Triode Experimental Concept
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Introduction:

Triode valve is a vacuum tube having three electrodes namely plate, cathode and grid inside evacuated glass tube. It works on the principle of thermionic emission. For the proper use of the triode valve plate is kept at high potential with respect to cathode, and grid is given relatively low negative potentials. When cathode of triode is heated by passing current in it, the cathode emits electrons. The electron first emitted repels the other electrons which follow, so that cloud of electrons (space charge) is formed near cathode. If plate is given positive potential with respect to cathode, electrons flow from cathode to plate through the grid. Thus plate current flows in plate circuit. As plate voltage increases the plate current also increase. The function of grid is to remove space charge and control the flow of electron from cathode, so that the grid is given small negative potential respect to cathode.

The current in circuit is controlled by plate and grid potentials. Controlling current by grid and plate the triode valve is used as amplifier.

2.1 Apparatus Used:

The triode valve, 6.3 volt heating filament (cathode), high tension source for plate (around 250V), low tension source for grid (nearly 15V), two voltmeters i.e. voltmeter (0-20V) and voltmeter (0-250V) , milliammeter (0-1 mA) and Rheostat (100Ω),connection wires.

2.2 Theory and Formula Used:

Triode is three electrodes vacuum tube and it works on the principle of thermionic emission. The cathode is source of electrons, which when reaches plate constitute plate current. For the flow of plate current in plate circuit the plate voltage is given high positive potential and grid is given low negative potential with respect to cathode. The plate current in plate circuit is control by both plate potential and grid potential. As grid is more nearer relative to plate so grid is more efficient in controlling the current. By this virtue the triode can be used as amplifier.

For the proper use of triode as amplifier it is always useful to know the characteristics and constants of triode valve. Characteristics curve shows relations among plate-current, plate potential and grid potential. There are two important types of characteristics.

(I) Plate (or anode) characteristics: These are the curve showing variation of plate current i_p with plate voltage V_p at constant grid voltage V_g. We obtain plate characteristics by plotting graph between plate current i_p with plate voltage V_p at constant grid voltage V_g say for -2V and plots same for different grid potential -4V, -6V⋯⋯. All the graphs show plate characteristics.

(II) Mutual characteristics: These are the graphs which are plotted with grid voltage V_g and plate current i_p at constant plate voltage V_p say at 150V. Same will be repeated for different plate voltage say for 200V, 250N⋯⋯.

Formulas for determining constants of triode are as follows

Amplification Factor (μ): It is the ratio of a small change in plate potential to the change in grid potential in opposite direction under the condition that plate current remains constant. Thus

$$\mu = -\left(\frac{\delta V_p}{\delta V_g}\right)_{i_p}$$

Plate resistance (r_p): It is define as ratio of small change of plate potential to the resulting change in plate current at constant grid potential.

$$r_p = -\left(\frac{\partial V_p}{\partial i_p}\right)_{V_g}$$

Mutual Conductance (g_m): It is define as ratio of small change of plate potential to the resulting change in plate current at constant grid potential.

$$g_m = -\left(\frac{\partial i_p}{\partial V_g}\right)_{V_p}$$

2.3 About apparatus:

Triode valve is a vacuum tube having three electrodes namely plate, grid and cathode inside evacuated glass tube as shown in figure 1. Cathode, which serve as source of electrons is an indirectly heated oxide-coated nickel cylinder. Cathode is heated indirectly by insulated heater filament enclosed within it. The cathode is surrounded by (wired mesh grid is surrounded by plate (hollow cylinder made of nickel, molybdenum or iron).

The apparatus in the experiment is a simple electric circuit as shown in figure 2. The triode valve have three electrode 6V battery is connected to the electric bulb with rheostat. For the measurement of current and voltage the DC Voltmeter (0-10V) & DC ammeter (0-1 A) are connected.

