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Faculty of Engineering
Electrical and Electronics Engineering

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EEM 303 Electronic II Laboratory 1

Power Amplifier Classes

	Student Name	Student ID	Group Number
1.			
2.			
3.			
4.			

Objective:

To understand and learn different power amplifier classes.

Equipment will be available at the laboratory:

DC power supply, Oscilloscope, Electronic Training Set(Y-0016), Patch wires,

Equipment will be ensured by students:

Digital Multi-Meter

Preliminary Work:

Read the laboratory sheets. There might be a test or classical exams in the beginning of each laboratory hour. Questions will be asked mostly from *Supplementary Information* and *Procedure* sections.

DC analysis of the given circuit in Figure 5 and Figure 6 should be documented into A4 paper and given to instructor(s) at beginning of laboratory hour. Beta (β) should be taken as 120

Supplementary Information:

Transistors are the active element of an electrical circuit and divided into operating classes. These classes are based on the proportion of each input cycle (conduction angle) during which an amplifying device passes current. Power amplifier circuits (output stages) are named as A, B, AB, C classes and D, E classes respectively for analog designs and switching designs. The operation class, the operating point (Q) on the load curve of the transistor is determined by the base pole of the transistor. Power amplifiers circuits can be easily constructed with a BJT (Bipolar Junction Transistor) in various methods. Most common used methods are implemented with an emitter grounded transistor which is shown in Figure 1. For the circuit in Figure 1.A, base terminal voltage of the transistor can be calculated through the voltage divider that consist of RB1 and RB2 resistors. This type of circuits is called as

'Fixed Base Bias Circuit', because the transistors base current, I_B remains constant for given values of V_{cc}, and therefore the transistors operating point must also remain fixed. For the circuit in Figure 1.B, the collector to base feedback configuration ensures that the transistor is always biased in the active region regardless of the value of Beta (β). This type of circuits is called as *'Collector Feedback Bias Circuit'*. In this laboratory hour, above-mentioned *'Fixed Base Bias Circuit'* will be used to examine different classes of power amplifiers.

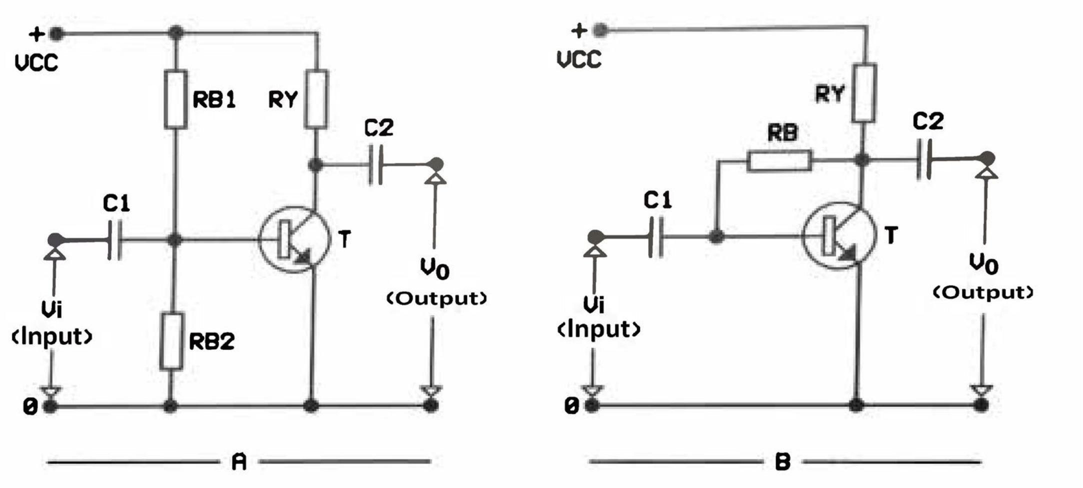

Figure 1: Emitter grounded power amplifiers

Class-A Amplifiers

The most important feature of these type amplifiers that the output signal is dependent on the input signal. Due to efficiency of class-A amplifiers, applied input signal is amplificated without being distorted. In this type amplifiers, load line and operating point are determined with I_C (Collector Current) and V_C (Collector Voltage) which was shown in Figure 2B. In this type circuits, even if no input signal is present, there will always be a current passing through the collector terminal.

