ASSIGNMENT 02 – AC Analysis

Prologue

The EN2110 assignment series from Assignment 01 to Assignment 04 is designed to provide a power amplifier design experience to the ENTC students. In this series of assignments, you will be starting with a reference amplifier circuit. The first assignment itself guides you to derive the design equations for DC analysis. The second and third assignments will guide you to derive equations for small-signal analysis and power analysis of the amplifier, respectively. The final assignment will guide you in the calculation of the resistor values to satisfy the design specifications. The coupling capacitor calculations are not included in this assignment series. A separate session will be conducted to discuss your answers and guide you in simulating such circuits to investigate the operating point, DC sweep, AC sweep, and time-domain behavior.

To do this, you need everything you learned about transistor circuits from Electronics I to Electronics III.

May the force be with you!

INSTRUCTIONS

- This assignment contains 6 questions which accounts for 25 marks.
- Clearly state any assumptions you made.
- Scan your answer scripts using a tool such as cam-scanner to compile it as a PDF. Submission file name should be in the following format.

  <assignment_number>_<index_number>

  For example, if your index number is 070022G and you are submitting the answers for assignment 1, the file name should be,

  A01_070022G

- If you are having any problems, send an email to "thilinaa@uom.lk" with the subject "EN2110-B18-<assignment number>".

A two-transistor cascaded amplifier is shown in Fig. 1. The DC current-gain of the transistors Q_1 and Q_2 are β_1 and $beta_2$, respectively. In this circuit, we assume that the capacitors are large enough to block the DC voltages and allow all AC signals to flow through them. Furthermore, all junction-capacitances of the transistors are negligible within the frequency band of interest.

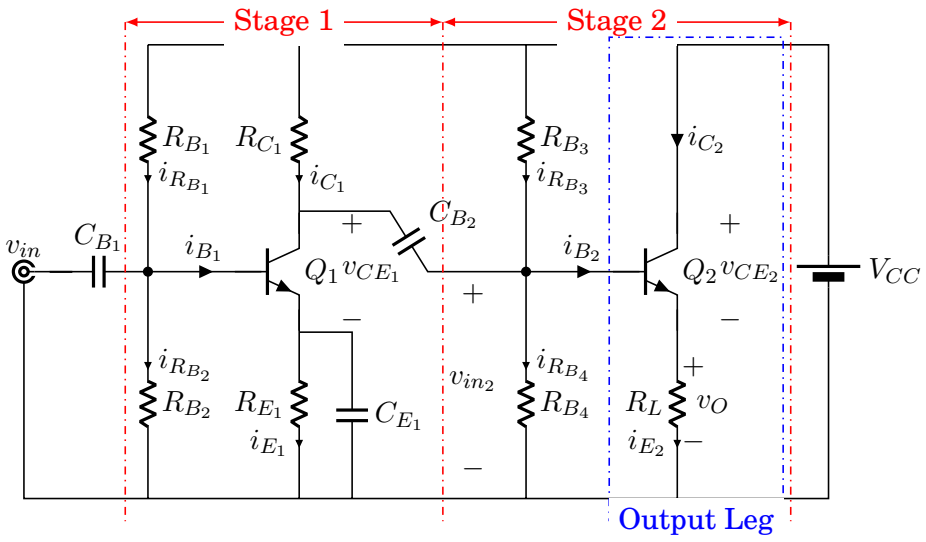

Figure 1: A two stage transistor amplifier.

In this assignment, you will be analyzing the small-signal AC behavior of the circuit in Fig. 1 by deriving design equations. If resistances R_1 and R_2 are parallel, denote its equivalent resistance as $R_1//R_2$. Assume the voltage source which provides v_{in} has zero source resistance. You may also neglect the small-signal output resistances r_{o_1} and r_{o_2} of the transistors Q_1 and Q_2.

1. Giving reasons select the suitable transistor models for Q_1 and Q_2 which ease the small-signal analysis. [4 marks]

2. Draw the small-signal equivalent circuit for the schematic given in Fig. 1. [5 marks]

3. Obtain an expression for the input resistance of stage 2 (R_{in_2}). [5 marks]

4. Obtain an expression for the voltage gain of stage 2 of the amplifier ($\frac{v_O}{v_{in_2}}$). [2 marks]

5. Derive an expression for the voltage gain of stage 1 of the amplifier ($\frac{v_{in_2}}{v_{in}}$). In this analysis, you have to consider the impact of the input resistance of stage 2 to the stage 1 gain.

   [5 marks]

6. Using the results in (4) and (5), obtain an expression for the overall voltage gain ($A_v = \frac{v_O}{v_{in}}$) of the amplifier. [4 marks]