Cairo University
Faculty of Engineering
Electronics & Comm. Dept.

Electronics (1)
First Year
2009-2010

Sheet 2
BJT as an amplifier

Problem (1):

Using the T equivalent model of the BJT, sketch the equivalent circuit of a transistor amplifier which a resistance (R_E) is connected between the emitter & the ground, the collector is grounded & an input signal source (v_b) is connected between the base & the ground (It's assumed that the transistor is properly biased to operate in active mode). Show that:

a. The voltage gain between the base & the emitter is given by:

$$\frac{v_e}{v_b} = \frac{R_E}{R_E + r_e}$$

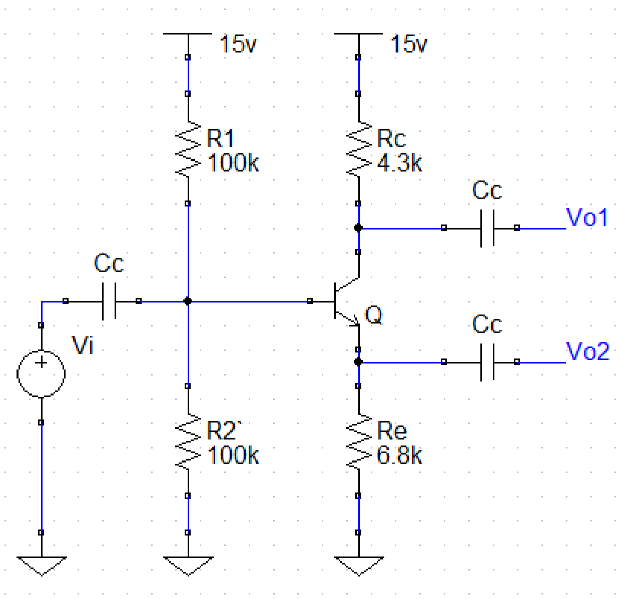
b. The input resistance (R_{in}):

$$R_{in} = \frac{v_b}{i_b} = (\beta + 1)(R_E + r_e)$$

Problem (2):

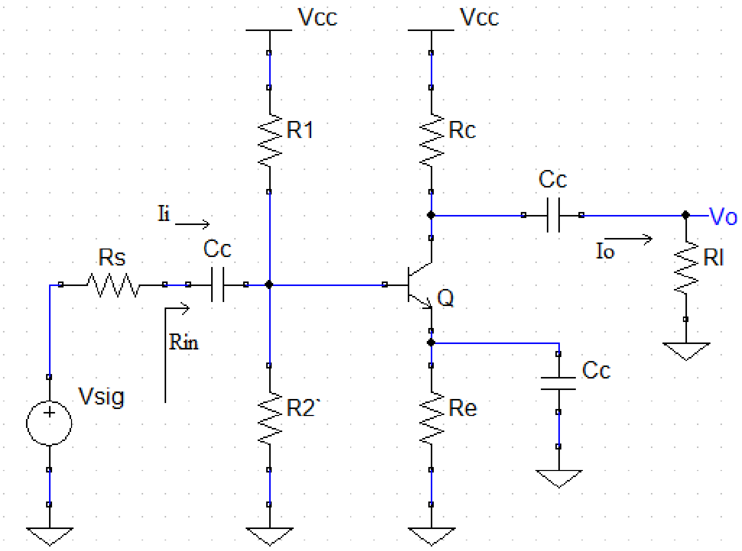
The transistor in the figure below is biased to operate in the active mode. Assuming that β is very large, find the collector bias current (I_C). Replace the transistor with the small-signal equivalent model (T-model with CCCS) and analyze the resulting amplifier equivalent circuit to show that:

$$\frac{v_{o1}}{v_{o2}} = -\frac{R_c}{R_e}$$



Problem (3):