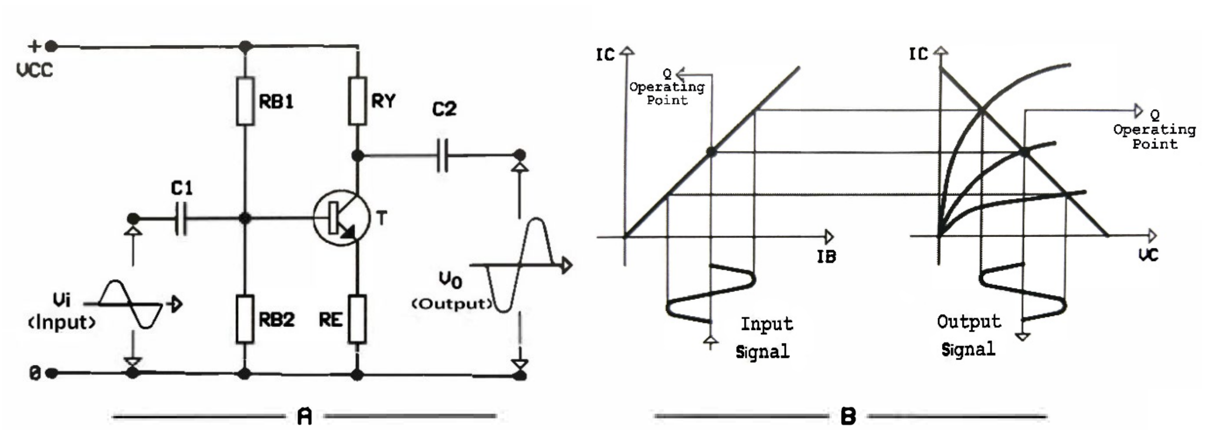

Figure 2: Circuit scheme of class-A amplifier and its characteristic

Class-B Amplifiers

This type of amplifier mostly uses the same circuit scheme but resistor with different values are used to operate the circuitry. Operating point is chosen as the smallest point on the load curve by changing the resistors named RB1, RB2 and RE in the Figure 3A. However, collector current is zero when there is no input signal. In the presence of input signal, collector current only occurs where the positive half period of the input signal is present. However, distortion level is high in class-B amplifiers. Therefore, pre-bias voltage that shifts the Q point a little to the right, is applied in order to reduce distortion.

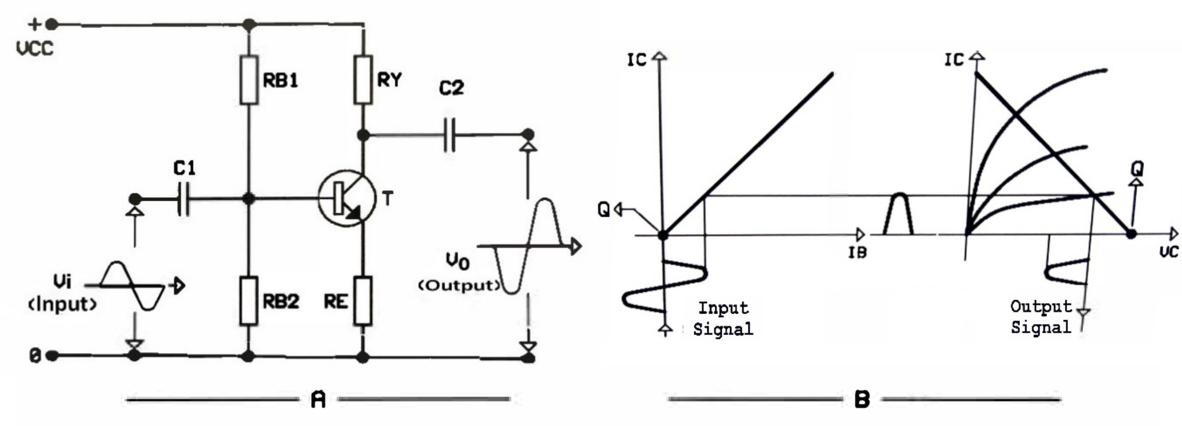

Figure 3: Circuit scheme of class-B amplifier and its characteristic

Class-C Amplifiers

A negative DC supply voltage is applied to base of the transistor in class-C amplifiers which can be seen in Figure 4A. Consequently, output signal is only affected at the positive peaks of the input signal. As it can be seen from the Figure 4B, the operating point is chosen outside load curve. Therefore, collector current only occurs at some portion of the positive period. Also, there is a lot of distortion in the output signal. Thus, these types of amplifiers mainly used as RF amplifiers.

