BME 323
MEDICAL ELECTRONICS
PUSH-PULL AMPLIFIER

EXPERIMENT 07

PUSH-PULL AMPLIFIER

Objective:

To demonstrate the use of the capacitor-coupled complementary push-pull class-AB power amplifier.

Discussion:

Figure 2 shows how a push-pull amplifier can be constructed without using a driver or an output transformer. Note the complementary (NPN and PNP) transistors, Q_1 and Q_2. When V_S is positive, NPN transistor Q_1 conducts and PNP transistor Q_2 is cutoff. When V_S is negative, Q_1 is cutoff and Q_2 conducts. For optimum operation, all components must be closely matched, in which case the dc voltage at point A is $V_{CC}/2$. Coupling capacitor C_C prevents the dc voltage from appearing in the load and eliminates the need for an output transformer. The coupling capacitor affects the low-frequency response of the amplifier. The lower cutoff frequency due to C_C is:

$$f_l(C_C) = \frac{1}{2\pi\,(R_L + R_E)\,C_C}$$

Preliminary Work:

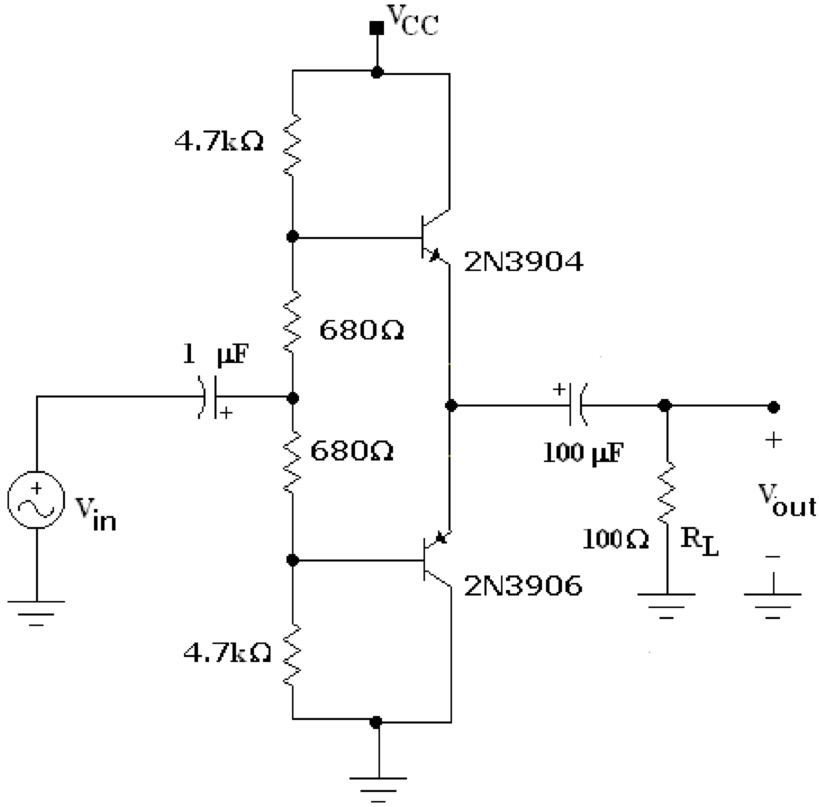

Figure 1

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Use an electronic simulation program (Electronics Workbench, PSpice, etc.) and make a home preliminary experiment to learn the main characteristics of these type of amplifiers. You may calculate some values by hand but the most important thing in this part is evaluation of your talency in usage of a simulation program and it is more easy and more funny than solving problems.Please print the circuit and drawings and edit all in a report way with your ID number.

<u>Preliminary Exp. Step1 </u>: Construct the circuit in Figure 1 and find the $I_{C(SAT)}$ (V_{CC}=10 V).
<u>Preliminary Exp. Step2 </u>: Fix the V_{CC} at 5 V and obtain 2V_{P-P} @ 1KHz from signal generator. Draw the output signal.
<u>Preliminary Exp. Step3 </u>: Reduce the input signal and V_{CC} to 0 V and connect multimeter to measure I_C then increase V_{CC} till I_C=1 mA. Note that V_{CC} value.
<u>Preliminary Exp. Step4 </u>: Measure V_{BE} and V_{EB} values of transistors.
<u>Preliminary Exp. Step5 </u>: Fix the signal generator to obtain 4 V_{P-P} at the output. Draw the input signal at this point.
<u>Preliminary Exp. Step6 </u>: Increase the input signal slightly-stepbystep, and notify that there is a cutoff at the output. Measure the value of Vout $_{P-P}$ at starting point of cutoff.
<u>Preliminary Exp. Step7 </u>: Find P_L. ($P_L = V_L{}^2{}_{PP}/8R_L$)

<u>Procedure:</u>

1. To demonstrate the capacitor-coupled, complementary push-pull class-AB power amplifier, connect the circuit in Figure 2.

