Experiment 4

Comparison of frequency response of Common-Emitter (CE) and Common-Base (CB) amplifiers

Objective – Measure the frequency response of CE and CB amplifiers.

Introduction – An amplifier has a frequency-dependant gain. In the mid-band region the gain is largest and at lower frequency the gain starts to decrease. The point at which the gain reduces to 71% of the highest value is called the lower 3dB point (f_L). At high frequencies the gain also goes down and the point where the gain is reduced to 71% of the highest value is called the upper 3dB point (f_H).

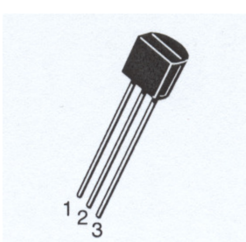
The mid-band gain for a CE amplifier is given by the expression $A_v = -g_m R_C // R_L$. Here, R_C and R_L are collector and load resistance, respectively. The negative sign in the gain indicates that the input and output are out of phase.

The mid-band gain for a CB amplifier is given by the expression $A_v = g_m R_C // R_L$. Here, the gain is same as the case of the CE configuration except for the negative sign.

The lower 3 dB frequency is determined by coupling and bypass capacitors. The upper 3 dB frequency is determined by the internal capacitance of the BJT. These capacitors arise because of junction capacitors. More specifically, these capacitors are emitter-base capacitance (C_π) and collector-base capacitance (C_μ). The expression of gain for mid-band region (A_v) is no longer correct because the small-signal model for the BJT includes junction capacitors such as C_μ and C_π. In this experiment we would like to see the frequency response of CE and CB amplifiers through simulation and then actual measurement.

Experimental Procedure –

<u>CE amplifier (Measurement)</u> – Assemble the circuit in Fig.2 on the circuit-board using BJT P2N2222A. The pin-out for this BJT is shown in Fig. 1.



Pin No.	P2N2222A BJT
1	Collector
2	Base
3	Emitter

Fig. 1

In Fig. 2 Vin should be replaced with a Function Generator with input as a sine wave. Vin (p-p) should be in around 40mV.

1. Using the DMM, measure V_C. From this measurement calculate I_C and then g_m ($g_m = I_C/25mV$). This information will be useful in answering questions.
2. Measure V_E and then calculate $V_{CE} = V_C - V_E$. This value should be greater than 0.3V so that the BJT is in the active mode. This is a necessary requirement for amplifier action.
3. Set the function generator to frequency, f=1 kHz, Vin (p-p) =40 mV and $V_{OFF} = 0$. In the oscilloscope observe V_{in} and V_{out} simultaneously. Note down the phase relationship between input and the output.
4. Now do a "Vout vs. f" measurement. Be prepared to reduce Vin (p-p) if the output saturates. On the other hand you could increase it if the output signal is noisy. The frequency f is given on the Function Generator while Vout is found from the oscilloscope. Start at f=30 Hz and increase it by a factor of 3 (Approximately). For example, you could go for f = 30 Hz, 100Hz, 300Hz, 1 kHz, 3 kHz etc. You should cover (i.e. exceed) the frequency range that gives you f_L and f_H.
5. Plot Gain (G_v) vs. f on a semi-log graph. Determine f_L and f_H.

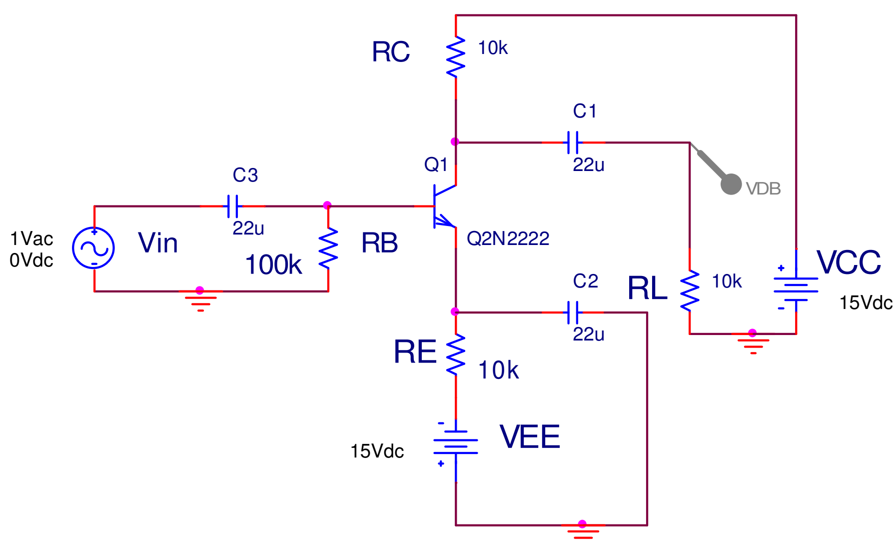


Fig. 2

<u>CB amplifier (Measurement) -</u> Assemble the circuit in Fig.3. In Fig.3 Vin should be replaced with the Function Generator, where the input should be Vin(p-p) should be in around 40mV.

Repeat steps 1-5 from above.

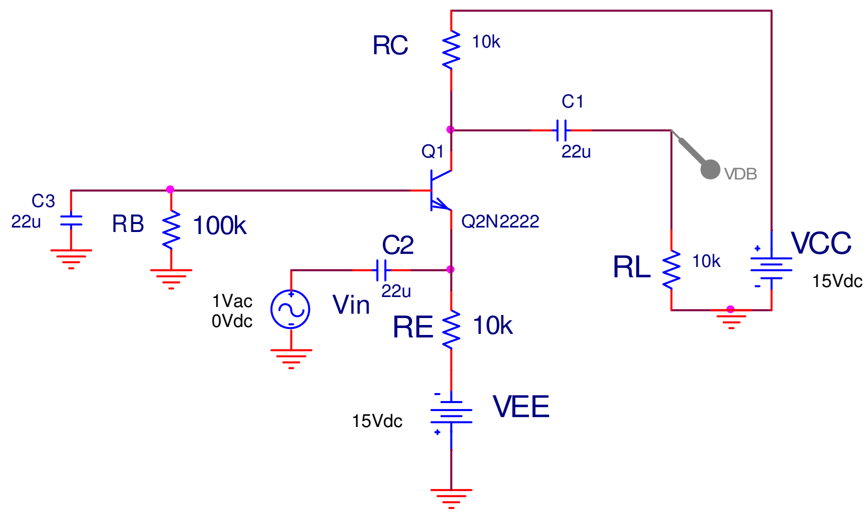


Fig. 3

<u>Questions</u> –

1. Comment on the mid-band gains obtained for the CE and CB amplifiers obtained by simulation. If they are very different (more than 10%) explain why?

2. Provide the mid-band gains obtained for the CE and CB amplifiers obtained by lab bench work. If they are very different (more than 10%) explain why?

3. Comment on the phase relation of the signals at the output and input for the CE and CB amplifiers (use the lab bench results).

4. Do the f_H values of the CE and CB amplifiers differ in the lab bench work? If yes, why?

5. What is the role of the transistor 'beta' (h_{fe}) on the values of (i) f_L, (ii) f_H? Justify by proper analysis. Consider only the CE amplifier.

6. What is the role of the transistor 'g_m' on the values of (i) f_L, (ii) f_H? Justify by proper analysis. Consider only the CE amplifier.