THE PENNSYLVANIA STATE UNIVERSITY

COMMONWEALTH CAMPUSES

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Course EE 810 Section 3ET

Exercise No. 5 Date performed 12/23/60

Performed by:

Reported by

REPORT RECEIVED LATE

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GRADE B-

Laboratory Exercise 5

Simple Triode & Transistor Amplifier

12/23/60

Squad C

Summary and Discussion of Results

The primary objective of an amplifier is to raise the level of a given signal. A small signal at the input (grid to cathode) produced a larger variation in the output circuit (plate to cathode) of a 6J5 triode. The gain as calculated from a load line on a set of static curves, was 14.1. The gain as calculated by the formula $A = \frac{\mu R_L}{r_p + R_L}$ was 15.3. The gain as calculated from the input and output voltages was 16.3. The average gain was 15.2.

In a transistor amplifier, a small change in the input circuit (base to emitter) causes a larger change in the output circuit (collector to emitter). The gain as calculated from the static curves was 22.5 and as calculated from the input & output measurments was 22.5.

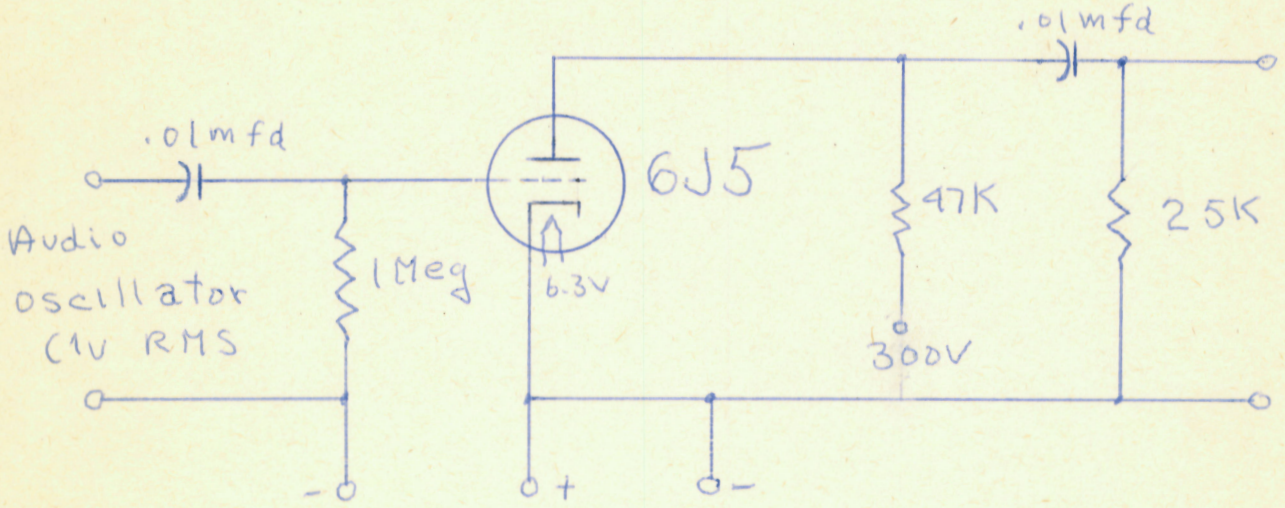
The range of voltages of the triode amplifier was greater than that of the transistor amplifier. There is more power output in the triode amplifier output because of its greater output voltage!