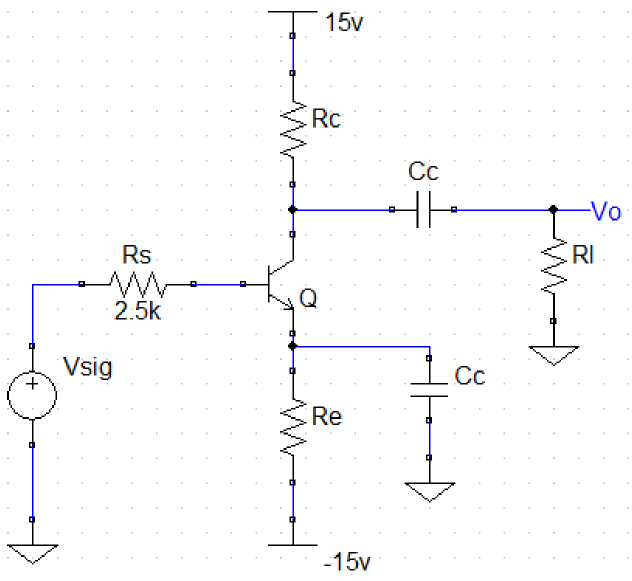
For the common emitter shown below: V_{CC} = 9v, R_1 = 27kΩ, R_2 = 15kΩ, R_E = 1.2kΩ and R_C = 2.2kΩ. The transistor β= 100 and V_A= 100v. Calculate the dc bias current I_E. If the amplifier is operating between a source resistance R_s= 10kΩ and a load resistance R_L= 2kΩ, replace the transistor with its hybrid π-mode and find the value of R_{in}, the voltage gain (v_o/v_{sig}) and the current gain (i_o/i_i).



Problem (4):

In the circuit shown below, (v_{sig}) is a small signal sine wave with a zero average. The transistor β is 100.

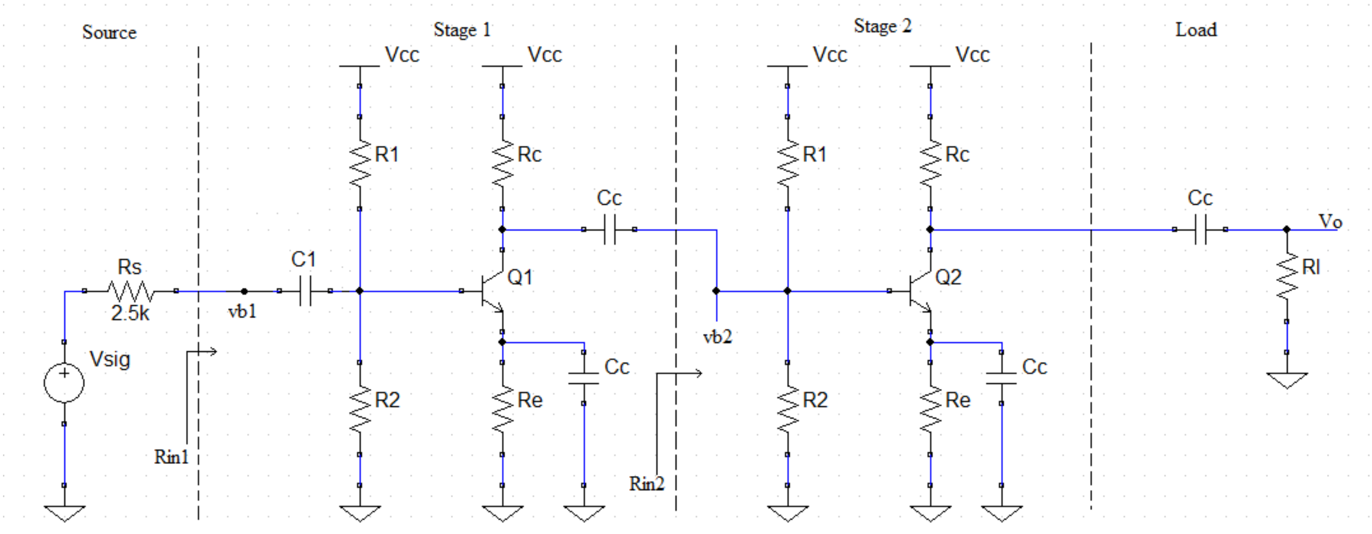
a. Find the value of R_E to establish a dc emitter current of about 1mA.
b. Find the value of R_C to establish a dc collector voltage of +5v.
c. For R_L= 5kΩ and the transistor r_o= 100kΩ, draw the small-signal equivalent circuit of the amplifier and determine its overall voltage gain, R_{in} and R_{out}.