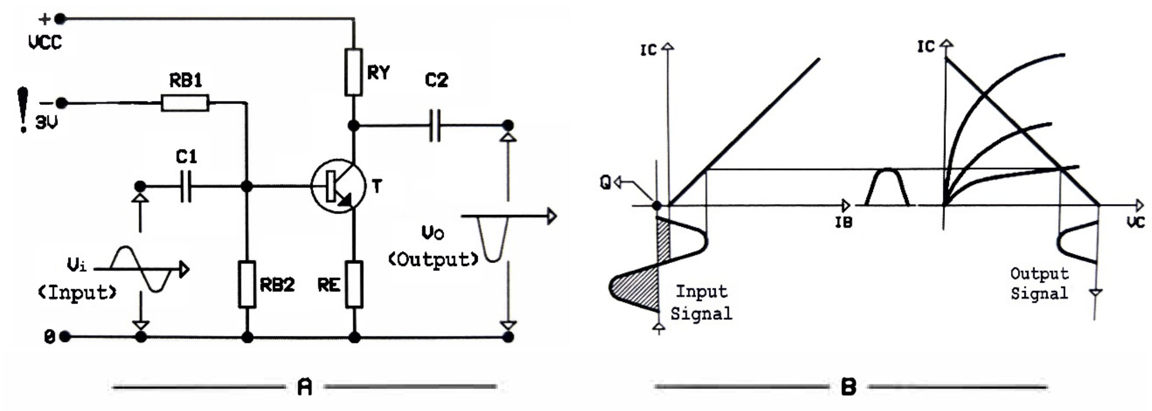

Figure 4: Circuit scheme of class-C amplifier and its characteristic

Procedure:

1. Turn on the oscilloscope and calibrate it,
2. Make sure the amplitude and frequency potentiometer of Function Generator adjusted to minimum, then, turn on the Training Set and connect the 'OUTPUT' to first channel of the oscilloscope,
3. Adjust the frequency to 1kHz and peak to peak voltage ($V_{i_{pp}}$) to $\boldsymbol{k}$ Volt where $\boldsymbol{k}$ defined as following relation,

$$\boldsymbol{k} = mod_4(Group\ Number)$$

4. Power off the Training Set and Oscilloscope,
5. Insert the Y-0016-009 module into training set.

Class-A Amplifier

6. Connect the patch wires to the module as it is shown in Figure 5.
7. Turn the power on Y-0016 Training Set and Oscilloscope.
8. Make sure the Function Generator is off, then measure the terminal voltages; V_E, V_B and V_C and fill the table inside the Figure 8 with measured values.
9. Sketch the input and output signal into Figure 8.

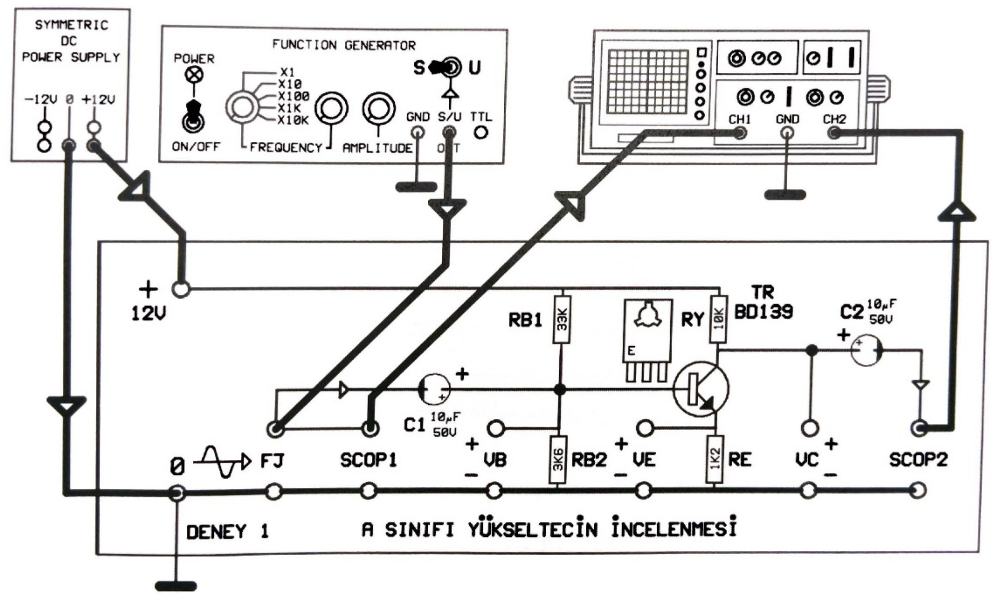

Figure 5: Connection scheme of class-A amplifier

Class-B Amplifier

10. Connect the patch wires to the module as it is shown in Figure 6.
11. Turn the power on Y-0016 Training Set and Oscilloscope.
12. Make sure the Function Generator is off, then measure the terminal voltages; V_E, V_B and V_C and fill the table inside the Figure 9 with measured values.
13. Sketch the input output signal into Figure 9.