Description of Work Done

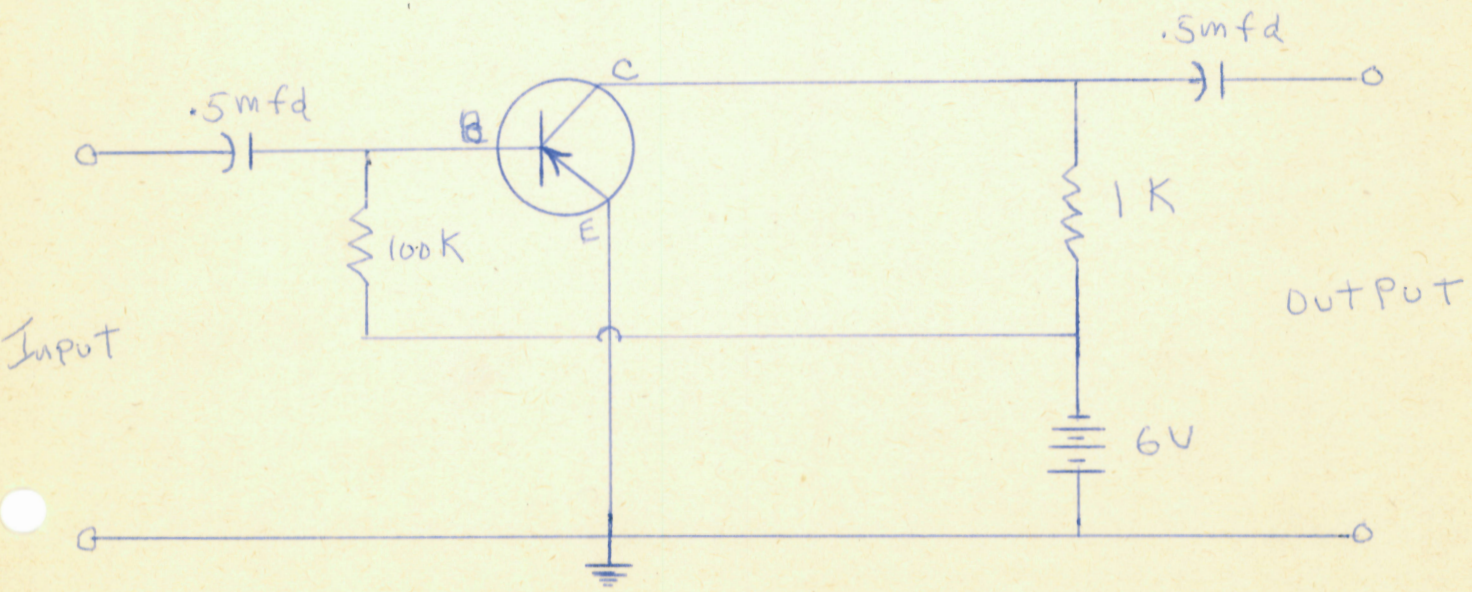
A resistance of 25,000 ohms was connected as R_L in the triode amplifier. From the TV power supply, 6.3 volts was connected to the filament and -12 volts to the bias terminals. a voltage of 300 volts was connected as E_{bb}. the bias at the tube was reduced to an operating bias of -6 volts. A 1000 cycle volt peak signal was introduced to the input terminals from the audio generator. the AC input and output was measured

A resistance of 1000 ohms was connected in the collector circuit as R_c. a resistance of 100K ohms was placed in the base circuit to limit bias current to operating base current of 60 microamps. A 1000 cycle 8 volt signal was connected to the voltage divider. the actual voltage input was calculated

R-C Coupled Single Stage Voltage Amplfier



Transistor Amplifier



Laboratory Ex- 5

Test Data

1 Triode:

input - 1Volt

output- 16.3 volts

2 Transistor

input = .008 volts

output = .18 volts

Calculations

Triode:

$$A = \frac{E_{out}}{E_{in}} = \frac{16.3}{1} = 16.3$$

$$A = \frac{N R_L}{r_p + R_L} = \frac{20 \times 25000}{77000 + 25000} = 15.3$$

$$A = \frac{\Delta E_b}{\Delta E_c} = \frac{40}{2.83} = 14.1$$

$$\text{Average Gain} = \frac{16.3 + 15.3 + 14.1}{3} = 15.2$$

Transistor

$$A = \frac{E_{out}}{E_{in}} = \frac{.18}{.008} = 22.5$$

$$\Delta E_{BE} = 1.414 \times .008 + 1.414 \times .008 = .0226$$

$$A = \frac{\Delta E_{CE}}{\Delta E_{BE}} = \frac{.508}{.0226} = 22.5$$

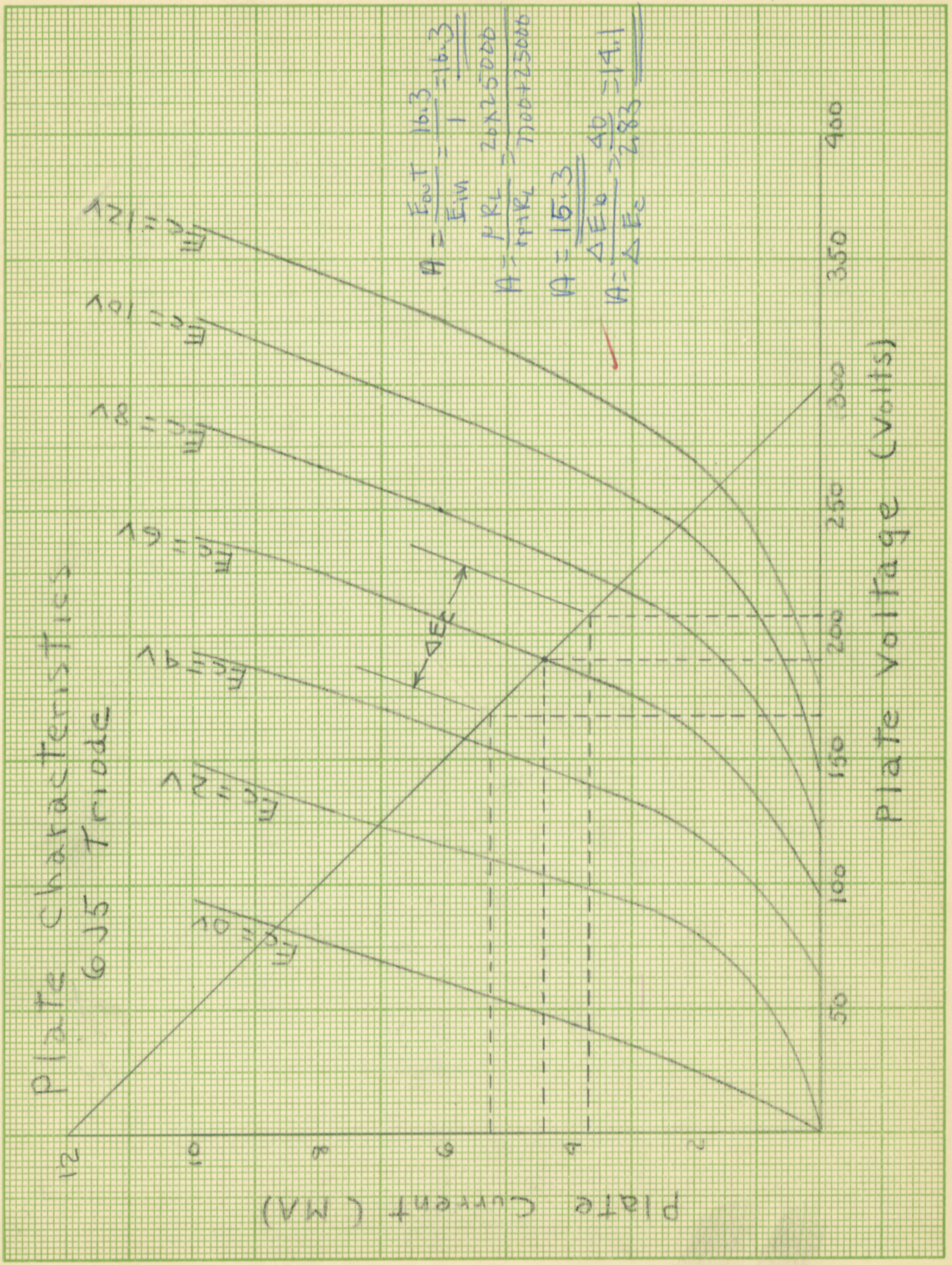
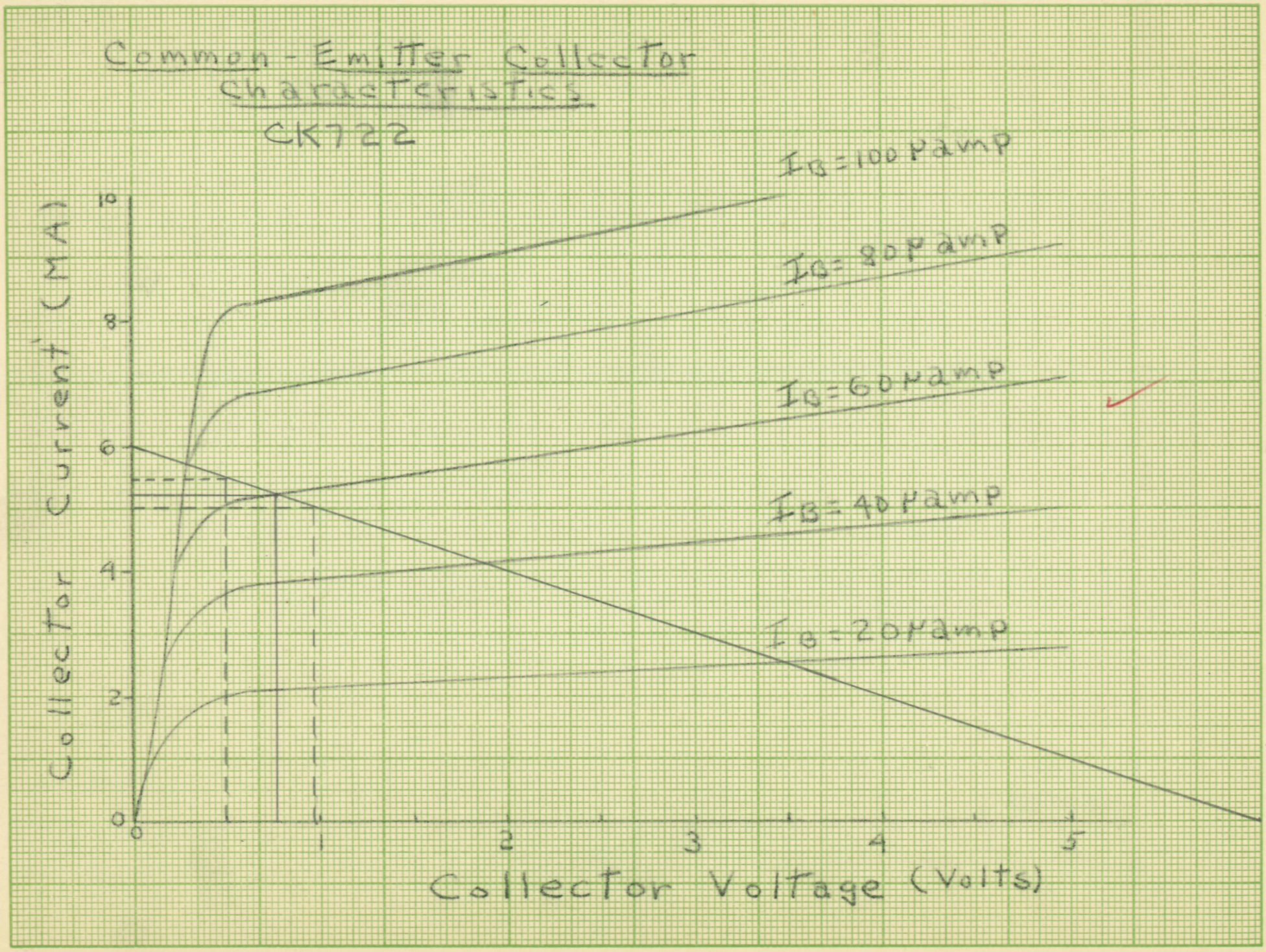


