Indian Institute of Technology, Delhi
EEL 204: Analog Electronic Circuits
Tutorial 3, January 30, 2011

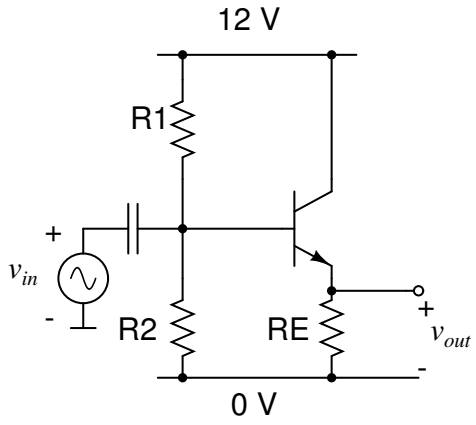
1. Figure (a) below shows a common collector circuit. The β of the transistor is 200. For a quiescent collector current of 5 mA, find out what RE should be for maximum symmetrical output swing. Assume V_{BE} to be 0.7 V. If $R1 \parallel R2$ is 10 kΩ, find (1) the input resistance of the circuit (2) the small signal gain of the circuit (3) the output resistance of the circuit. Assume r_o of the device to be infinitely large.

2. In Figure (b) below, assume V_{BE} is 0.7 V. Further assume the β of the transistor is 100. Compute the swing limits at the output of the circuit. Evaluate the (1) input resistance (2) the small signal voltage gain and (3) the output resistance of the circuit. What kind of controlled source would you classify this circuit as?

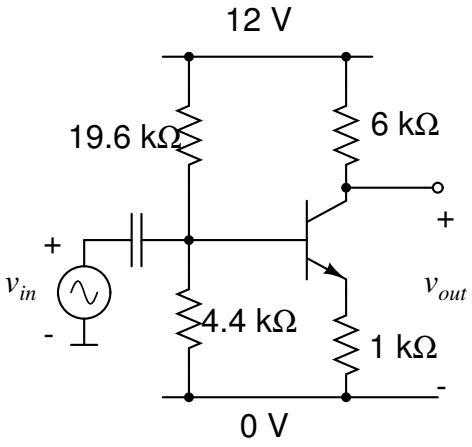
3. In Figure (c) below, assume V_{EB} is 0.7 V, the β of the transistor is 100. Compute (1) the swing limits at the output of the circuit, (2) the input resistance looking in from the input coupling capacitor, (3) the output resistance, (4) the small signal voltage gain. What kind of controlled source would you classify this circuit as?

4. In Figure (d), assume that the drain current of the MOSFET is given by:
$$I_D = K(V_{GS} - V_T)^2$$
where K is 10 mS/V, and the V_T of the device is 0.5 V. Find the bias conditions of the circuit. The MOS transistor remains in saturation as long as $V_{DS} > V_{GS} - V_T$. Find the swing limits at the output of the circuit. Assuming $g_m r_{ds} = 50$, find the (1) output resistance and (2) the small signal voltage gain of the circuit.

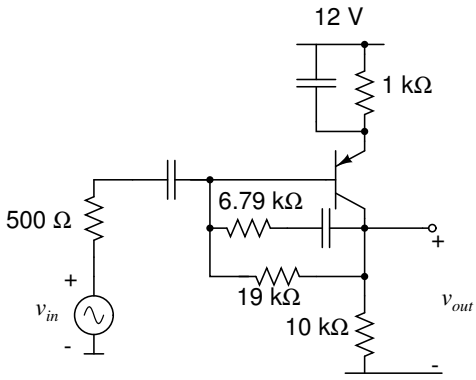
5. Consider the nMOS transistor as described in the previous question, now arranged as in Figure (e). Find the operating point voltages at all the nodes in the circuit. How is it different from the previous topology?


12 V
R1
+
v_{in}
-
R2
RE
+
v_{out}
-
0 V

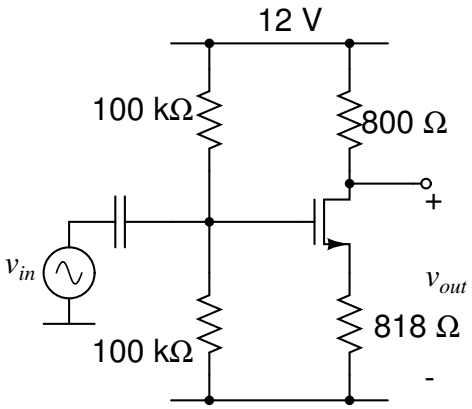
(a)


12 V
19.6 kΩ
6 kΩ
+
+
v_{in}
v_{out}
-
4.4 kΩ
1 kΩ
-
0 V

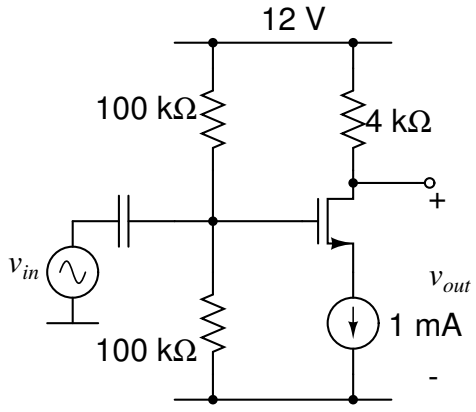
(b)


12 V
1 kΩ
6.79 kΩ
500 Ω
+
+
v_{in}
19 kΩ
v_{out}
10 kΩ
-
-

(c)


12 V
100 kΩ
800 Ω
+
v_{in}
v_{out}
100 kΩ
818 Ω
-

(d)


12 V
100 kΩ
4 kΩ
+
v_{in}
v_{out}
1 mA
100 kΩ
-

(e)