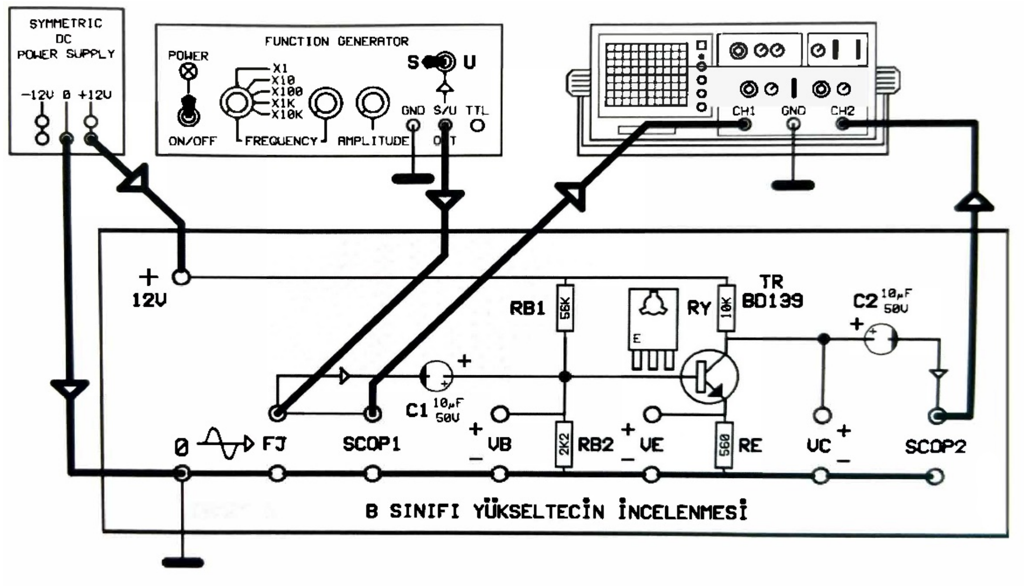

Figure 6: Connection scheme of class-B amplifier

Class-C Amplifier

14. Connect the patch wires to the module as it is shown in Figure 7.
15. Turn the power on Y-0016 Training Set and Oscilloscope.
16. Make sure the Function Generator is off, then measure the terminal voltages; V_E, V_B and V_C and fill the table inside the Figure 10 with measured values.
17. Sketch the input output signal into Figure 10.

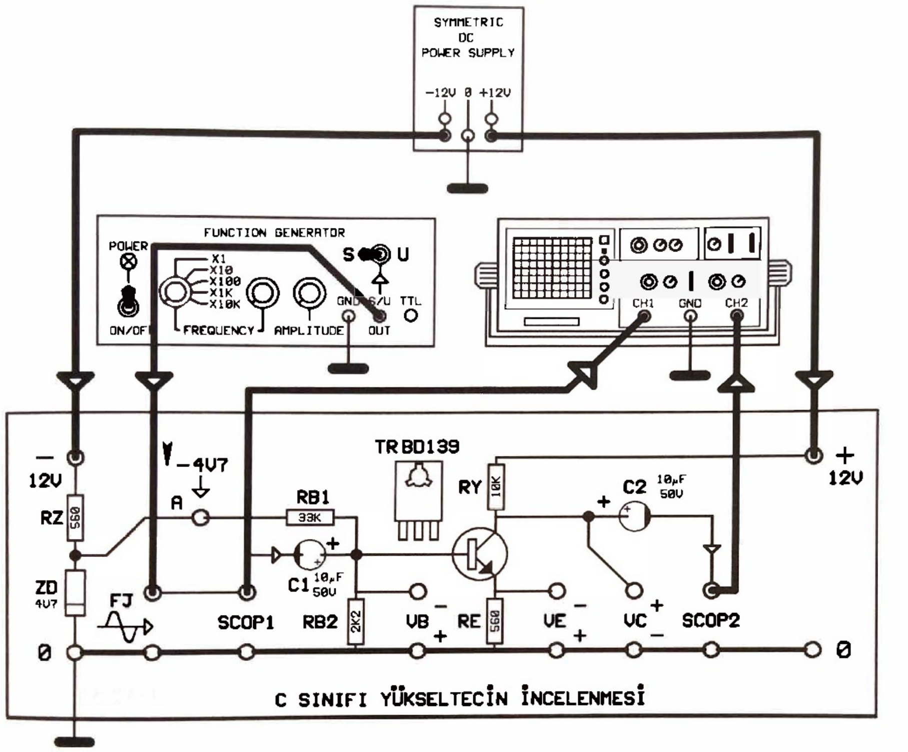

Figure 7: Connection scheme of class-C amplifier

Results:

Class-A Amplifiers

Terminal Voltages

$V_E =$
$V_B =$
$V_C =$

Input Signal

Volt/div = ……….

Time/div = ……….

Output Signal

Volt/div = ……….

Time/div = ……….

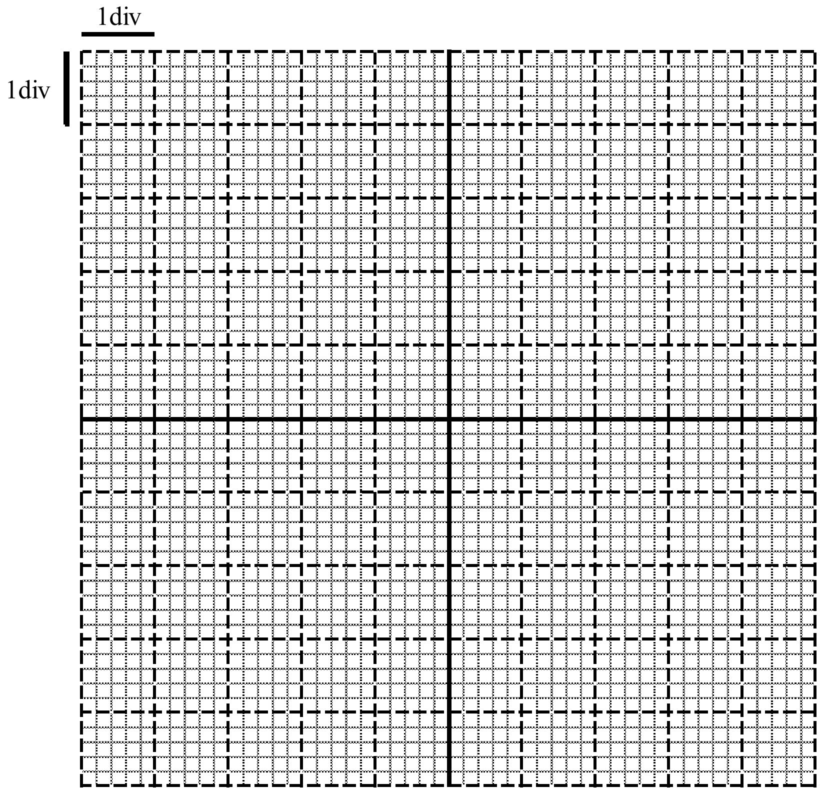

Figure 8: Input signal versus output signal oscillograph and terminal voltage measurements for Class-A.

1. According to measured terminal voltages, which state does the transistor in?

2. What is the phase relationship between input and the output signal? Why?

3. Does the output signal match with the input signal? Compare the two signals for all classes.

4. What can be said about the efficiency of Class-A Amplifiers?

Class-B Amplifiers

Terminal Voltages

$V_E =$
$V_B =$
$V_C =$

Input Signal

Volt/div = ……….
Time/div = ……….

Output Signal

Volt/div = ……….
Time/div = ……….

