

ASSIGNMENT 03 – Power 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 7 questions which accounts for 30 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 β_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.

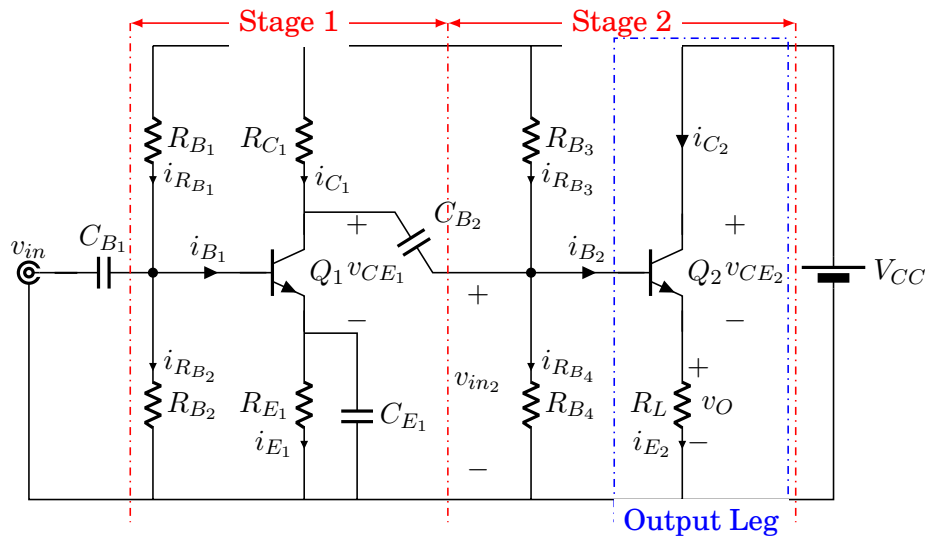


Figure 1: A two stage transistor amplifier.

In this assignment you will be analyzing the power consumption of the output leg of the amplifier.

1. Draw the ac large-signal equivalent circuit for the output leg. Clearly indicate the voltages and currents. [3 marks]
2. Plot v_{in2} , i_{B2} , v_{CE} , i_{E2} , and v_L versus time. The input to the stage 2 v_{in2} is a sinewave of peak amplitude \bar{V}_p with an angular velocity of ω . Assume the ac component of the v_O waveform is having a peak amplitude of V_p . [10 marks]
3. Let the peak ac current component through R_L is related to V_p as $V_p = I_p R_L$. Write down expressions for v_{CE} and i_E clearly indicating their AC and DC components. [2 marks]
4. Derive an expression for the average power delivered to the load R_L . [5 marks]
5. Write down an expression for the average power delivered to the output leg of the amplifier from DC power supply. [3 marks]
6. Obtain an expression for the efficiency of the output leg assuming Class A operation of transistor Q_2 . [5 marks]
7. Write down an expression for the overall efficiency of the amplifier. You may use results obtained in assignment 1, question 6 for this. [2 marks]