Plate Current (MA)
Plate voltage (volts)
Characteristics of 6J5 Triode
$E_c = 2V$
$E_c = 4V$
$E_c = 6V$
$E_c = 8V$
$E_c = 10V$
$E_c = 12V$
ΔE_c
ΔE_p
$\mu = \frac{\Delta E_p}{\Delta E_c} = \frac{16.3}{2.83} = 14.1$
$R_p = \frac{\Delta E_p}{\Delta I_p} = \frac{16.3}{1.7 \times 10^{-3}} = 20 \times 2500 = 7000 + 2500$
$G = \frac{1}{R_p} = \frac{1}{7000 + 2500} = 10.3$
$G = \frac{I_p}{E_{in}} = \frac{1}{10.3} = 16.3$


Common-Emitter Collector Characteristics
CK722
I_B = 100 μamp
I_B = 80 μamp
I_B = 60 μamp
I_B = 40 μamp
I_B = 20 μamp
Collector Current (MA)
10
8
6
4
2
0
0
1
2
3
4
5
Collector Voltage (Volts)

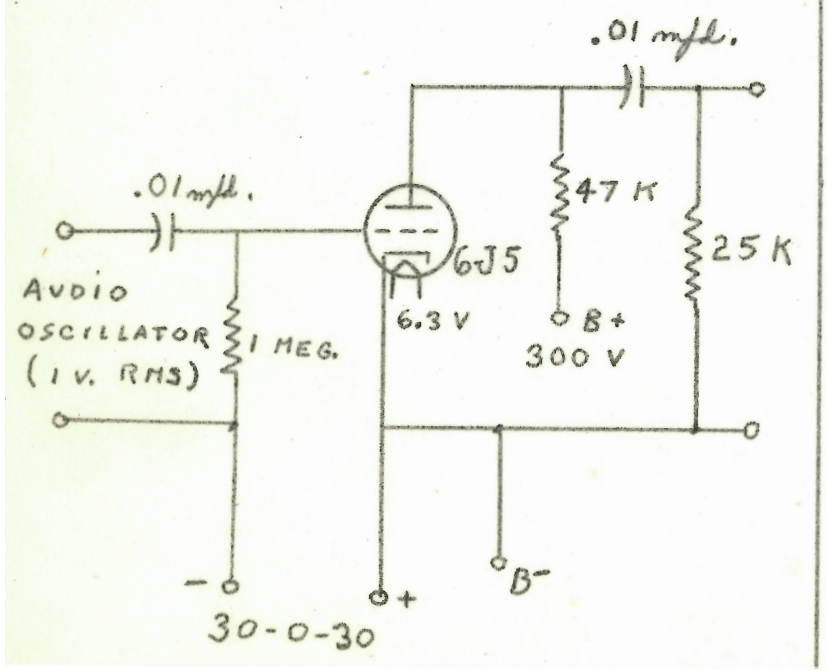
SQUAD (C) 12/23/60

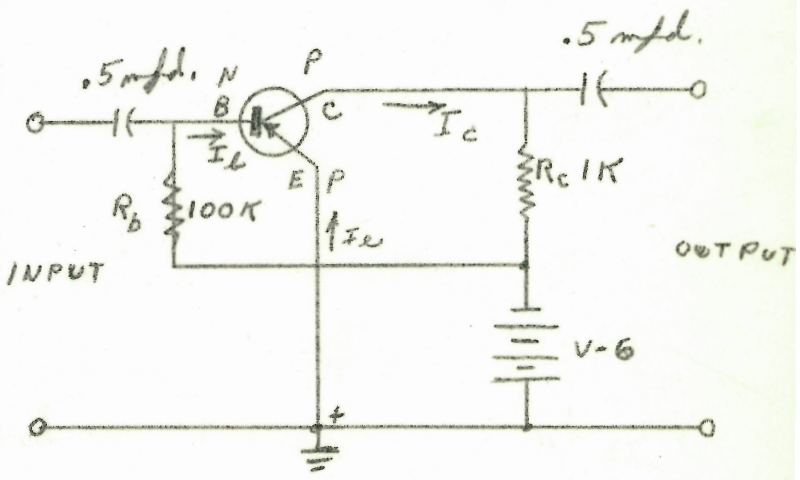
EQUIPMENT : TRIODE AMPLIFIER BOARD, R-86446 (6J5
TRANSISTOR AMPLIFIER BOARD, R-87624
AUDIO GENERATOR - 008-12153
T.V. POWER SUPPLY, R-81686
VARIAC, 0-130 V., R-83744
G.E. D-C, MICROAMMETER, 0-500, R-79682
SYLVANIA V.T.V.M., R-81654
SIMPSON "260", R-83764

(c) 1 VOLT INPUT
16.3 " OUTPUT

(d) .008 VOLT INPUT
.18 VOLT OUTPUT

R-C COUPLED
SINGLE-STAGE VOLTAGE AMPLIFIER





Laboratory Exercise 5

Simple Triode and Transistor Amplifier

Materials:

Triode amplifier board
transistor amplifier board
VTVM
TV Power Supply
0-500 DC Microammeter
Audio Generator
1,000 Ω 1 watt
25,000 Ω 1 watt

Discussion:

The primary object of an amplifier is to raise the level of given signal. A small signal at the input (grid to cathode) produces a larger variation in the output circuit (plate to cathode) of a vacuum tube.

Similarly, in a transistor amplifier, a small change in the input circuit (base to emitter) causes a larger change in the output circuit (collector to emitter).

These changes and net gain can be visually indicated by the use of a load line and a set of static curves. The actual gain can be measured by placing the circuit under test and measuring input and output values of signal. Deviations may occur in the transistor test because of its temperature sensitivity.

