PH-211
Electronics Lab.

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Experiment no. 2
Experiment - Push Pull Amplifier
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Push-Pull Amplifier

Aim: To obtain the maximum power output of the given push pull amplifier and its efficiency.
To draw load vs power output curve and to study cross over distortion

Working formulae:

1) Input D.C Power ($P_{i(DC)}$) $\Rightarrow$

V_{cc} : Bias Voltage

I_{DC} : DC current drawn from power supply where

$$\left[I_{DC} = \frac{2I(p)}{\pi} = \frac{2V_{o(p-p)}}{\pi \cdot 2 \cdot R_L} = \frac{V_{o(p-p)}}{\pi R_L} \right]$$

I_p = peak ac current

$V_{o(p-p)}$: peak to peak output voltage

R_L : load resistance

$$\left[P_{i(DC)} = \frac{V_{cc} \cdot V_{o(p-p)}}{\pi \cdot R_L} \right]$$

2) Output AC power ($P_{o(AC)}$) $\Rightarrow$

$$\left[P_{o(AC)} = \frac{V_L^2 (rms)}{R_L} = \frac{V_{o(p-p)}^2}{8 R_L} \right]$$

3) Efficiency (η) $\Rightarrow$

$$\left[\eta \% = \frac{P_o(AC)}{P_i(DC)} \times 100 = \frac{\pi V_{o(p-p)}}{8 V_{cc}} \times 100 \right]$$

4) Maximum efficiency (η_{max})

η_{max} will be obtained when $V_{o(p-p)} = V_{cc}$.

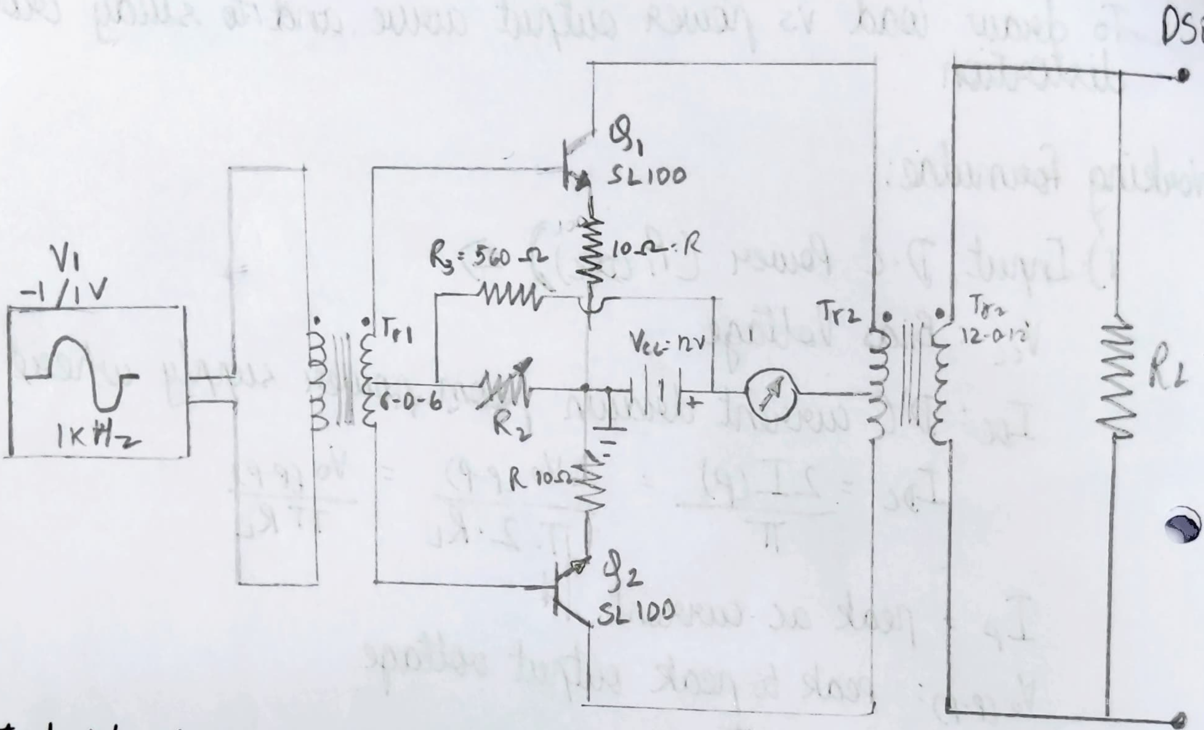
$$\eta_{max} = (P_{o(AC)} / P_{i(DC)}) \times 100$$

$$= \frac{V_{cc}^2 / 2R_L}{V_{cc}(\frac{2}{\pi} \cdot V_{cc}/R_L)} \times 100$$

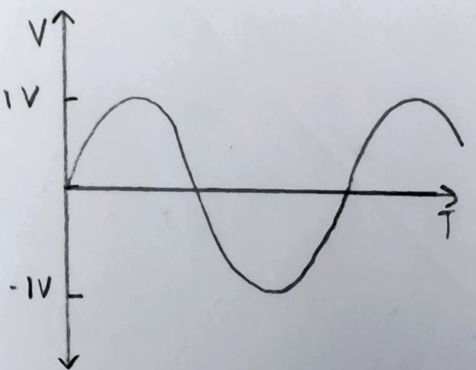
$$= \frac{\pi}{4} \times 100 = \boxed{78.54\%}$$

