Lab Experiment 6

Power Amplifiers

In this lab, we will analyse and experimentally test the working of Class A and Class B Push-Pull power amplifiers. We will determine the load line & operating point of the said amplifier circuits and measure their efficiency.

Power conversion efficiency of these amplifiers are given as,

$$\frac{AC\ power\ in\ the\ Load}{Power\ delivered\ by\ the\ DC\ source\ or\ supplies}$$

Now, let us say if the peak voltage seen across a resistive load is $\widehat{vo}$ then the AC power in the load is given as,

$$P_{ac} = \frac{(\widehat{vo}/\sqrt{2})^2}{RL} = \frac{\widehat{vo}}{2RL} \quad (1)$$

$\widehat{vo}$ can be measured from the DSO by looking at the output signal.

a. For Class A amplifier as shown, the average DC power drawn from the supply will be

$$P_{DC} = V_{CC} I_{CQ} \quad (2)$$

$$\eta = (P_{AC}/P_{DC}).100$$

$$\Rightarrow \eta = \frac{(\widehat{vo})^2}{2RL.Vcc.Ic} \quad (3)$$

- Here we see that the efficiency will be maximum at $\widehat{vo}$ will be equal to Vcc.

b. For Class B amplifier, the current drawn from each supply will consist of half-sine waves of peak amplitude $\widehat{vo}/RL$. Thus the average current drawn from each of the two power supplies will be $\frac{\widehat{vo}}{\pi RL}$. It follows that the average power drawn from each of the two power supplies will be the same,

$$P_{S+} = P_{S-} = \left(\frac{\widehat{vo}}{\pi RL}\right) . Vcc$$

Hence, the total supply power will be,

$$P_S = P_{DC} = \left(\frac{2\widehat{vo}}{\pi RL}\right) . Vcc \quad (4)$$

$$\eta = (P_{AC}/P_{DC}).100$$

$$\Rightarrow \eta = \frac{\pi \widehat{vo}}{4Vcc} \quad (5)$$

- Here we see that the efficiency will be maximum when $\widehat{vo}$ will be equal to Vcc.

