German Jordanian University

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Communication Circuit Lab Manual

Experiment 2

Tuned Amplifier

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Introduction

The power amplifiers are the amplifiers which deliver maximum undistorted symmetrical output voltage swing to the low impedance load. Generally any system (like a stereo, radio or television) consists of several stages of amplification. When the signal passes through these stages, the power level of signal rises so much that the later stages require high power handling circuit elements such as power transistors. Also as the load impedance of these later stages is very small (of the order of 8 ohm for stereo amplifier speakers), heavy collector current flows. To handle this, transistors having power rating of 1W or more are used in power amplifiers.

Power amplifiers are broadly classified as :

1. Class A (Voltage Amplifier)

2. Class B (Push-Pull Emitter Follower)

3. Class C Tuned Amplifier

Class C Tuned Amplifier :

Class C amplifier is a power amplifier in which collector current of the amplifying transistor flows for less than 180° of input AC signal.

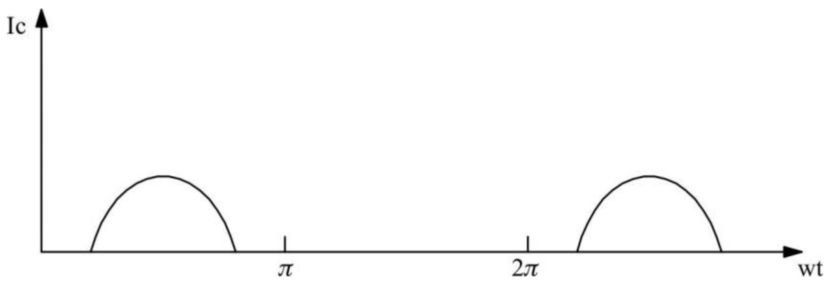

Figure 1

In short a class C amplifier is one in which the operating point is chosen so that the output current (or voltage) is zero for more than one half of an input sinusoidal signal. The output signal would be distorted if this non-sinusoidal current flows through the resistive load. To avoid the distortion that would occur due to purely resistive load, load is usually a resonant tank circuit (LC circuit), which therefore has a high resistive value at the frequency of interest. Hence, the selected signal output is free from non-linear distortions. The resonant tank circuit is tuned to the frequency of input signal. When the circuit has a high quality factor (Q), parallel resonance occurs at approximately. The resonant frequency is given as:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Where,

L = inductance

C = capacitance

,

The AC equivalent circuit of base-emitter junction is as shown in Fig.2 when Q of the circuit is high enough.

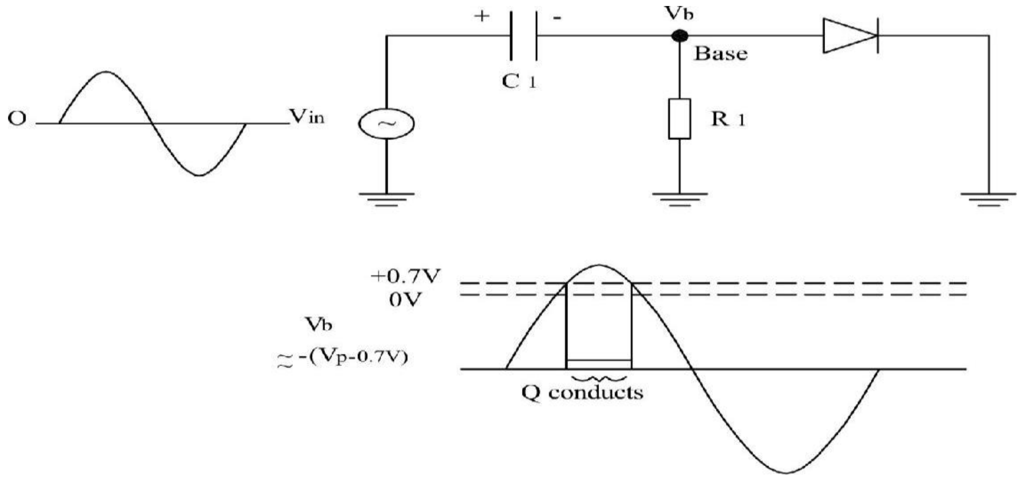

Figure 2

As shown the input capacitor is a part of a negative clamper and hence the signal is negatively clamped. On the positive half cycle of the input signal the coupling capacitor charges to approximately. V_P with polarity shown as the base-emitter diode conducts. On the negative half cycle, capacitor discharges through R_1. Capacitor continues to discharge till the period T of the input signal is less than time constant R_1C. As the base voltage swings slightly above 0.7V the base-emitter diode turns on, thus recharging the capacitor.

