ECE 65: Components & Circuits Lab

Practice 4

Amplifier practice problems

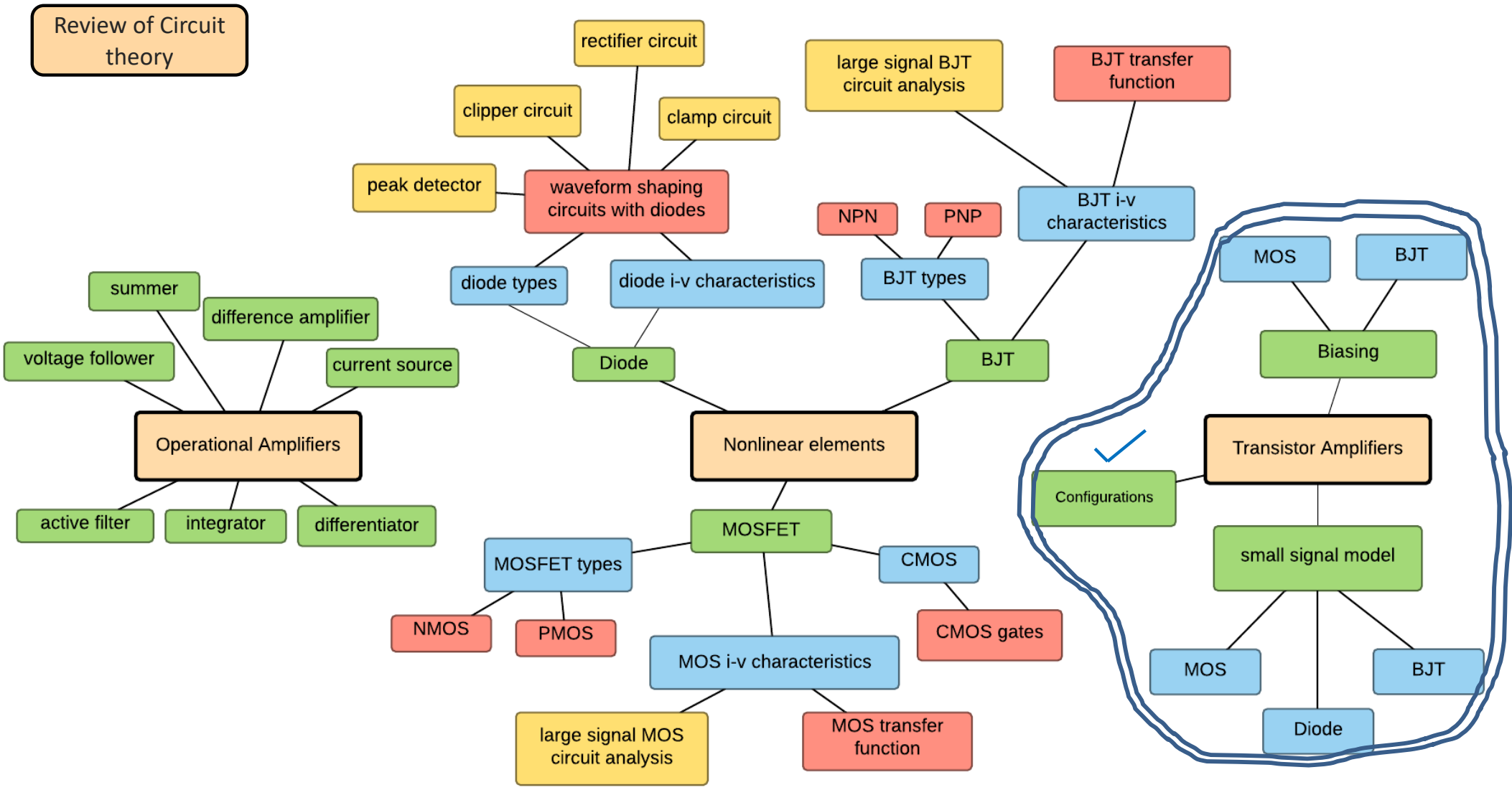
Reference notes: sections 6.1, 6.2

Sedra & Smith (7th Ed): section 7.3

Saharnaz Baghdadchi

Course map

7. Transistor Amplifier Configurations



Practice problem 1.

