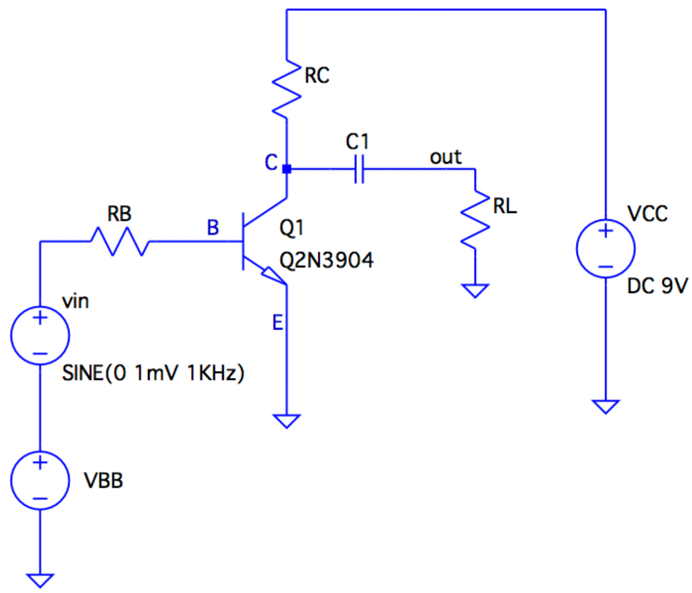
Objectives:

- Performing DC and small signal AC analysis of the circuit
- Implementing the circuit in an experimental setting, taking measurements and comparing the circuit behavior with theoretical results

Pre-Lab



Consider the amplifying circuit provided in figure. Select adequate values for RB, RC and VBB so that the DC bias point is set at VCE=4.5V and IC=10 mA.

Use SPICE to infer the β of the BJT. Hint: plot of the transistor's β=Ic(Q1)/Ib(Q1) vs. VCE curve using the model of the 2N3904 provided by LTSPICE. Extract the value of β for a DC bias point reasonably close to IC=10 mA, VCE=4.5V

β =

Provide the symbolic equations and numerical values of the following quantities:

RC =

IB =

VBB =

RB =

gm =

rπ =

AV = vc/vin with RL not connected =

Lab

Use the DC offset in your AWG for generating VBB.

1. Before applying the AC input signal to the base, adjust its DC offset (that is VBB) until VC=4.5V
   Measure the value of VBB required to set VC at 4.5V, and measure the value of VBE.

   VBB =

   VBE =

2. Now, apply also the AC sinusoidal input signal. Measure the gain of the amplifier at a frequency of 10KHz with RL not connected (AV = vc/vin). Compare your measurement with your theoretical prediction from the prelab.

   amplitude of the AC signal applied =

   AV =

Parameter	Theoretical prediction	Measurement	% Error
AV =			

3. Measure the maximum output swing you can achieve.

   a. Maximum output swing

   ____

   b. Corresponding maximum input swing

   ____

   c. When clipping, does the transistor go in saturation or cut off? ______________

   Explain shortly your conclusion:

   ____

   ____

   ____

4. Connect a load of 100 Ω to the collector via capacitive coupling. Measure the gain again

a. AV with RL connected =

b. Did the gain increase, decrease or remain the same? ________________________________

Increase the input voltage until clipping occurs.

c. What is the maximum output swing: ____

d. Does the transistor go into saturation or cut-off first? ________________________________

5. Use SPICE .OP and .AC analysis to simulate the circuit you have built (use the version with RL not connected). Lookup the values of βDC (hFE), βAC (hfe), rπ (hie) and ro (1/hoe) provided on the data sheet of the transistor.

a. Compare the quantities provided on the data sheet with the quantities obtained using SPICE

Quantity	SPICE	Data Sheet	% Error
βDC			
βAC			
rπ			
ro			

% Error = 100 x (SPICE – DataSheet) / SPICE

b. Circle the value of β you used for computing |AV|?

βDC βAC

Was it the best choice? ____

c. Estimate the importance of choosing the correct value of β.

$100 \times (\beta_{DC,SPICE} - \beta_{AC,SPICE}) / \beta_{AC,SPICE} =$

$100 \times (\beta_{DC,DATASHEET} - \beta_{AC,DATASHEET}) / \beta_{AC,DATASHEET} =$

d. If you used βDC compute |AV| again, but this time using βAC

e. Compare the gain measured, the gain estimated and the gain obtained with SPICE (use the version with RL not connected)

Quantity	SPICE	Measured	Estimated
|AV|			