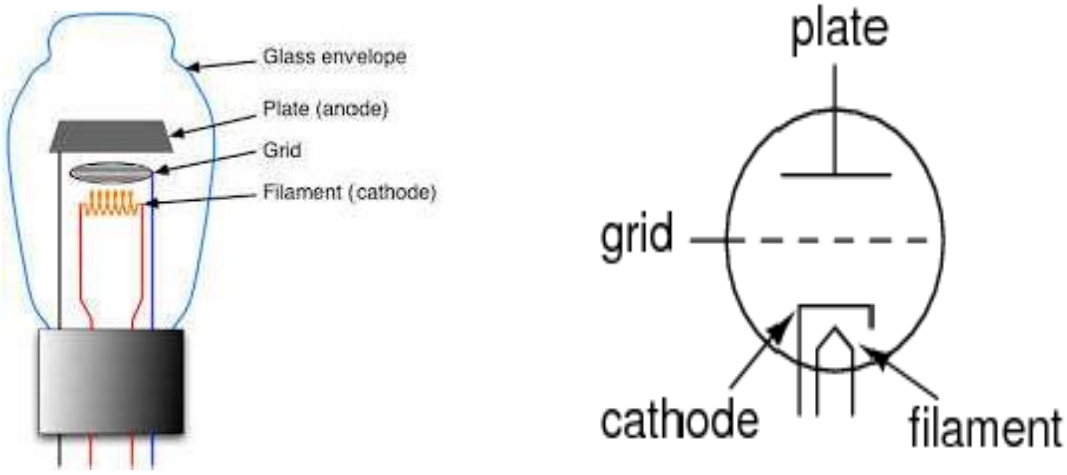

Figure 1

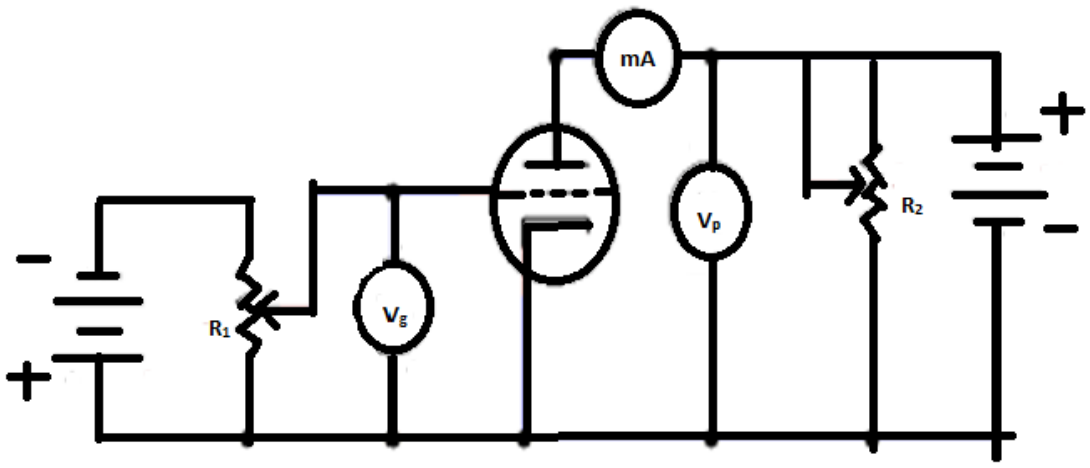

Figure 2

2.4 Procedure:

For plate characteristics, perform the experiment in following steps.

6. Make connection as shown in figure 2.
7. With the help of rheostat (by varying resistance R_2) adjust plate voltage say 20 V.
8. With the help of rheostat (by varying resistance R_1) adjust grid voltage say -2 V.
9. Note down the plate current in milliamter.
10. Now increase the plate potential in the steps (say in 5V step) and read the corresponding plate current in milliamter.

11. Draw the graph between plate voltage and plate current, which is called plate characteristics of triode.
12. Repeat the observations for the different grid potential as for -4V, -6V……, and draw the graphs for same.

For mutual characteristics, perform the experiment in following steps.

1. With the help of rheostat (by varying resistance R_1) adjust plate voltage say 150 V.
2. With the help of rheostat (by varying resistance R_2) adjust grid voltage say -2 V.
3. Note down the plate current in milliamter.
4. Now increase the grid potential in the steps (say in 1V step) and read the corresponding plate current in milliamter.
5. Draw the graph between grid voltage and plate current, which is called mutual characteristics of triode.
6. Repeat the observations for the different plate potential as for 150V, 200V……, and draw the graphs for same.

2.5 Calculation and Discussion:

(i) It is the ratio of small change in plate voltage to the change in plate current produced by it, the grid voltage remaining constant. From the graph 1

$r_p = \frac{\Delta V_p}{\Delta I_p}$, At constant V_g

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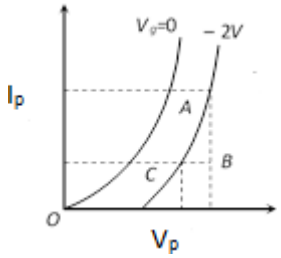
$r_p = \frac{\Delta BC}{ÆB}$



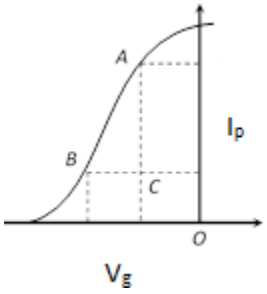
Graph 1

(ii) Mutual conductance or trans-conductance (gm)

It is defined as the ratio of small change in plate current (ΔI_p) to the corresponding small change in grid potential (ΔV_g) at constant V_p. From the graph 2

$g_m = \frac{\Delta I_p}{\Delta V_g}$ at constant plate voltage V_p

$$g_m = \frac{\Delta ÆC}{\Delta BC}$$



Graph 2

(iii) The value of amplification factor (μ) is calculated by following relation

$$\mu = r_p \times g_m$$