ELEC2205 D3 – Two-Stage Amplifier Design

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Abstract

1 Theoretical Design

1.1 Voltage Gain Derivation

1.1.1 Stage 1

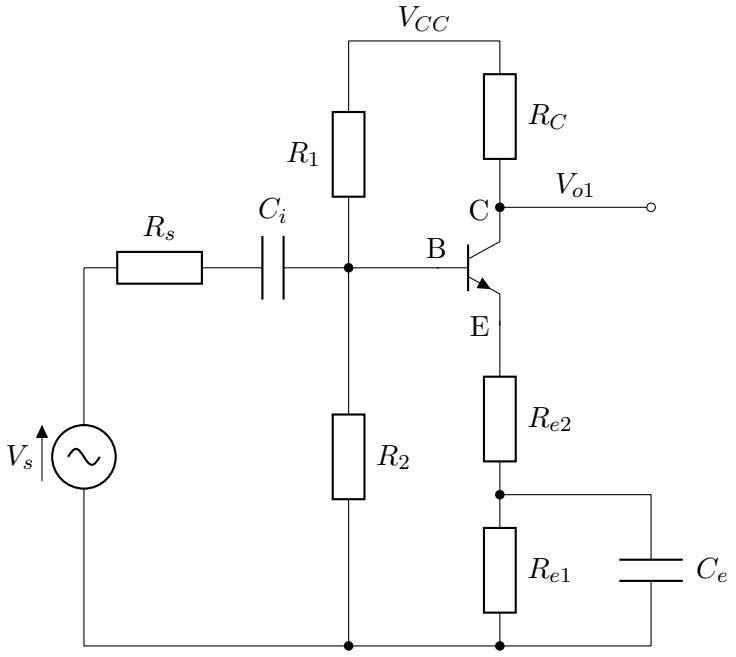

Figure 1: Circuit diagram of the first stage of the amplifier.

In order to derive the voltage gain of this circuit, we need to analyse it using a small signal model. The hybrid-π model (figure 2) will be used.

Using Kirchoff's current law on the base:

$$\frac{v_b - v_s}{R_s} + \frac{v_b}{R_2} + \frac{v_b}{R_1} - \frac{v_b - v_e}{r_\pi} = 0$$
$$\frac{v_b - v_s}{R_s} + v_b\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{v_b - v_e}{r_\pi} = 0$$

It can be seen that $v_\pi = v_b - v_e$. The small signal output resistance, r_π, is defined as $\frac{\beta}{g_m}$ [1, p. 29].

Using Kirchoff's current law on the emitter:

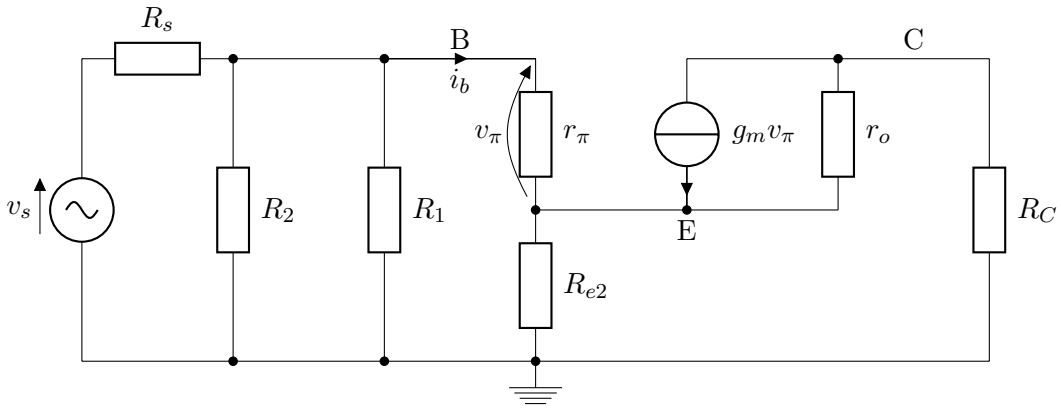

Figure 2: Hybrid-π model of the first stage of the amplifier.

$$\frac{v_e - v_b}{r_\pi} + g_m(v_b - v_e) - \frac{v_e}{R_{e2}} - \frac{v_e - v_c}{r_0} = 0$$

$$\text{Assuming } r_0 \text{ is large: } \frac{v_e - v_b}{r_\pi} + g_m(v_b - v_e) - \frac{v_e}{R_{e2}} = 0$$

Using Kirchoff's current law on the collector:

$$\frac{-v_c}{R_c} - g_m(v_b - v_e) = 0$$

2 Voltage Gain Measurement

3 Impedance Measurement

4 Reflection or w/e

Appendix A Some appendix

References

[1] P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, *Analysis and Design of Analog Integrated Circuits*, 5th ed. Don Fowley, 2009.