V and $K_p = 250$ μA/V^{-1} for PMOS.

   (Ans: (a) Saturation region, $V_{DS} = 16.28$ V, $I_D = 3.43$ mA; (b) triode region)



(a) (b)

Figure 2

3. A common-emitter amplifier circuit is shown in Figure 3. Assume that the capacitors have infinite value, $\beta = 100$, $V_{CC} = V_{EE} = 15$ V, $R_I = 750\ \Omega$, $R_1 = R_2 = 200$ kΩ, $R_L = 100$ kΩ, $R_E = 280$ kΩ, and $R_C = 100$ kΩ. Calculate the DC operating point of the amplifier. (Ans: $I_C = 50\ \mu A$, $V_{EC} = 10.86$ V).

Calculate the dc power dissipation in each element in the amplifier circuit. Compare the result to the total power delivered by the sources.
(Ans: $P_{R1} = 1.125$ mW, $P_{R2} = 1.125$ mW, $P_{Rc} = 0.25$ mW, $P_{RE} = 0.71$ mW, $P_{BJT} = 0.54$ mW. $P_S = 3.76$ mW)

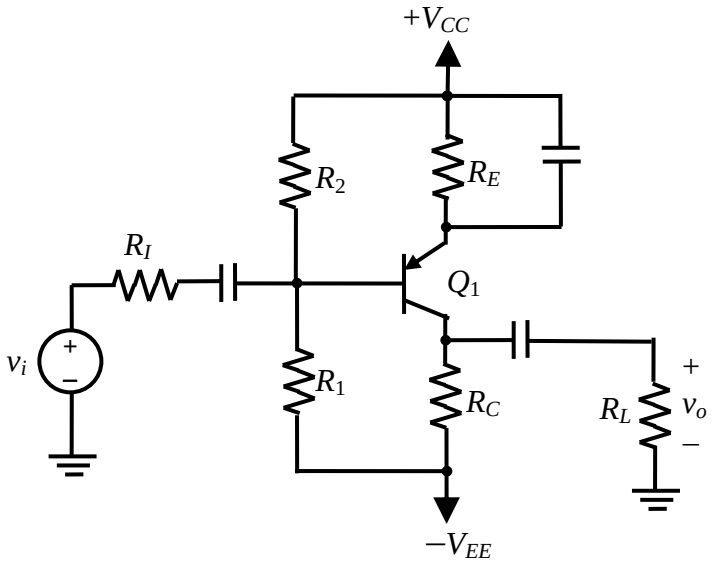


Figure 3

4. Draw the DC equivalent circuit for the common drain amplifier of Figure 4. Assume that the capacitors have infinite value, $K_n = 1$ mA/V^2, $V_{TN} = 1$V, $R_I = 100\ \Omega$, $R_1 = 1.2$ MΩ, $R_2 = 910$ kΩ, $R_L = 250\ \Omega$, $R_S = 3$ kΩ and $V_{DD} = 15$ V, calculate the DC operating point of the amplifier.
(Ans: $I_D = 1.87\ mA$, $V_{DS} = 9.39$ V).

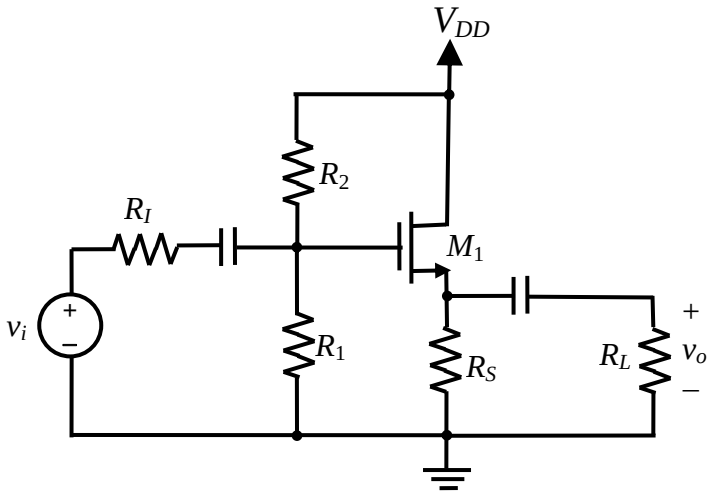


Figure 4