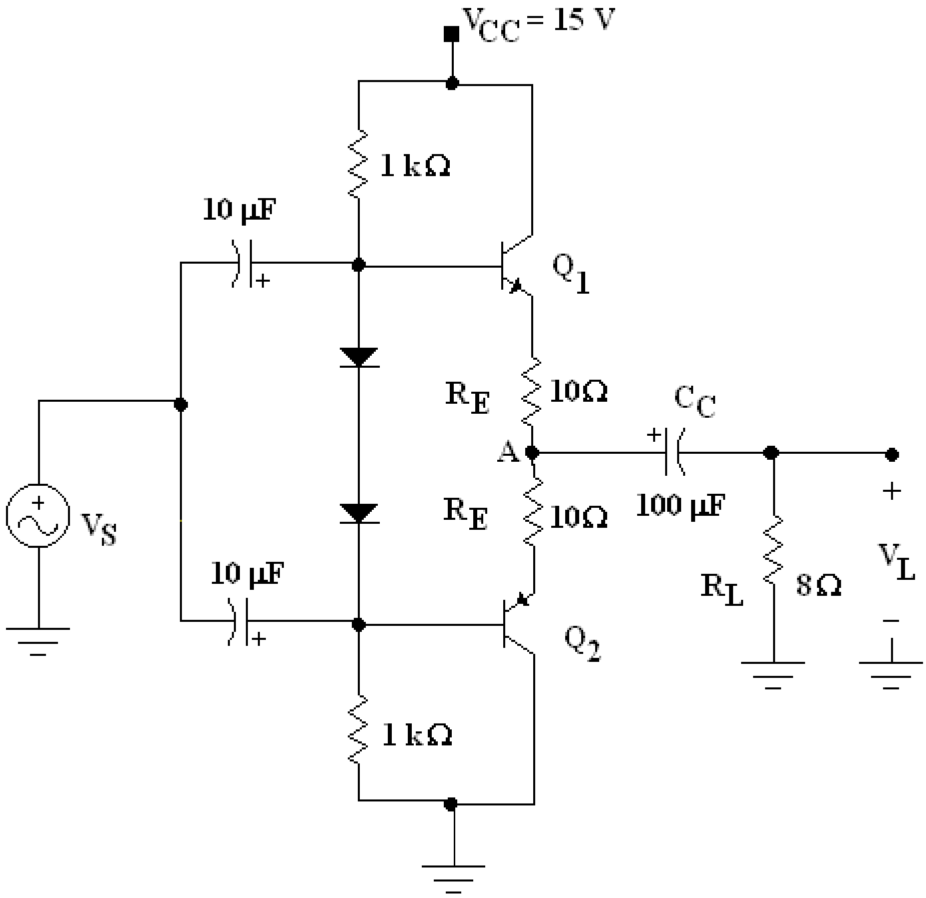

Figure 2

2. With V_S = 3 Vpp @ 1 kHz, connect a dual-trace oscillscope so that V_S and V_L can be observed simultaneously. Sketch the output voltage V_L and the input voltage V_S. Also sketch the voltage at point A.in the circuit, with the oscilloscope set for dc input coupling. Note and record the dc level in the waveform at this point.

3. Decrease the frequency of the signal source, V_S, until the output voltage, V_L, equals 0.707 times the output voltage measured in procedure step 2. Measure and record this frequency, the lower cutoff frequency due to C_C , $f_l(C_C)$.

Questions:

1. Using the sketch obtained in procedure step 2, calculate the average load power for the class-AB complementary, push-pull amplifier of Figure 2. What could cause the positive and negative amplitudes of the output waveform to be slightly different?

2. Calculate the theoretical lower cutoff frequency, $f_l(C_C)$, due to the output coupling capacitor in the circuit of Figure 2. Compare this theoretical frequency to the frequency measured in procedure step 3. If the power amplifier in Figure 2 had to be operated over the entire audio frequency range (20 Hz to 20 kHz), what new value would the output coupling capacitor have to be?