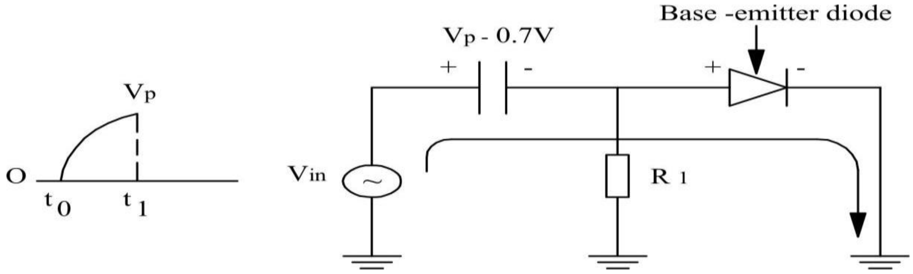

Figure 3

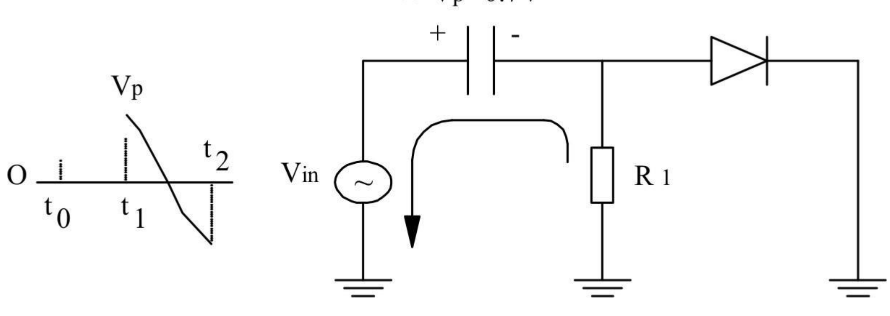

Figure 4

At the output side the collector current source drives a parallel resonant tank circuit. At resonance, the AC load impedance is purely resistive and the collector current is minimum and the peak-to-peak load voltage reaches a maximum. Above and below the resonance, AC load impedance decreases and the collector current increases, thus reducing the amplification level or introducing distortion in the output signal. A class C amplifier is a narrowband circuit it amplifies only the signals of resonant frequency and near to it. As the amplification level reduces when input frequency is moved up and down the resonant frequency, we can find out the bandwidth of the amplifier. The bandwidth of the Class C amplifier can be find out as follows,

$$BW = F_H - F_L$$

Where,

F_H = upper half power frequency

F_L = lower half power frequency

The half power frequencies are identical frequencies at which the voltage gain equals 0.707 times the maximum gain. The smaller the difference, narrower is the bandwidth of amplifier.

The dc collector current depends on the conduction angle and hence the overall efficiency of the amplifier. In short as the duty cycle increases the efficiency of the amplifier decreases. For the conduction angle of 180° the amplifier efficiency is 78.5%. If we further reduce the conduction angle the stage efficiency will increase. The class C amplifier efficiency can be 100% at the maximum.

The following formulas are used for Class C Tuned Amplifier,

- Input AC Power, $Pi_{(ac)} = V_{p-p}^2 / 8 * R_S$ (R_S = Input impedance)
- Output AC Power, $Po_{(ac)} = V_{p-p}^2 / 8 * R_L$ (R_L= Output impedance)
- Power Gain, $Ap = Po_{(ac)} / Pi_{(ac)}$
- Input DC Power, $Pi_{(dc)} = Vcc * I_{dc}$ (I_{dc} = Input DC Current)
- Efficiency, $n\% = Po_{(ac)} * 100 / Pi_{(dc)}$

Experiment 1

Objective :

To study the operation of Class C Tuned Amplifier

Apparatus required:

- Analog board of **AB23.**
- Variable DC power supply +12V from external source or **Scientech 2612 Analog Lab**.
- Function Generator from external source or **Scientech 2612 Analog Lab**.
- Oscilloscope.
- Ammeter.
- 2 mm patch cords.