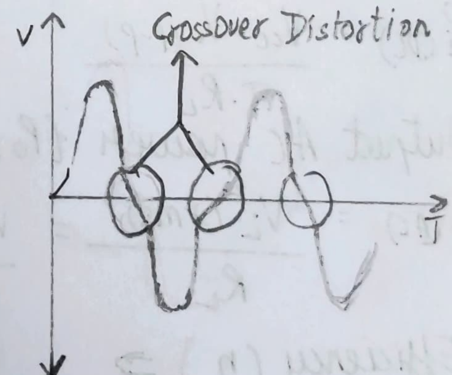
Circuit Diagram:

Figure of Push Pull Amplifier



Expected Waveform:





Input Waveform

sine wave

freq = 1KHz

Output Waveform.

I.R = $\frac{9}{10}$

Observation:

S no.	Frequency (Hz)	Load Resistance (Ω)	V_{cc} (V)	$V_{in(p-p)}$ (V)	$V_{o(p-p)}$ (V)	P_{out} (mW)	Efficiency (η)%
1	1000	100	12	1	0.452	0.255	1.48
2	1000	220	12	1	1	0.568	3.27
3	1000	560	12	1	2.54	1.44	8.31
4	1000	820	12	1	3.64	2.02	11.91
5	1000	~~1,500~~ 1000	12	1	4.36	2.37	14.26
6	1000	1,500	12	1	6.36	3.37	20.81
7	1000	2,200	12	1	9.1	4.70	29.77
8	1000	3600	12	1	13.8	6.61	45.16
9	1000	4700	12	1	16.8	7.51	54.97
10	1000	5600	12	1	19.0	8.06	62.17
11	1000	330	12	1	1.55	0.91	5.07
12	1000	8000	12	1	17.8	4.95	58.20

OBS=9

Apparatus: Breadboard, Digital storage Oscilloscope, Transistors (SL100), Function Generator, (6-0-6) Transformer, (12-0-12) Transformer, Potentiometer, Multiple power supply, Wires, Resistance (10, 560Ω)

Load Resistances: 100 Ω
220 Ω
330 Ω
560 Ω
820 Ω
1000 Ω
1500 Ω
2200 Ω
3600 Ω
4700 Ω
5600 Ω.

EX1=10

Calculation:

- Theoritical max efficiency →

$$P_{o(AC)} = \frac{V_{o(P\text{-}P)}^2}{8R_L} = \frac{V_{i(P)}^2}{2R_L}$$

Max $P_o(AC)$ will be obtained when $V_i = V_{cc}$

$$\therefore P_{o(AC)} = V_{cc}^2 / 2R_L$$

$$P_i(DC) = V_{cc}\left(\frac{2}{\pi} I_{(P)}\right),$$

$$P_{i(DC)} = \frac{2V_{cc}^2}{\pi R_L}.$$

$$\therefore \text{Max } \eta\% = \frac{P_{o(AC)}}{P_{i(DC)}} \times 100$$

$$= \frac{V_{cc}^2 / 2R_L}{V_{cc}\left(\frac{2}{\pi} \cdot V_{cc} / R_L\right)} \times 100$$

$$= \frac{\pi}{4} \times 100$$

$$= 78.54\%$$

$\therefore$ The theoritical maximum efficiency is 78.54%

From the graph,

P_{max} is achieved at approximately $R = 5.6K\Omega$

$P_{max_{R=5.6K\Omega}} = P_{max} = 8.06\ mW$

$P_{i_{R=5.6K\Omega}} = 16.37\ mW$

$\eta\%_{P_{max}} = 62.17\%$

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Scale: y-axis: Power Output 0.5 units of graph = 1 mW
x-axis: Load Resistance (Ω)

Power Output (W) V/s Load Resistance Graph

1) ... voltage is inputed from the power supply it decreases when
a ... resistance is connected and there is a large current drawn. There
is ... errors due to the decrease in voltage.

