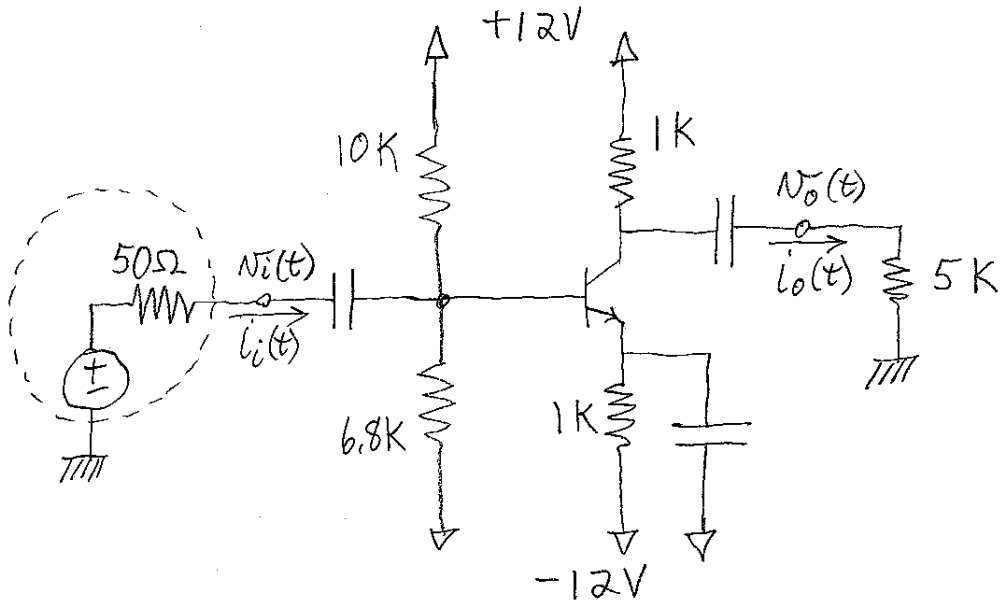
The BJTs in the circuits that follow are all biased in the active region at the Q-point indicated. You need not verify the Q-points but may do so if you wish. The static current gain of the transistors is $\beta = 99 = h_{fe}$ and the capacitors are very large. For each one of the circuits,

1. Sketch the AC model in its simplified form,
2. Calculate the voltage gain, the input impedance, the output impedance, the current gain and the power gain (I would recommend that you calculate them in this order but you don't need to),
3. Calculate the expressions of $I_C(t)$ and $V_{CE}(t)$ as functions of $v_i(t)$, and
4. Calculate the AC load line and the allowable range of $v_i(t)$ for which the BJT remains in the active region.

