EXPERIMENT No. - 04

Aim of the Experiment:

Design, assemble and test of a common emitter amplifier and calculate its voltage gain.

Theory:

Common Emitter Amplifier:

In electronics, 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 (for example, it may be tied to ground reference or a power supply rail), hence its name.

Common- emitter amplifiers give the amplifier an inverted output and can have a very high gain that may vary widely from one transistor to the next. The gain is a strong function of both temperature and bias current, and so the actual gain is somewhat unpredictable. Stability is another problem associated with such high gain circuits due to any unintentional positive feedback that may be present. Other problems associated with the circuit are the low input dynamic range imposed by the small-signal limit; there is high distortion if this limit is exceeded and the transistor ceases to behave like its small-signal model. One common way of alleviating these issues is with the use of negative feedback, which is usually implemented with emitter degeneration. Emitter degeneration refers to the addition of a small resistor (or any impedance) between the emitter and the common signal source (e.g., the ground reference or a power supply rail). So the voltage gain depends almost exclusively on the ratio of the resistors R_C/R_E rather than the transistor's intrinsic and unpredictable characteristics. The distortion and stability characteristics of the circuit are thus improved at the expense of a reduction in gain.

It is suggested that putting the bypass capacitor the output voltage gain is increased. Bypassing it increases the AC gain as you're removing most of the negative feedback (there's still some, due to the internal emitter resistance).

Circuit Analysis:

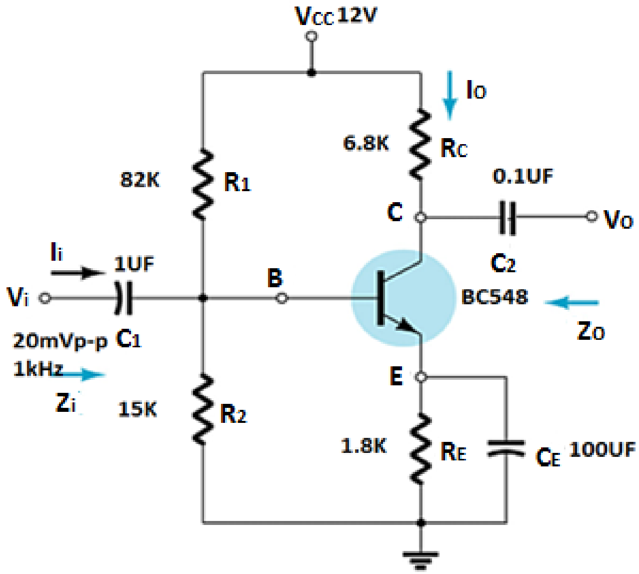


Fig: Common Emitter Amplifier circuit

DC analysis:

Approximate Analysis:

Where $I_B << I_1$ and $I_1 \cong I_2$

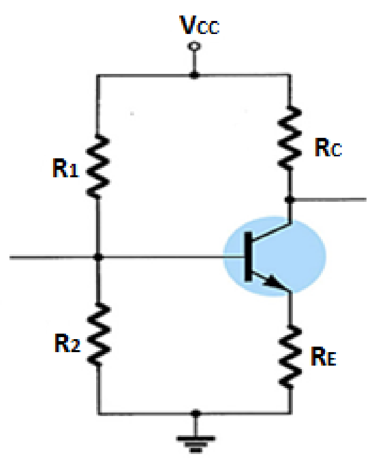
$$V_B = \frac{R_2 V_{CC}}{R_1 + R_2}$$

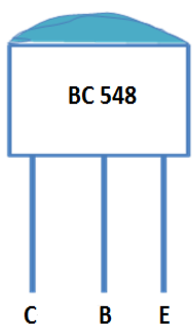
Where $\beta R_E > 10R_2$:

$$V_E = V_B - V_{BE}$$

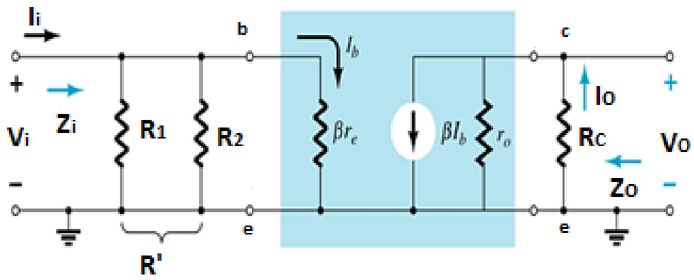
$$I_E = \frac{V_E}{R_E}$$

$$r_e = \frac{26\ mV}{I_E}$$





AC analysis:



Input impedance:

$$R' = R_1 \parallel R_2$$

$$Z_i = R' \parallel \beta r_e$$

Output impedance:

$$Z_o = R_C \parallel r_o$$

$$Z_o \cong R_C \Big|_{r_o \geq 10R_C}$$

Voltage gain:

$$A_v = \frac{V_o}{V_i} = \frac{-R_C \parallel r_o}{r_e}$$

$$A_v = \frac{V_o}{V_i} \cong -\frac{R_C}{r_e}\Big|_{r_o \geq 10R_C}$$

Current gain:

$$A_i = \frac{I_o}{I_i} = \frac{\beta R' r_o}{(r_o + R_C)(R' + \beta r_e)}$$

$$A_i = \frac{I_o}{I_i} \cong \frac{\beta R'}{R' + \beta r_e}\Big|_{r_o \geq 10R_C}$$

$$A_i = \frac{I_o}{I_i} \cong \beta \Big|_{r_o \geq 10R_C,\ R' \geq 10\beta r_e}$$

Current gain from voltage gain:

$$A_i = -A_v \frac{Z_i}{R_C}$$

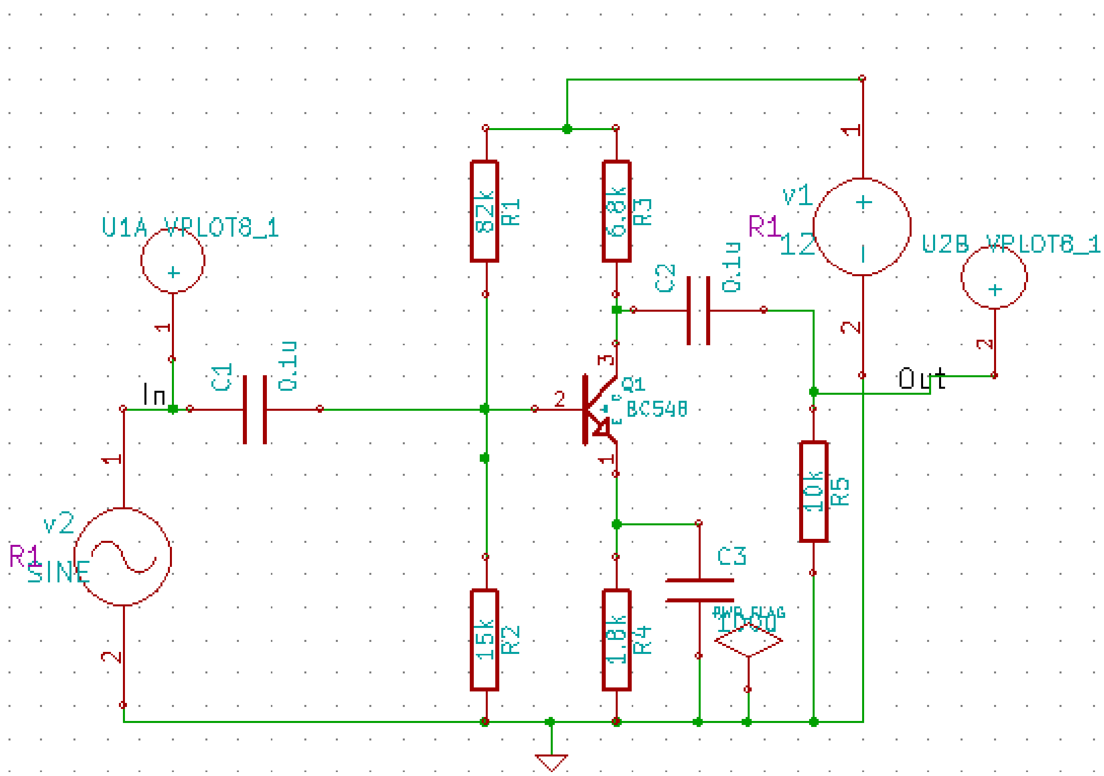
AC analysis:

Voltage Gain:

