SingleStageAmplifier -- Overview

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Objective

At the end of this lab experiment, students will be able to:
• Design an RC coupled single stage BJT amplifier
• Determine frequency response
• Compute Input impedance
• Compute Output impedance

Equipment

To carry out this experiment, you will need:
• TBS 1000B-EDUOscilloscope from Tektronix.
• Voltage probe (provided with oscilloscope) / BNC cables
• Breadboard and connecting wires
• Circuit components - Resistors, Capacitors, NPN Transistor SL 100, Regulated DC supply 0-30V DC
Signal /Function generator 10Hz to 1 Mhz, Multimeter (for testing), DRB 0 to1 Meg ohm

Theory

• In RC coupled amplifier the input capacitor is used to couple the input signal to the base of first transistor.

• Since the coupling from one stage to next stage can be achieved by a coupling capacitor followed by a connection to a shunt resistor such amplifiers are called resistance capacitance (RC) coupled amplifiers.

• When an ac signal is applied to the input of the first stage it is amplified with a phase reversal by the transistor.

• The frequency response is a graph of the gain (in decibels) versus the frequency (in logarithmic scale). This characteristic can be subdivided into low, medium and high frequency regions.

• To fix the boundaries of frequency where the gain is relatively high and constant, 0.707Amid is chosen to be the voltage gain at the cut-off levels.

• The corresponding frequencies f1 and f2 are generally called the corner, cut-off, band, break or half power frequencies. The multiplier 0.707 is chosen because at this level the output power is half the mid-band power output.

Design

Given: VCC = 10V ,VCE = 5V, IC = 2m β = 100 (assumed)

Assume VBE = 0.7V for silicon diodes
VE = 10% of Vcc = 1V

Assume IE ~ IC
RE = VE /IE = 1V/ 2mA = 500Ω
Rc = (Vcc- VCE -VE) / IC =(10-5-1) / 2mA = 2k ohm (Use 2.2kΩ)

V2 =VB = VE + VBE = 1+0.7 = 1.7V

$\beta R_E \geq 10 R_2$

R2 = (βRE)/10 = 5kΩ (use 4.7 kΩ)

V1 = Vcc – V2 = 10-1.7= 8.3V
V1/ V2 = R1 / R2
R1 = (V1/ V2) * R2 = 22.9kΩ (use 22 kΩ)

Circuit Diagram

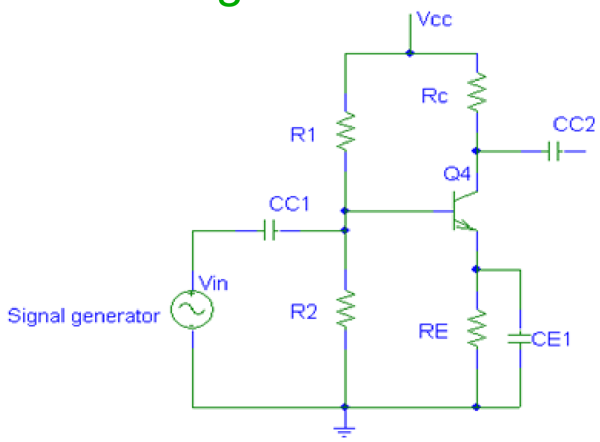


Fig a: Single Stage CE, BJT amplifier

SingleStageAmplifier -- Procedures

Step 1

Draw and study the circuit.

Place the components on bread board and connect them as per given Fig a.

Note: Measure the DC values of VCE, VBE and ensure that they are close to the designed values, before connecting the function generator, coupling capacitors and bypass capacitors.

Step 2

To find gain – frequency response:

• Connect the signal generator and apply a sine wave of peak-to-peak amplitude 50mV, 1kHz .
• Connect input and output (Vo) of the circuit to the two channels of CRO. And observe the waveforms. The input and output waveforms should be undistorted.

Step 3

• Note down the peak to peak amplitude of Vin and Vout. Calculate Voltage gain for maximum undistorted output , Avm = Vo/Vi

Step 4

• Vary the FREQUENCY of the input sine wave (keeping the amplitude constant) stepwise – from 100HZ to 1MHZ.

• Note down the output peak to peak amplitude Vo for every frequency of the input.

Step 5

• Calculate the gain = output to input ratio (Vo / Vin) for every value of the input frequency.