Design the following amplifier circuit, to achieve a voltage gain of $v_0/v_{sig} = -40\ V/V$.

a) You have a 15 V power supply available.

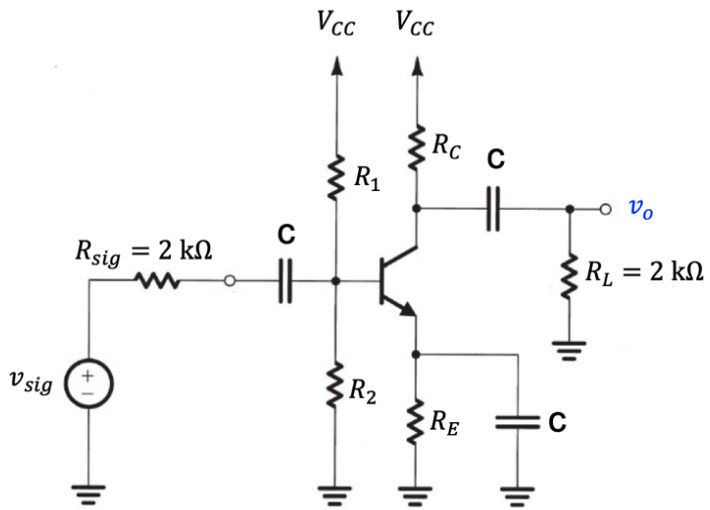
b) An emitter current of 2 mA is desired.

c) The current through R_2 is to be one-tenth of I_E.

d) The DC voltage at the base should be equal to one-third of the power supply.

The available transistor has $\beta = 100$ and $V_{D0} = 0.7\ V$. Ignore the early effect in bias and signal circuits. Assume Capacitors are short in the signal circuit. Use $V_T = 25\ mV$.

Draw the signal circuit and calculate the signal parameters.



Hints:

Practice problem 1.

$v_o/v_{sig} = -40\ V/V$

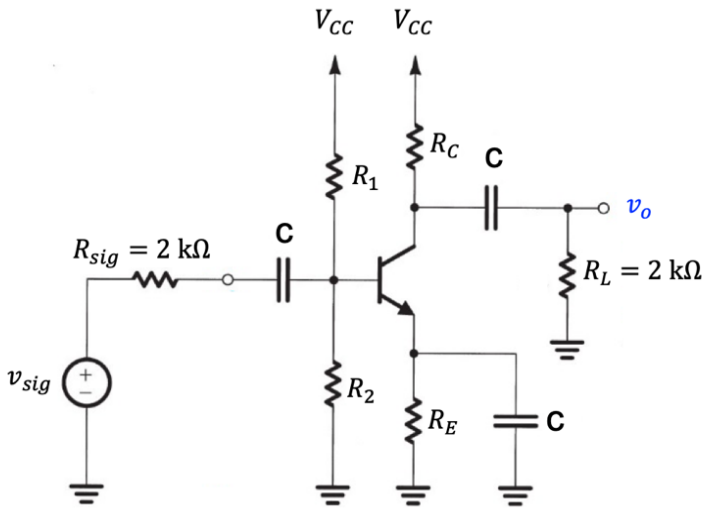
a) You have a 15 V power supply available.

b) An emitter current of 2 mA is desired.

V_{CC} = 15V, I_E = 2 mA, and V_B = 5V

c) The current through R_2 is to be one-tenth of I_E.

d) The DC voltage at the base should be equal to one-third of the power supply.



- You can start by drawing the bias circuit and solving it to find R_1 and R_2.

- You can use Ohm's law to find R2.

- Using I_E and knowing that the BJT is in active mode, you can find I_B. Then using a KCL at the base and I_{R2} you can find I_{R1}. Using Ohm's law you can then find R_1.

- Writing a KVL at the BE loop will give you an equation with R_E as the only unknown. You can solve that equation for R_E.

- To find R_C, you can use the given total circuit voltage gain. You will need to find the small signal parameters (r_{pi}, r_o, and g_m) first.

- Identify the amplifier type and write the equations of the amplifier parameters, then use the voltage amplifier model (voltage divider networks) to find an equation relating v_o to v_{sig}. The only unknown in that equation should be R_C.

- Another way of finding R_C is to draw the signal circuit and solve it to get an equation relating v_o to v_{sig}. The only unknown in that equation should be R_C.