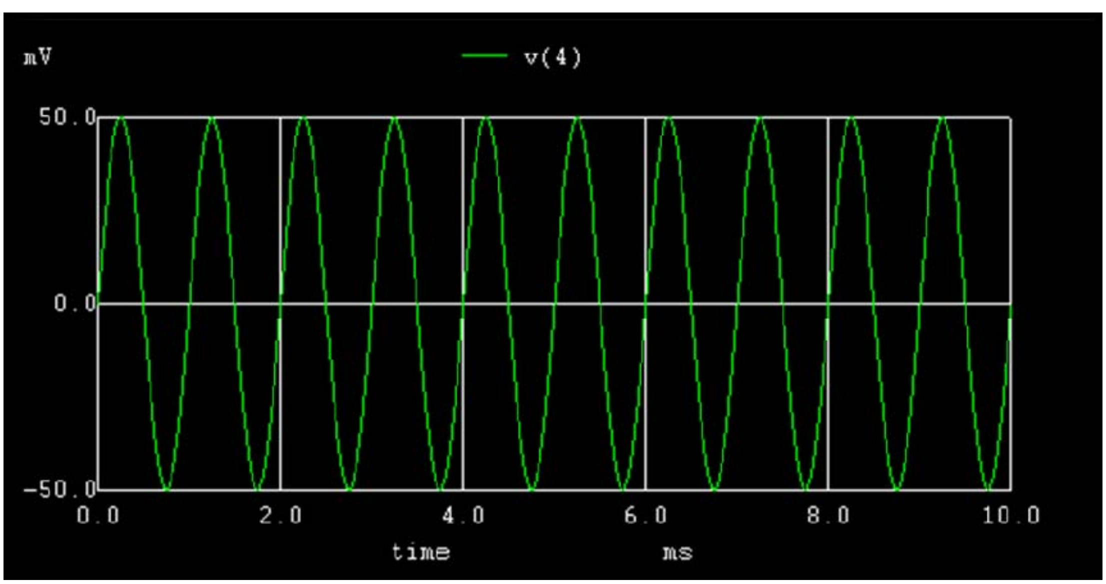
AC Voltage Gain= A_V = $-Rc/r_e$ ……………….. (Theo.)

AC Voltage Gain = $A_V = V_O / V_{IN}$ ………………(Prac.)

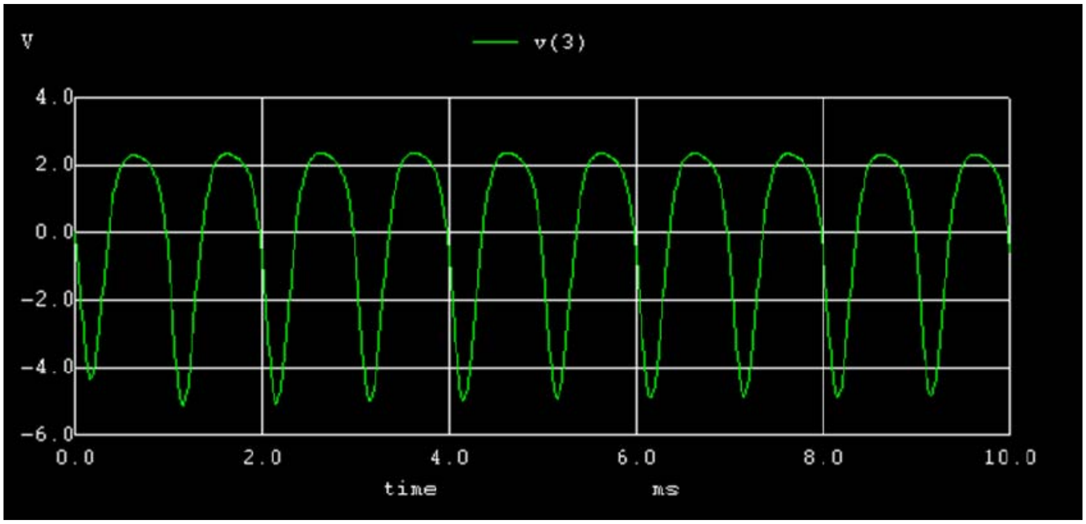
Schematic Circuit:



Input Waveform:



Output Waveform:



Conclusion

Date: **Signature of the Student**

NAME:

ROLL NO.:

GROUP ID:

SUB GROUP NO.:

Experiment Mark: **/ 20** **Instructor's Signature**