Circuit diagram :

Circuit used to study the operation of Class C Tuned Amplifier is shown below

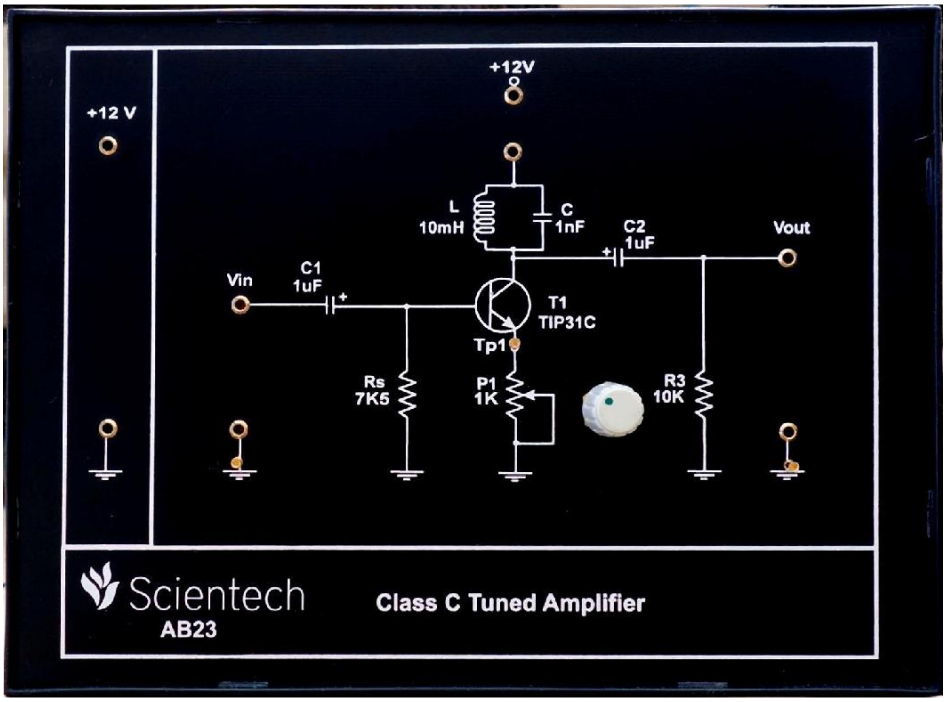

Figure 5

AB23

Procedure :

- Connect + 12V DC power supply at their indicated position from external source or **Scientech 2612 Analog Lab**.
- Connect 2V_{p-p} AC signal (10 KHz and above) at the V_{in} input of the **AB23** board.

1. Connect Oscilloscope at the output terminals of **AB23** and observer the output waveform.
2. Connect Patch cord between the +12V and LC junction.
3. Gradually increase the input signal frequency up to the value till the maximum undistorted amplified output is obtained.
4. Vary the pot such that the output voltage amplitude increases. Adjust the pot to get maximum undistorted (unclipped) output voltage.
5. Note the frequency at which this amplification is obtained and check it against the theoretically calculated resonant frequency calculated using Eq. l.
6. Observe the conduction angle at the test point TP1 on **AB23** board.
7. Calculate the peak-to peak value of the output signal.
8. Observe the output voltage level above and below to resonant frequency by varying input frequency from 5 KHz to 100 KHz.
9. Carryout the following calculations.
10. Apply +15V or +10V to the input bias voltage instead of +12V and observer the changes in the output voltage.

Results :

- Input AC signal amplitude (V_{in}) : .... V_{p-p}
- Output AC signal amplitude (V_{out}) :...................... V_{p-p}
- Resonant Frequency (F_r) : (Practical value) : .... Hz
- Resonant Frequency (f_r) : (Theoretical value) : .....Hz (From Eq.l)
- Input AC Power ($Pi_{(ac)} = V_{p-p}^2 /8 * R_s$) : ....W.
- Output AC Power ($Po_{(ac)} = V_{p-p}^2 / 8 * R_L$): ....W.

AB23

- Power Gain ($Ap = Po_{(ac)} / Pi_{(ac)}$) : ....
- Input DC power ($Pi_{(dc)} = Vcc * I_{dc}$) : .... W

(Note: To calculating DC power, switch off the AC signal and now read the ammeter for DC current I_{dc})

- Efficiency ($n \% = Po_{(ac)} * 100 / Pi_{(dc)}$) : ....
- 3dB voltage ($V_{out\ (max)} - (V_{out\ (max)} * 0.707)$) :..........
- Higher Cutoff Frequency (F_H) :.............................
- Lower Cutoff Frequency (F_L) : ....
- Bandwidth ($BW = F_H - F_L$) :..................................
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Carry out the same calculations after applying +15V and +10V and observe the change