**CMPE 314: Principles of Electronic Circuits**

**Dr. Yan**

**Lab 05 Report**

**Common Emitter Amplifier Circuit**

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1. **Objective**

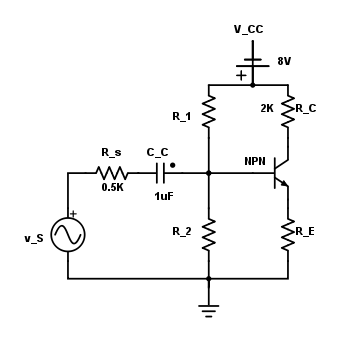
Construct and study the common-emitter amplifier circuit.

1. **Equipment**
   1. Resistors;
      1. Given: 1 × 560 Ω, 1 × 2.2 kΩ
      2. Computed: 1 × 470 Ω, 2 × 4.7 kΩ, 1 × 6.8 kΩ, 1 × 15 kΩ, 1 × 22 kΩ, 1 × 47 kΩ
      3. Potentiometer: 1 × 2 MΩ
   2. Capacitor; 1 × 1 µF
   3. Transistor; 1 × 2N3904 NPN
   4. Breadboard, DC power supply, digital multi-meter(s), oscilloscope, function generator
2. **Background**

A common-emitter amplifier is one of three basic single-stage bipolar-junction- transistor (BJT) amplifier topologies, typically used as a voltage amplifier. In this circuit, the base terminal of the transistor serves as the input, the collector is the output, and the emitter is common to both.

1. **Procedures**

**4.1 Part A. Pre-lab Exercise**



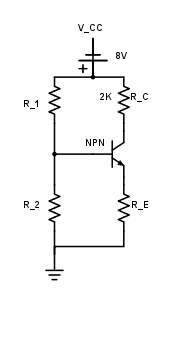
**Figure 1: Common Emitter Amplifier with an NPN Transistor**

* 1. Assuming βF = 100, study the circuit from Figure 1.
  2. Determine the values of R1, R2, and RE so that the Q-point is in the middle of the forward active region VCEQ = 4 V. Calculate IBQ, ICQ, and VCEQ.
  3. Repeat step b. so that the Q-point is near the cut-off region.
  4. Repeat step b. so that the Q-point is near the saturation region.

**4.2 Part B. Lab Procedures**

1. Set VCC = 8 V. Use the values given and computed in the pre-lab for R­1, R­2, R­C and R­E such that the Q-point is in the middle of the forward active region.
2. Measure IBQ, ICQ and VCEQ and compare against the calculated values. Find the DC forward current gain.
3. Connect the sinusoidal voltage source vs with amplitude ±100 mV and at frequency 10 kHz to the circuit. Record down both the input voltage vs and output voltage vo waveforms using the oscilloscope. Comment on the phase relationship. Find the small signal voltage gain and compare to the theoretical value.
4. Increase the input sinusoidal voltage, and record down any signal distortion. Comment on whether it is due to cutoff clipping or saturation clipping. What is the maximum symmetric swing?
5. Use a potentiometer as load resistor (20 MΩ). Vary and measure the resistance, record down the output waveforms. Comment how the small signal gain is influenced by the value of the load resistance, and the output impedance of the amplifier circuit.
6. Plot the DC and AC load lines.
7. Change R1 or R2 value (near the cutoff region). Repeat steps b. to d.
8. Change R1 or R2 value (near the saturation region). Repeat from step b. to d.
9. **Results**

For computing the resistor values, only the portion of the circuit affected by the DC voltage was considered.



**Figure 2: DC Portion of Common Emitter Amplifier with an NPN Transistor**

Computation for the circuit with its Q-Point in the middle of the forward active region:

Computation for the circuit with its Q-Point near the cut-off region:

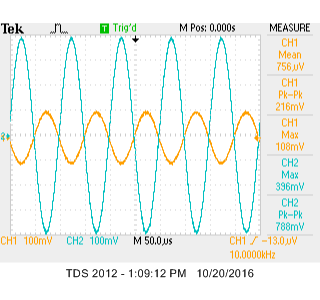
Computation for the circuit with its Q-Point near the saturation region:

After all the resistor values for all the different regions were computed, the DC part of the circuit was constructed, as per Figure 2. The resistance values for the Q-point were selected as R1 = 22 kΩ and R2 = 4.7 kΩ. IBQ, ICQ and VCEQ were measured and the outputs are displayed below:

**Table 1: Transistor Voltage and Current Measured at Q-point**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **VCEQ (V)** | **ICQ (mA)** | **IBQ (mA)** |
| Measured | 3.78 | 1.5 | 0.2 |
| Computed | 4 | 1.62 | 0.0162 |

The sinusoidal voltage source was added, along with the other components to construct the circuit from Figure 1. The following waveform was captured:

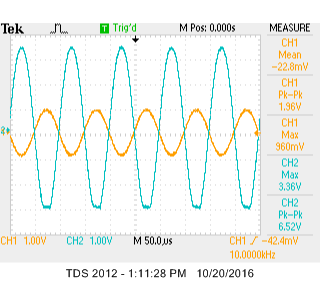


**Figure 3: Input and Output Voltages of the Circuit at Q-Point**

The voltage gain, , can be computed with the relationship:

although the voltage gain can be observed from the input and output voltages themselves, it does not agree with the ratio of the resistors. The error may be due to the different resistor values used for the simulation of the circuit since resistors with the exact computed values were not available.

The input voltage was increased until the output starting to appear distorted, and the maximum symmetric swing was determined to be 900 mV.

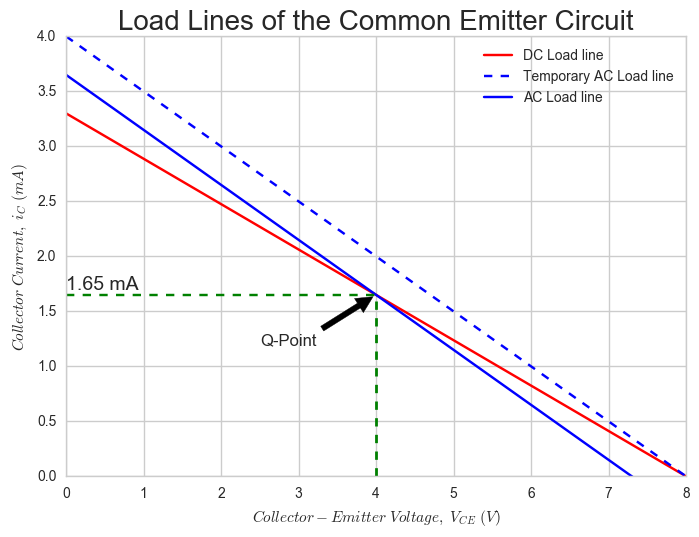


**Figure 4: Input and Output Voltages at the Maximum Symmetric Swing**

The load lines were then calculated for the circuit constructed.

The DC load line was computed with the relationship:

The AC load line was computed with the relationship:



**Figure 5: DC and AC load lines of the Circuit Constructed**

Due to constraints in time, only the DC portions of the cut-off and saturation region analysis were completed.

The resistance values for the circuit such that its Q-point was near the cut-off region were selected as R1 = 22 kΩ and R2 = 4.7 kΩ. IBQ, ICQ and VCEQ were measured and the outputs are displayed below:

**Table 2: Transistor Voltage and Current Measured with its Q-point in the Cut-Off Region**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **VCEQ (V)** | **ICQ (mA)** | **IBQ (mA)** |
| Measured | 7.97 | 0.1 | 0 |
| Computed | 8 | 0.148 | 0.00148 |

The resistance values for the circuit such that its Q-point was near the saturation region were selected as R1 = 22 kΩ and R2 = 4.7 kΩ. IBQ, ICQ and VCEQ were measured and the outputs are displayed below:

**Table 3: Transistor Voltage and Current Measured with its Q-point in the Saturation Region**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **VCEQ (V)** | **ICQ (mA)** | **IBQ (mA)** |
| Measured | 0.61 | 2.9 | 0 |
| Computed | 0.7 | 3.02 | 0.0302 |

The tolerance for the ammeter inside the multimeter used was not able to measure very low magnitudes of current, so IBQ appeared to be negligibly zero.

1. **Conclusion**

There were several aspects of this lab that yielded outputs with significant errors. If more time was permitted, and more preparation was made by the team members especially in the pre-lab assignment, the issues would have been resolved. Nevertheless, a voltage gain was demonstrated and even with an error in this lab report, provided better insight on small signal waves.