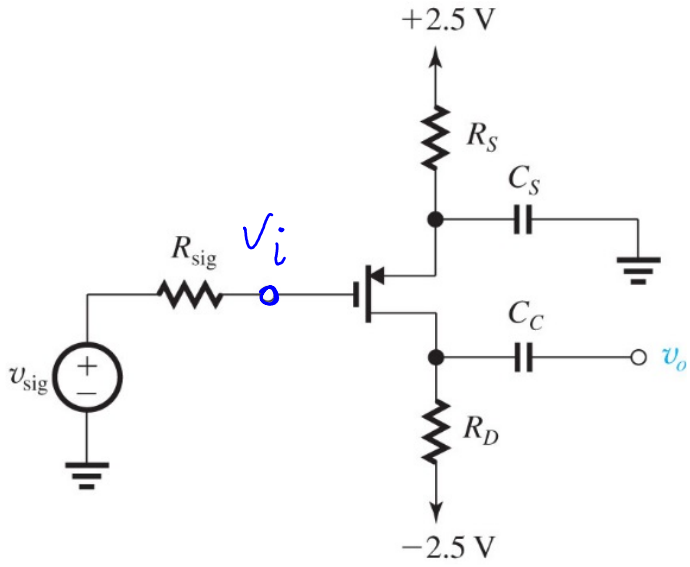
Practice Problem 2 from last lecture

The PMOS in the below common-source amplifier circuit has $V_{tp} = -0.7\ V$ and $\lambda = 0$.

1. Select a value for R_S to bias the transistor at $I_D = 0.3\ mA$ and $V_{OV} = 0.3\ V$.

2. Select a value for R_D that results in $A_V = -10\ V/V$.

3. If $v_{sig} = 5 \sin(\omega t)$ (mV) and $R_{sig} = 1k\Omega$, find and sketch all node voltages & i_D.



DC node voltages and DC drain current:

$V_S = 1V$, $V_G = 0V$, $I_D = 0.3\ mA$

$V_D = R_D I_D - 2.5\ V = 5k\Omega \times 0.3mA - 2.5 = -1V$

Practice problem 2.

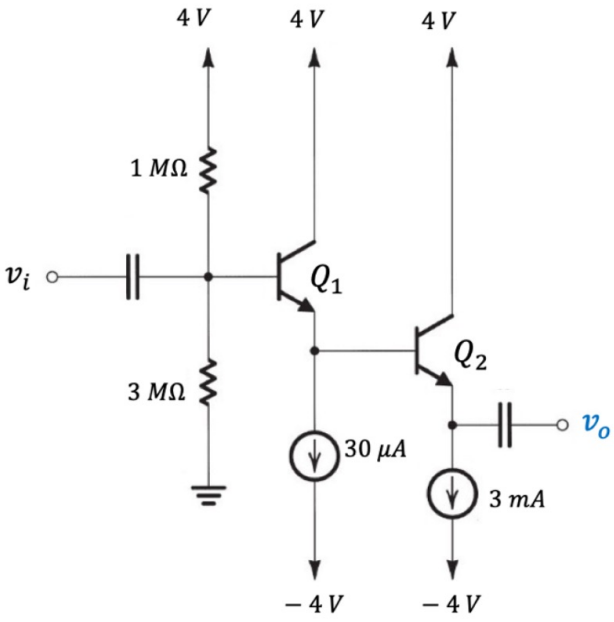
In the below amplifier circuit,

a) Find the DC emitter currents and the DC Base node voltages of Q1 and Q2.

b) Find the small signal parameters.

c) If a load resistance $R_L = 10\ k\Omega$ is connected to the output terminal, and a signal source with $R_{sig} = 0$ is connected to the input terminal, final $A = \frac{v_o}{v_{sig}}$.

$\beta_1 = 60, \beta_2 = 100, V_T = 25\ mV, V_{D0} = 0.7\ V.$
Neglect the early effect in the bias and signal circuits. The capacitors are short for the signal circuit.



The input resistance of the second stage will act as the load resistor for the first stage.

For a common-collector amplifier use $A_{vo} = \frac{(1/g_m) \| r_\pi \| R_E \| r_o}{(1/g_m) \| r_\pi}$