• Calculate the gain in dB for each of the above readings:
Gain in dB = 20 log (Vo / Vin)

Step 6

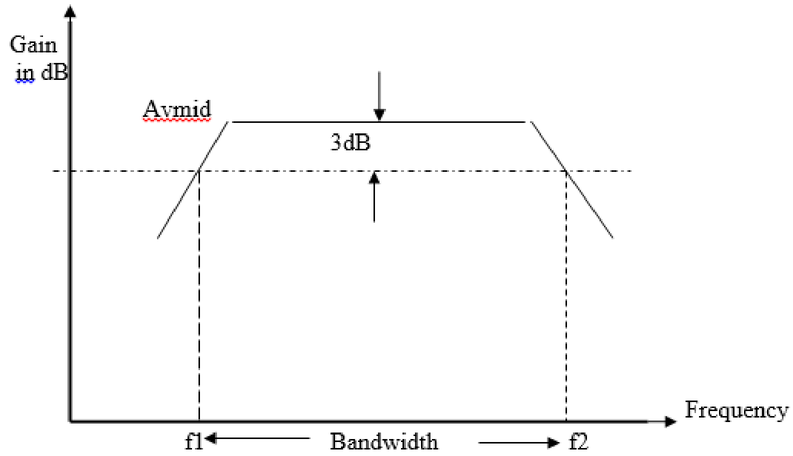
Tabulate the readings as below and Plot the Gain versus frequency plot on the sem log graph.

V_{in} = ------- Volts (Peak to Peak)

SL. No	Input frequency	Output Peak – Peak (Volts)	Gain = V_o / V_{in}	Gain in dB = 20 log (V_o / V_{in})

Step 7

Model Frequency response Curve



X axis is in log scale; Y axis is in normal scale
f1 – Lower cut-off frequency
f2 – Higher cut-off frequency
f2-f1 – Band width of the amplifier
3dB - 20log10(0.707)

Step 8

To find input impedance

• Connect as given in fig b with DRB resistance zero. Adjust the input Vin to 50 mV. (Let the frequency of the input be around 2kHZ)

• Note down the peak to peak amplitude of the corresponding output Vo . Let Vo=Va

Step 9

• Increase the the resistance included in DRB and observe the magnitude of the output Vo simultaneously on the Oscilloscope.

• When the magnitude of the output Vo is reduced to half of its original value, stop varying the resistance further and remove the potentiometer from the circuit. Vo=Va/2

• Measure the value of the DRB and this measured value will be the input impedance (Ri) of the circuit.

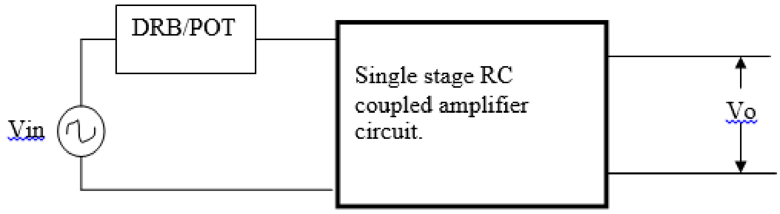


Fig b

Step 10

To find output impedance

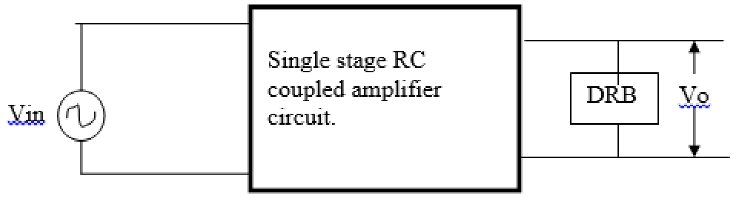


Fig c

• Adjust the input sinusoidal peak to peak in such a way that the output sine wave is not clipped.

• Note down this value of the input Vin. (Let the frequency of the input be around 2kHZ)

Step 11

• Note down the peak to peak amplitude of the corresponding output Vo . Let Vo=Va

Step 12

• Connect a DRB (with maximum resistance included)at the output as shown in fig c.

• Increase the DRB / potentiometer and observe the magnitude of the output Vo simultaneously on the Oscilloscope.

• When the magnitude of the output Vo is reduced to half of its original value, stop varying the potentiometer further and remove the potentiometer from the circuit. Vo=Va/2

• Measure the value of the DRB/ potentiometer and this measured value will be the output impedance (Ro) of the circuit.

Step 13

Result

The single stage CE amplifier was designed and its performance verified. The output waveform is in 180° phase shifted with input signal.

The readings obtained are given below:-

Voltage Gain =
Bandwidth =
Gain-Bandwidth product =
Input Resistance =
Output Resistance =