In the triode amplifier the gain = $\frac{\Delta E_b}{\Delta E_c}$ for a given signal measured along the load line.

In the transistor amplifier the gain = $\frac{\Delta E_{CE}}{\Delta E_{BE}}$ for a given signal along the load line.

$$\Delta E_{BE} = \Delta I_{B} x R_{in}$$

$$R_{in} = 800 \text{ ohms}$$

Procedure:

Triode

(a) Connect 25,000 ohms as R_L in the triode amplifier board.

(b) From the TV Power Supply, connect 6.3 volts to the filament and -12 volts to the bias terminals (observe polarity).

(c) Connect 300 volts as E_{bb}.

(d) Reduce bias at the tube to operating bias of -6 volts.

(e) Introduce a 1000 cycle volt peak signal to the input terminals from the Audio generator and measure the AC input and output on the oscilloscope.

Transistor

(a) Connect 1000 ohms in the collector circuit as R_C.

(b) Place approximately 100K ohms in the base circuit to limit bias current to operating base current of 60 microamps. (A microammeter may be necessary in the circuit to measure the 60 microamps).

(c) Connect a -1000 cycle 8 volts signal to the voltage divider. This divider reduces the AC voltage input to the transistor to a safe value. Calculate the actual voltage input when the one ohm resistance is connected to the transistor base.

(d) Energize and measure the AC output across R_C.

Report:

1. Construct a load line for the triode on static curves obtained from previous exercise.

2. Tabulate the triode gains obtained by:

$$A = \frac{E_{out}}{E_{in}} \qquad A = \frac{UR_I}{r_{p+} R_L} \qquad A = \frac{\Delta E_b}{\Delta E_c}$$

3. Construct load line for the transistor on static curves obtained from previous exercise.

4. Tabulate the transistor gains obtained by:

$$A = \frac{E_{out}}{E_{in}} \qquad A = \frac{\Delta E_{CE}}{\Delta E_{BE}}$$

5. Compare range of voltages involved in both amplifier cases.

6. In which amplifier is there more power output.