Problem 1. Simple common-emitter amplifier

\[ +Vcc \]
\[ Rb1 \]
\[ Rgen \]
\[ Vin \]
\[ Vgen \]
\[ Rb2 \]
\[ Ree \]
\[ Rc \]
\[ Vout \]
\[ RL \]
\[ \text{We want the emitter to be biased at +0.5 volts and the collector to be biased at +2.0 volts. The DC collector current is to be 2 mA, and the DC current through Rb2 is to be 0.1 mA.} \]

We want the emitter to be biased at +0.5 volts and the collector to be biased at +2.0 volts. The DC collector current is to be 2 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: \( gm, re, Rbe, Rce \)

d) find the ac small signal input impedance, and the AC voltage gains \( \frac{V_{out}}{V_{in}}, \frac{V_{in}}{V_{gen}} \) and \( \frac{V_{out}}{V_{gen}} \).

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

Problem 2. Simple common-source amplifier

\[ +Vdd \]
\[ Rg1 \]
\[ Rgen \]
\[ Vin \]
\[ Vgen \]
\[ Rg2 \]
\[ Rd \]
\[ Vout \]
\[ RL \]
\[ \text{Find the gate width necessary to carry 1.0 mA drain current at } V_{gs} = 0.4 \text{ V.} \]

Find the gate width necessary to carry 1.0 mA drain current at \( V_{gs} = 0.4 \text{ V.} \)

Find the drain resistance \( Rd \) necessary to obtain \( V_{d} = 1 \text{ V.} \)

We want the input impedance to be 1 MOhm.

Find Rg1, Rg2
transistor parameters: gm, Rds 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 3. Another common-source amplifier

\[ V_{DD} \] \[ V_{in} \] \[ V_{out} \]

- a) The NMOSFET has \( v_{th} = 0.2 \) Volt
  \[ K_\mu = 16 \text{mA/V}^2 \cdot (W_g / 1 \mu \text{m}) \]
  \[ K_v = 2.40 \text{mA/V} \cdot (W_g / 1 \mu \text{m}) \]
  \[ \Delta V = 75 \text{mV} \]
  \[ 1/\lambda = 5 \text{ Volts} \]

The PMOS has the same parameters except, of course, \( v_{th} = -0.2 \) Volt,

Vdd is 0.5 Volt. The input has 0.25 V DC bias, to which a small-signal input voltage is added.

b) Find the following small signal transistor parameters: gm, Rds for both transistors.
c) draw the small-signal equivalent circuit of the amplifier.
d) ac small signal voltage gain Vout/Vin

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

Problem 4. 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 word, 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, which is what you must work this week
a) with the network to the left, derive by
nodal analysis
...the input impedance $\frac{V_{in}}{I_{in}}$
...the *extrinsic* transconductance $\frac{I_{out}}{V_{in}}$

b) with the network to the left, derive by
nodal analysis
...the output resistance $\frac{V_{out}}{I_{out}}$