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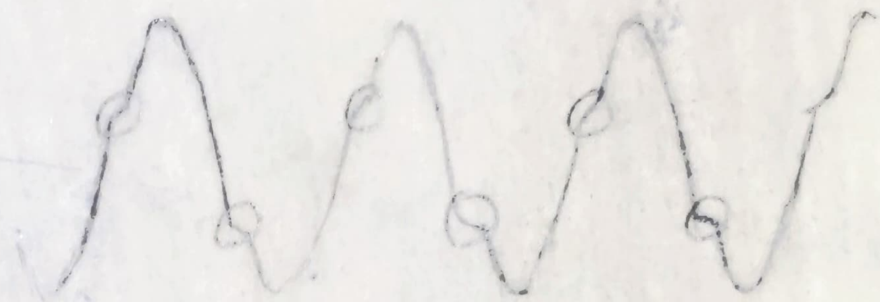
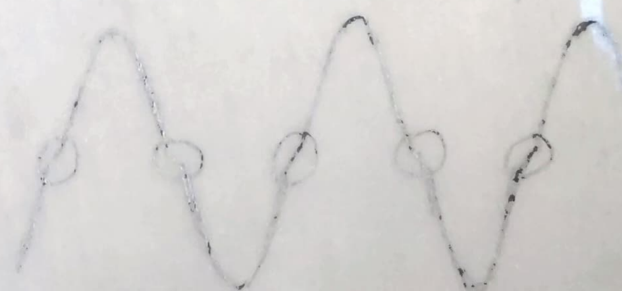
Input
Sine wave - 1KHz
$V_{i(p-p)} = 1V$

Output
No load
Distortion is present



Input
sin wave - 1KHz
$V_{i(p-p)} = 1V$

Output
Load Resistance
= 5.6KΩ
where Maximum
Power Delivered
Distortion present.



mmary of Result

1) Max power output observed at $5.6\,k\Omega$ is $8.06\,mW$

2) Efficiency observed at maximum power delivery is 62.17%

3) Max efficiency is 62.17% at $5.6\,k\Omega$

~~4) Audible range of frequency is 728 Hz to 14.75 KHz~~

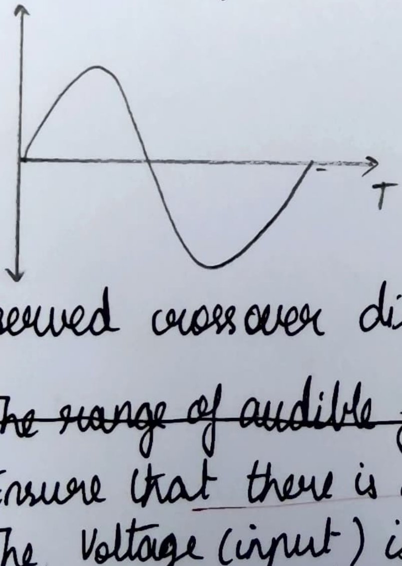
4) Beyond $5.6\,k\Omega$ power decreases and so does efficiency

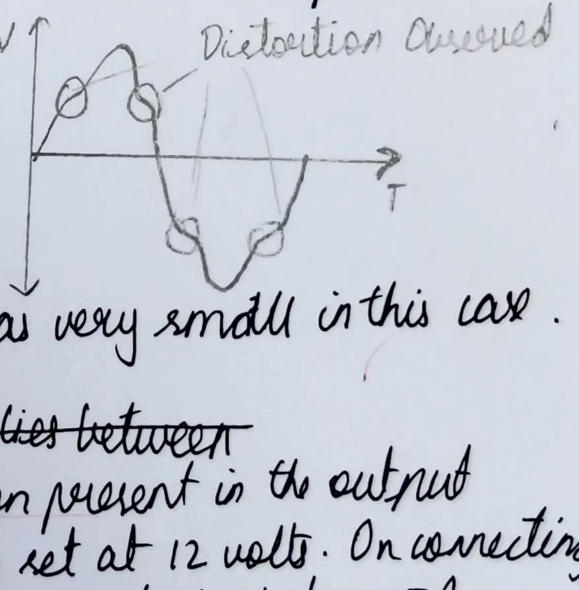
5) At $8\,k\Omega$ power output is $4.95\,mW$ & efficiency is 58.20%

Brief Discussion of result along with Precautions:

1) The practical / experimental efficiency of circuit is much lower than theoritical efficiency.

2) Input Waveform | Observed Output.





Observed crossover distortion was very small in this case.

~~3) The range of audible frequency lies between~~

3) Ensure that there is a distortion present in the output

4) The Voltage (input) is initially set at 12 volts. On connecting a load resistor the voltage decreases to 1.8V at 0.05A.

5) All connections should be checked to avoid loose wires.

6) Precaution should be taken when connecting transformer to transistor

Reasons for difference in result from theoritical value:

① When voltage is inputed from the power supply it decreases when a resistance is connected and there is a large current drawn. There is an error due to this decrease in voltage.

2) Part of the Voltage is lost when connected accross a transformer due to inefficiency in conversion of A.C to DC ~~to~~ Voltage. Due to this there are errors.

3) To overcome these inefficiencies we require a higher voltage than V_{cc} and hence we had our maximum power output at a voltage higher than V_{cc} i.e we got max. efficiency at $V_{o(P-P)} > V_{CC}$ instead of getting it at $V_{o(P-P)} = V_{CC}$.

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