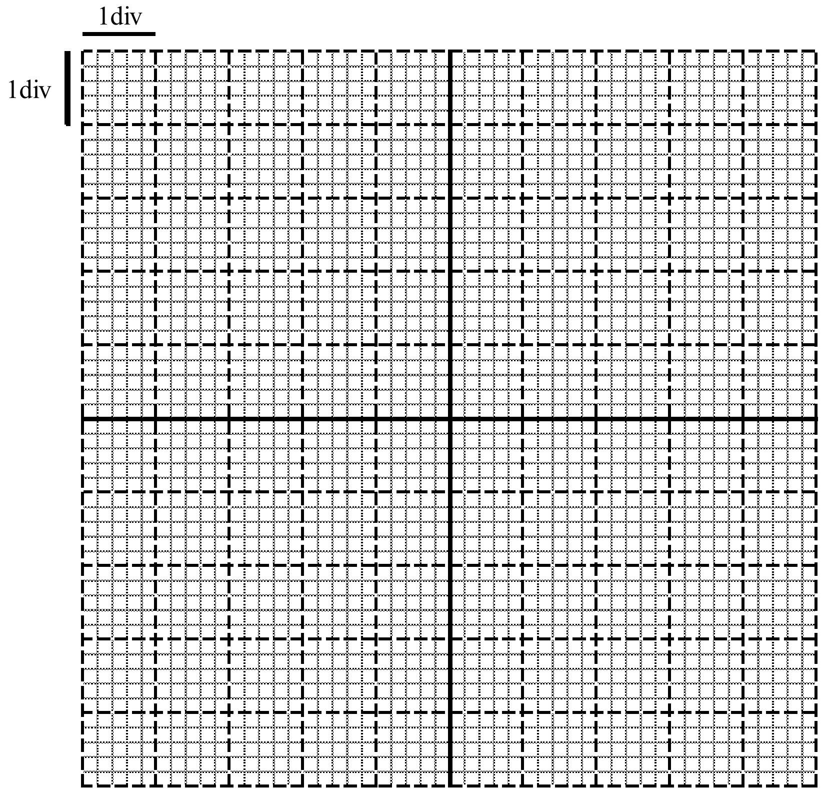

Figure 9: Input signal versus output signal oscillograph and terminal voltage measurements for Class-B.

1. According to measured terminal voltages, which state does the transistor in?

2. What is the phase relationship between input and the output signal? Why?

3. Does the output signal match with the input signal? Compare the two signals for all classes.

4. What can be said about the efficiency of Class-B Amplifiers?

Class-C Amplifiers

Terminal Voltages

$V_E =$
$V_B =$
$V_C =$

Input Signal

Volt/div = ……….

Time/div = ……….

Output Signal

Volt/div = ……….

Time/div = ……….

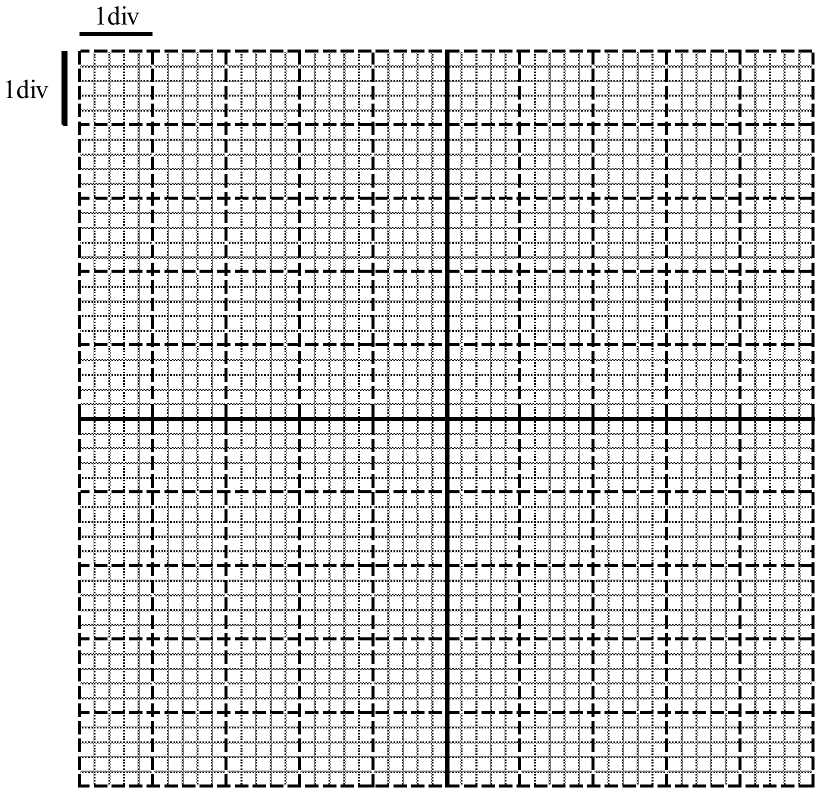

Figure 10: Input signal versus output signal oscillograph and terminal voltage measurements for Class-C.

1. According to measured terminal voltages, which state does the transistor in?

2. What is the phase relationship between input and the output signal? Why?

3. Does the output signal match with the input signal? Compare the two signals for all classes.

4. What can be said about the efficiency of Class-C Amplifiers?