Equipment List:

- 2N2222, 2N2907 silicon transistors or the equivalent
- DC power supply (15 V)
- Analog signal generator (variable sine wave @ 1 kHz)
- Resistors: 2*1 kΩ, 2*10 Ω (0.5 W), 1*8 Ω (0.5 W)
- Capacitors: 1*100 μF, 2*10 μF (all 25 V)
- Dual-trace oscilloscope
- Diodes ~4001

References:

Electronic Devices and Circuits, Fifth Edition: Section 14-5, Push-Pull Amplifier Principles; Section 14-8, Distortion in Push-Pull Amplifiers; Section 14-9, Transformerless Push-pull Amplifiers.

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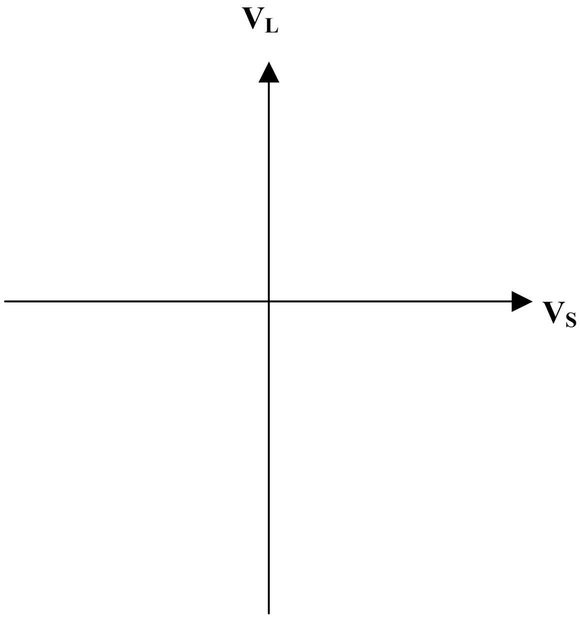
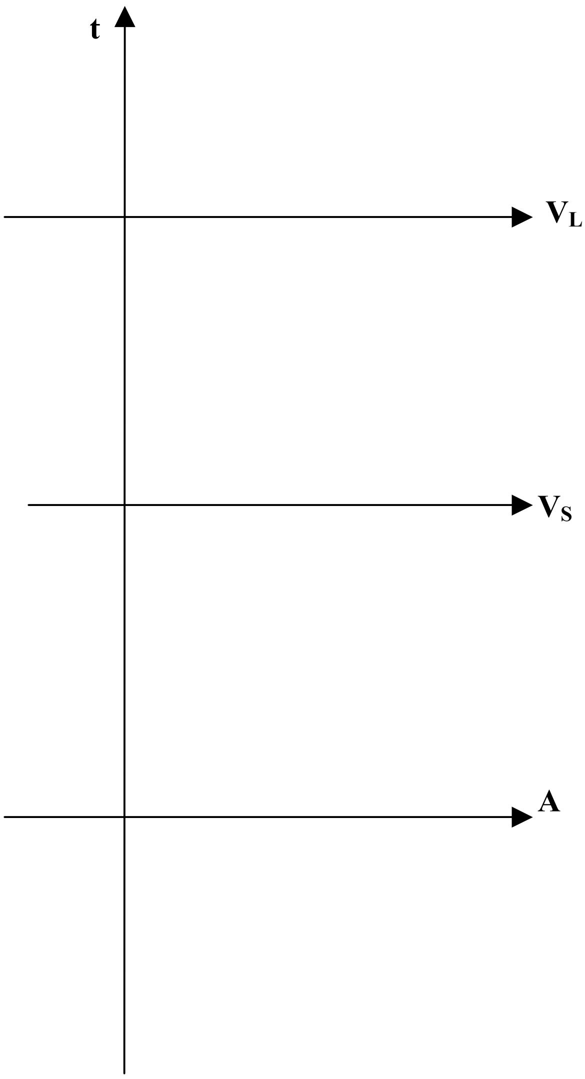
Student ID # :
Name :

REPORT:

Procedure 2.



(AC coupling)



(DC Coupling)

Procedure 3.

the lower cutoff frequency due to C_C

$f_l(C_C)$=.......... **(experimental)**

Question 1.

P_{AV} =...........

Question 2.

$f_l(C_C)$=.......... **(theoretical)**

Comment:

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