Problem (5):

The amplifier below consists of two identical common-emitter amplifiers connected in cascade. Observe that the input resistance of the second stage, R_{in2}, acts as the load resistance of the second stage.

a. For V_{CC}= 15v, R_1= 100kΩ, R_2= 47kΩ, R_E= 3.9kΩ, R_C= 6.8kΩ and β= 100, determine the dc collector current and collector voltage of each transistor.
b. Draw the small-signal equivalent circuit of the entire amplifier and give the values of its entire component. Neglect r_{o1} & r_{o2}.
c. Find R_{in1} and $\frac{v_{b1}}{v_{sig}}$ for R_s= 5kΩ.
d. Find R_{in2} and $\frac{v_{b2}}{v_{b1}}$.
e. For R_L= 2kΩ, find $\frac{v_0}{v_{b1}}$.
f. Find the overall voltage gain $\frac{v_o}{v_{sig}}$.

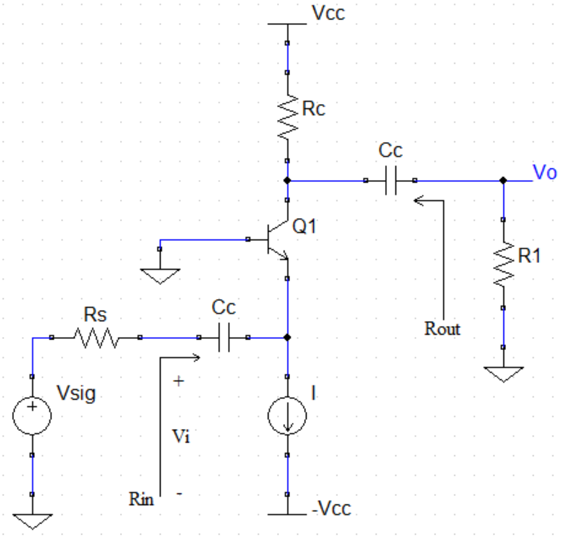


Problem (6):

Consider the common base amplifier in the figure below with a 10kΩ load resistance connected to the collector via a large capacitance. Let R_C = 10kΩ, V_{CC}= 10v and R_s= 50Ω.

a. To what value must (I) be set in order that the input resistance at Emitter is equal to that of the source (namely 50Ω)? What is the resulting voltage gain from the source to the load?
(Assume α=1).

b. Find the voltage gain (A_v) for R_L = 10kΩ.



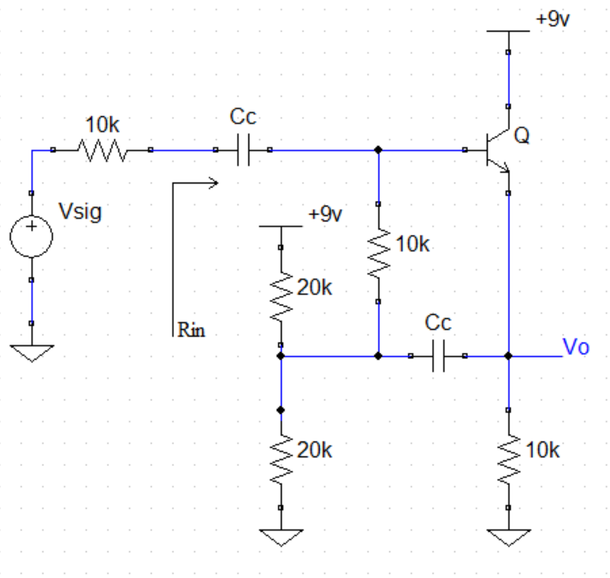
Problem (7):

For the circuit shown, called a boot-strapped follower:

a. Find the dc emitter current, g_m, r_o and r_π. Use β=100.

b. Replace the BJT with its hybrid π-model (neglecting r_o) and analyze the circuit to determine the input resistance (R_{in}) and the voltage gain (v_o/v_{sig}).

c. Repeat (b) for the capacitor at the emitter is open circuit. Compare the results with those obtained in (b) to find the advantages of bootstrapping.



Good Luck