CHAPTER 9

EXPERIMENTS

EXPERIMENT NO. 1

Objective : To study the operation of the following instruments:-

(1) Regulated power supply (2) Multimeter

(3) Ammeters (4) Voltmeters

(5) C.R.O. (6) Signal generators

Objective (a) To study the operation of a regulated power supply

Apparatus required :

S. No.	Name of the instrument	No.
1.	Regulated power supply	1
2.	Connecting wires	

Theory : A power supply, the D.C. output of which remains constant, irrespective of A.C. input voltage fluctuations or load variations, is called a regulated power supply.

Special electronic devices are employed to obtain regulated power supply. For getting regulated low voltages, a zener diode is always used. However for high regulated voltages (≥ 30 V) neon tubes are employed.

Block diagram of a regulated power supply

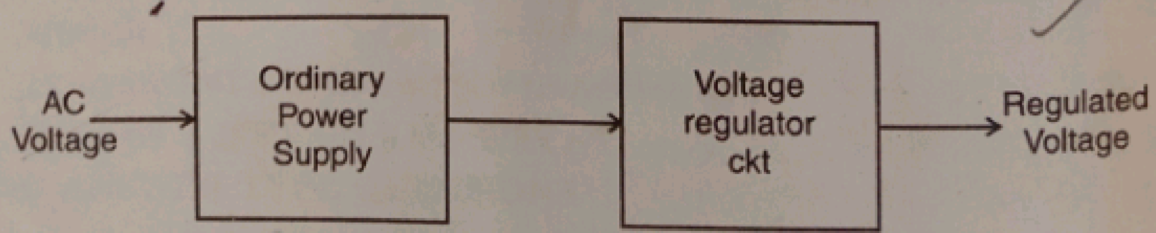


Fig. P-1 Block diagram of regulated power supply

Circuit Diagram of a regulated power supply

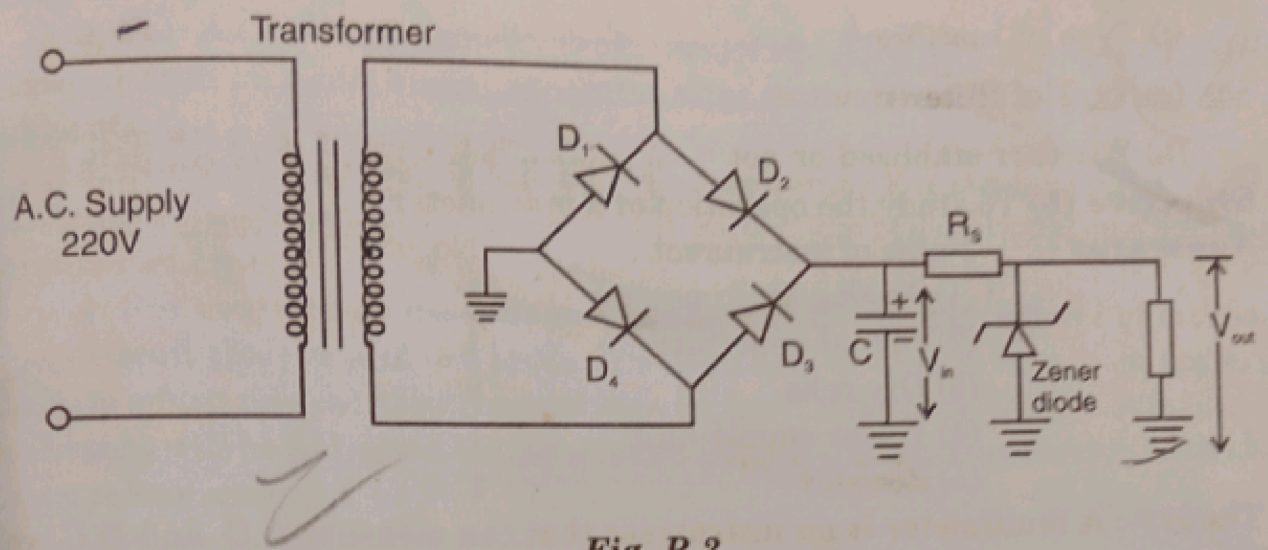


Fig. P-2

Procedure : Observe the maximum O/P voltage of power supply and maximum allowed current. To calculate the internal resistance of high voltage power supply, Take the O/P voltage without any load i.e. using only voltmeter. Now connect the resistor so that maximum allowed current flows in the O/P. Take the O/P voltage again, this is called full load O/P.

Then for each current value

$$\text{Internal resistance} = \frac{\text{No load O/P} - \text{Full load O/P}}{\text{Current}}$$

Observation Table:

Type of power supply

(Wheather low or high voltage) =

1. High voltage power supply :
   - (a) Max. d.c. O/P voltage = ...
   - (b) Whether fixed or variable output = ...
   - (c) Maximum allowed current = ...
   - (d) Internal resistance = ...%
   - (e) Ripple factor = ...
   - (f) Type of rectifier = ...
   - (g) Type of filter circuit = ...
   - (h) Whether stablized or not =...
2. Low voltage power supply:
   - (a) Maximum O/P d.c. available = ...
   - (b) Whether fixed or variable output = ...
   - (c) Max. current = ...

(d) Internal resistance = ...

(e) Ripple factors = ...

(f) Type of ractifier = ...

(g) Type of filter circuit = ...

(h) Whether stablized or not = ...