#1



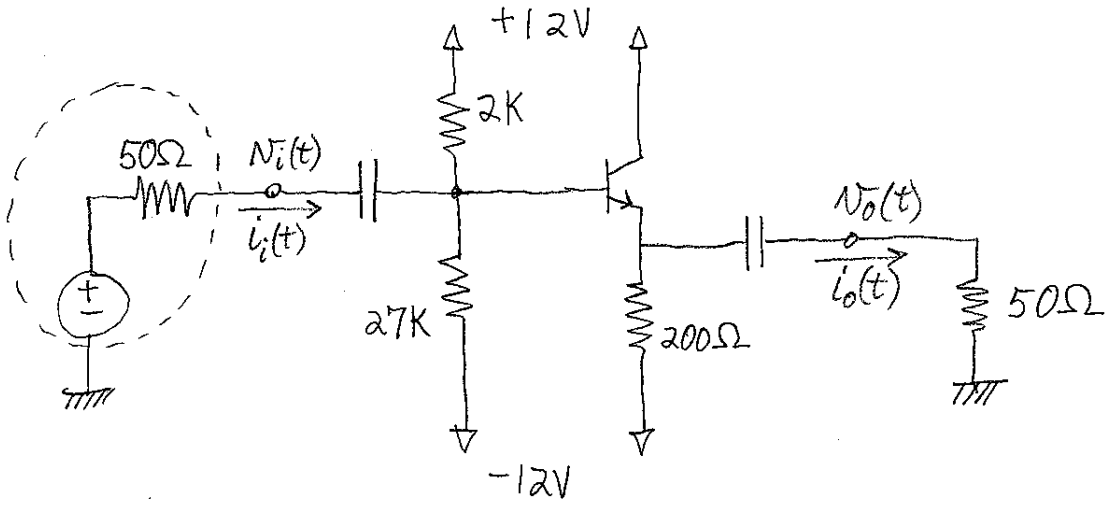
$I_B = 86.6\,\mu A$

$I_C = 8.577\,mA$

$V_{CE} = 6.76\,V$

$V_{BE} \approx 0.7V$

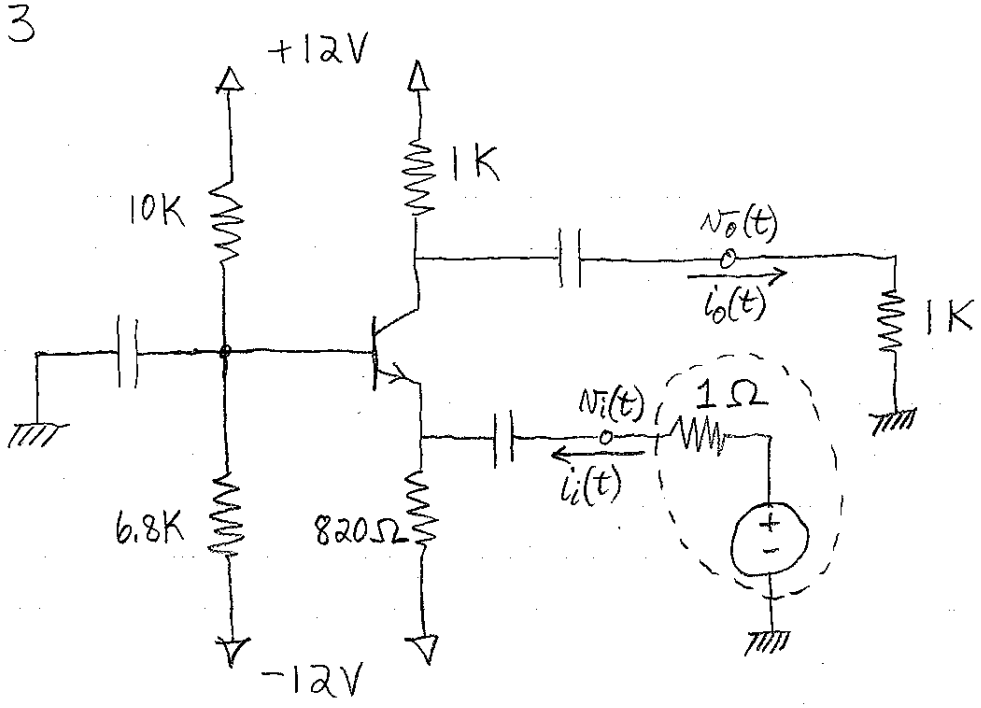
#2



$I_B = 0.99\,mA$ $\quad V_{BE} \approx 0.7V$

$I_C = 98.01\,mA$ $\quad V_{CE} = 4.199V$

#3



$I_B = 0.1048mA$ $V_{BE} \approx 0.7V$

$I_C = 10.37mA$ $V_{CE} = 5.039V$

Answers:

#1 $h_{ie} = 291\,\Omega$

$A_V = -284$ $A_I = -15.4$ $A_P = 4370$

$Z_{in} = 271\,\Omega$ $Z_{out} = 1\,k\Omega$

AC load line: $I_C = -1.2\,mS\,V_{CE} + 16.69\,mA$

$-25.2\,mV \leq v_i(t) \leq 23.1\,mV.$

#2 $h_{ie} = 25.5\,\Omega$

$A_V = 0.994$ $A_I = 25.3$ $A_P = 25.1$

$Z_{in} = 1.27\,k\Omega$ $Z_{out} = 0.74\,\Omega$

AC load line: $I_C = -24.75\,mS\,V_{CE} + 202\,mA$

$-3.99\,V \leq v_i(t) \leq 4.02\,V$

#3 $h_{ie} = 241\,\Omega$

$A_V = 206$ $A_I = 0.494$ $A_P = 102$

$Z_{in} = 2.40\,\Omega$ $Z_{out} = 1\,k\Omega$

AC load line: $I_C = -2.01\,mS\,V_{CE} + 20.50\,mA$

$-23.6\,mV \leq v_i(t) \leq 25.2\,mV.$