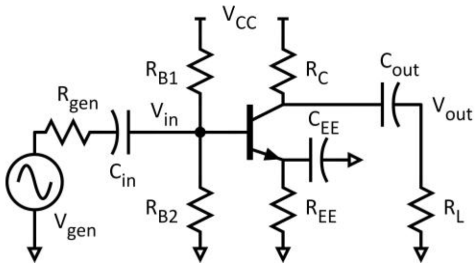
ECE137A Problem set #2

Problem 1. Simple common-emitter amplifier



a) The transistor has beta=200.
Vcc is +10.0 Volts. RL=1000 Ohm. Rgen=1 kOhm. The transistor has Va=100 V and Vcesat=0.5 volts

We want the emitter to be biased at +2.0 volts and the collector to be biased at +5.0 volts. The DC collector current is to be 0.5 mA, and the DC current through Rb2 is to be 0.1 mA.

Find Rb1, Rb2, Rc, Ree

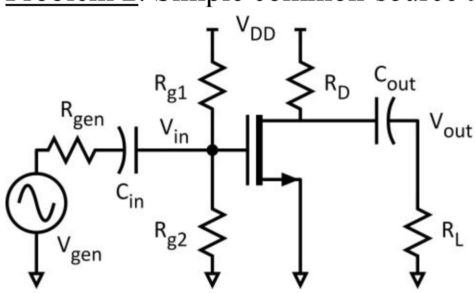
b) Find the following small signal transistor parameters:
gm, Rbe, Rce

c) draw the small-signal equivalent circuit of the amplifier, taking all capacitors as AC shorts and supplies as AC ground.

d) find the ac small signal input impedance, and the AC voltage gains Vout/Vin, Vin/Vgen and Vout/Vgen.

e) find the maximum AC peak-peak amplifier output before clipping.

Problem 2. Simple common-source amplifier



a) The MOSFET has v_{th} =0.3 Volt,
$K_\mu = 0.55\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$,
$K_v = 0.69\text{mA/V} \cdot (W_g / 1\mu\text{m})$
$\Delta V = 0.625\text{V}$
and $1/\lambda$ =5 Volts

Find the gate width necessary to carry 2 mA drain current at Vgs = 0.4 V.

Vdd is +2.0 volts. Rgen=25 kOhm, RL=500 kOhm

Find the drain resistance Rd necessary to obtain V_D =1 V.

We want the *input impedance to be 1 MOhm. Find Rg1, Rg2

b) Find the following small signal transistor parameters: gm, Rds

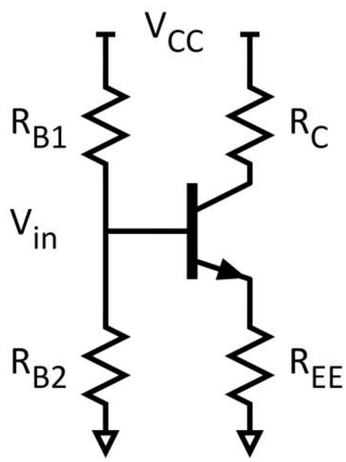
c) draw the small-signal equivalent circuit of the amplifier, taking all capacitors as AC shorts and supplies as AC ground.

d) find the ac small signal input

e) find the maximum AC peak-peak amplifier impedance, and the AC voltage gains Vout/Vin, Vin/Vgen and Vout/Vgen.

output before clipping.

<u>Problem 3</u>. Nodal Analysis

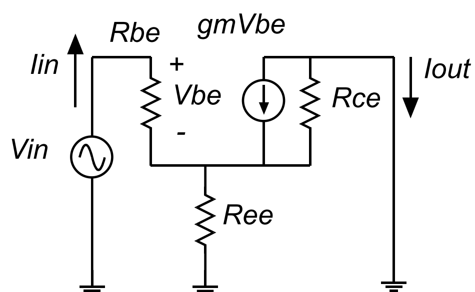


We will frequently need to analyze circuits with resistance in the emitter or source lead.

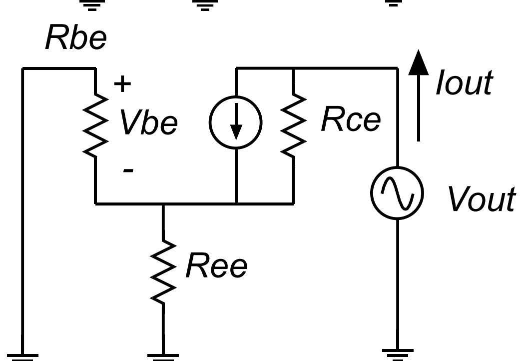
So, this problem is both a tutorial in how these work, and an exercise in nodal analysis, for which much practice is needed.

The overall circuit and the transistor small-signal model are as indicated on the right….

But the problem can be broken into the units below



a) with the network to the left, derive ***by nodal analysis***
…the input impedance Vin/Iin
…the *extrinsic* transconductance Iout/Vin



b) with the network to the left, derive ***by nodal analysis***
…the output resistance Vout/Iout