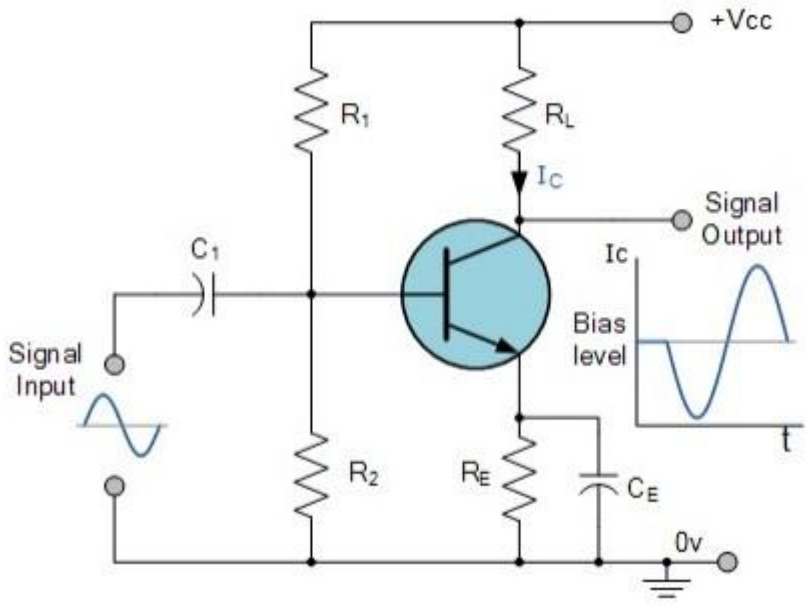

Figure 1: Class A Power Amplifier

Part A: Class A Power Amplifier **(5 Points)**

1. A single stage Class A power amplifier circuit is shown in Figure 1.
2. The load resistance $R_L = 1K\Omega$, emitter resistance $R_E = 100\Omega$ and supply voltage $V_{CC} = 12V$, $C_E = 100\mu F$ and $C_1 = 10\mu F$.
3. The transistor has the parameters $\beta = 150$ (SL100) and $V_{BE} = 0.7V$.
4. Determine the values of resistors R_1 and R_2 to obtain $V_{BB} = 3.5V$ and $V_{CEQ} = 6V$.
5. Connect the class A power amplifier circuit as shown in the figure.
6. Apply a sinusoidal signal of frequency $1kHz$.
7. Calculate the output AC power (*refer to equation 1*) and power drawn from the supply voltage ($P_{DC} = V_{CC}I_{CQ}$) (refer to equation 4).
8. Calculate the efficiency of the amplifier, $\eta = (P_{ac}/P_{DC}) * 100$ (refer equation 5).
9. Repeat the experiment for different values of input voltage signal (take at least three sample, where withing the samples a largest peak value of the input should be selected such that $\widehat{vo}$ = Vcc).

***Grade:* Award 5 points, if the followings are satisfied:**

1. *Bias points are verified as expected in point 4.*
2. *Point no. 7 and 8 are verified for atleast two input samples.*

***Scope of partial marking:* 2 points, if:**

1. *R1 and R2 are correct, circuit is properly connected, and able to demonstrate the bias points.*

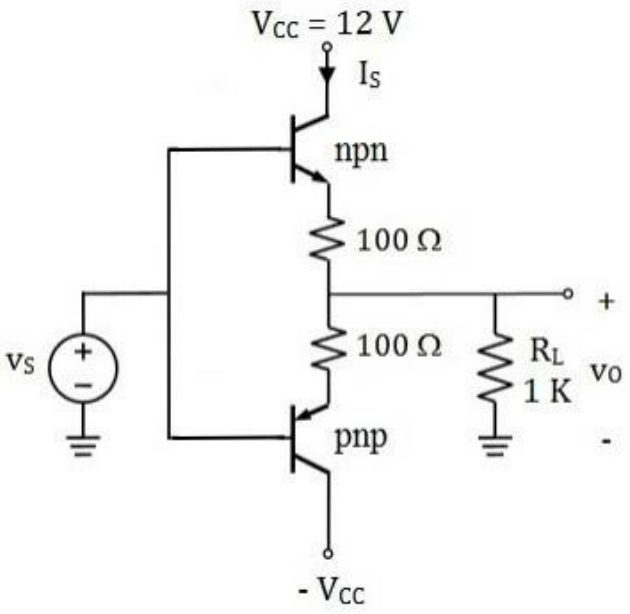

Figure 2: Class B Power Amplifier

Part B: Class B Push Pull Power Amplifier **(5 Points)**

1. A Class B power amplifier in push pull configuration is shown in Figure 2.
2. Connect the circuit as shown in the figure and apply a sinusoidal signal of frequency 1*kHz*.
3. Observe output signal voltage and determine its maximum voltage.
4. Calculate the output ac power (refer equation 1) and power drawn from the supply voltage (refer equation 1). Calculate the efficiency of Class B power amplifier.
5. Repeat the experiment for different values of input voltage signal (take at least three sample, where withing the samples a largest peak value of the input should be selected such that $\widehat{vo}$ = Vcc).

***Grade:* Award 5 points, if the followings are satisfied:**

3. *The circuit is properly connected as expected and point no. 3 is verified.*
4. *Point no. 4 and 5 are verified for atleast two input samples.*

***Scope of partial marking:* 2 points, if:**

2. *The circuit is properly connected as expected and point no. 3 is verified. Hoever, not able to measure or get the results for point 4 and 5.*

Note:

1. Complete the write-up for the experiment before coming to lab. Presenting the lab report in each lab is mandatory.
2. All the observations made must be noted down in the lab report and get the report verified at the end of each experiment.

3. Plot figures from previous lab must be completed and get the same signed at the end of lab. Take a printout of any plots from SPICE simulations and staple them with corresponding experiment.

Common Point for Rubric:

If there are minor mistake in any connections, cross check the MOSFET IC and give hints to rectify the bug. Even after the hints, the students are not able to make the right connections as said, zero marks will be given.