Objective (b) To study the operation of a multimeter

Apparatus :

Name of instrument	No.
(1) Analog Multimeter	1
(2) Signal generator	1
(3) Dry cells	2
(4) Power supply unit	1
(5) Resistor	1

Theory : A multimeter is an instrument that can measure A.C. and D.C. voltages, current and resistances. It consists essentially of separate voltage, current and resistance measuring circuits. The meter movement is common for all the three circuits. A selector switch is provided to set up the required circuit for a desired measurement.

CKT. Diagram

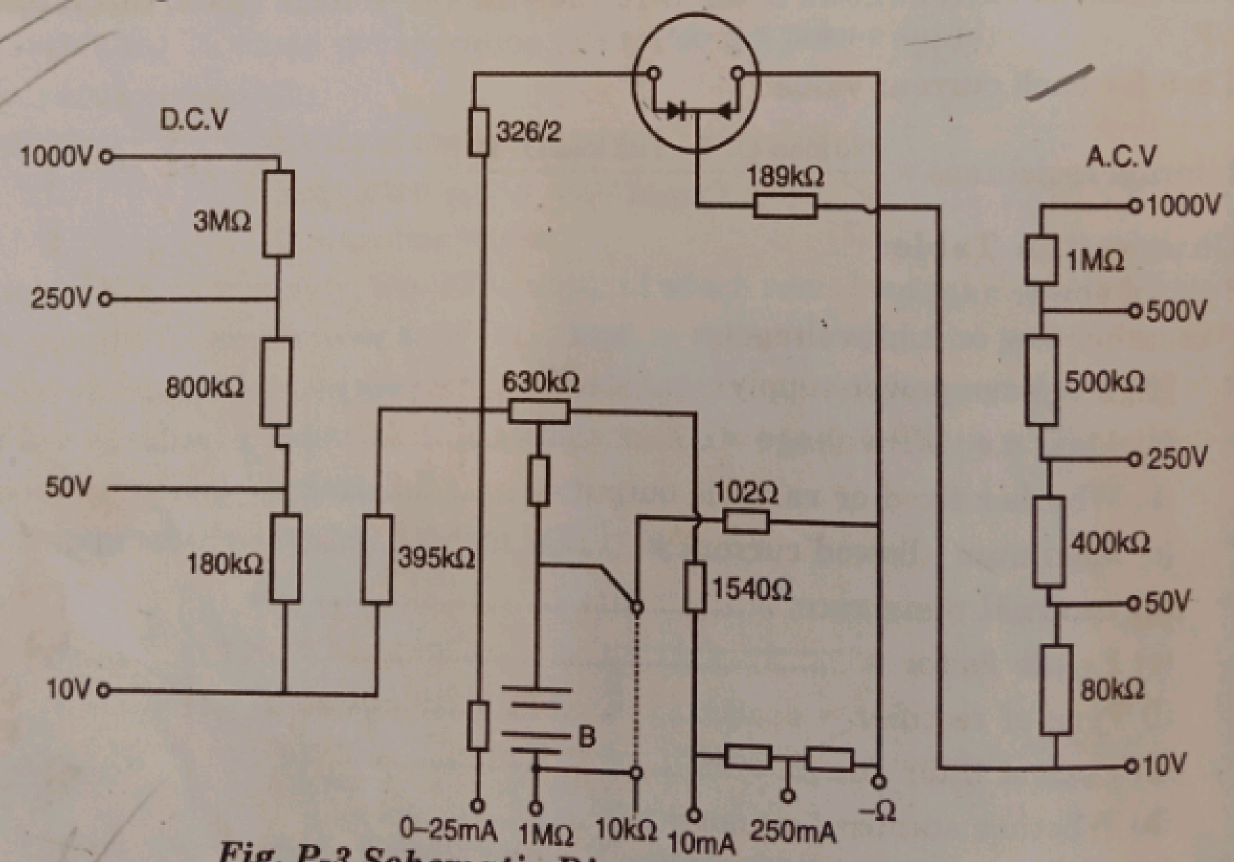


Fig. P-3 Schematic Diagram of a Multimeter

Procedure :

1. **For D.C. measurements (voltage) :** Connect meter leads to the two terminals of a dry cell after setting the function switch for d.c. voltage measurement. Red colour positive lead is connected to +ve side and Black colour –ve lead to –ve side.

Always start with the highest range if approx. value of voltage is to be measured is not known and then switch down to select the suitable range. Read the value of voltage on scale.

2. For A.C. measurement (voltages) : Measure A.C. voltages of different values obtained from an audio signal generator after setting the function switch for A.C. measurements.

3. For A.C. and D.C. current measurement : For measurement of D.C. and A.C. currents, the meter should be connected in series. The conventional current enters the +ve terminal and leaves the -ve terminal.

4. For resistance measurement : Set the function switch for ohms measurement. Short circuit the +ve and –ve leads. If needle does not indicate zero on scale, then adjust the zero adjust control. Now connect the unknown resistance to the test leads. The value of resistance will be indicated on the scale. Compare the measured value with that found by using colour code.

Observations :

1. Voltage of the dry cell = ...V
2. Voltage of the d.c. supply = ...V
3. Voltage of a.c. mains = ...V
4. Maximum voltage obtainable from signal generator = ...V
5. Difference between measured and actual d.c.voltage = ...V

Observation table (For measurement of resistance)

S.No.	Measured Value	Value indicated in colour code	Tolerance indicated	Difference between measured and given value

Objective (c) To study the operation of Ammeters

Apparatus reqd.

Name of apparatus	No.	Range
(1) Ammeter (A.C. type)	1	0.5 A
(2) Ammeter (D.C. type)	1	0.5 A
(3) Connecting wires		

Theory : Ammeters are used to measure currents. These can be classified on the basis of type of current (A.C. or D.C.) or the maximum current to be measured during the experiment. The ammeters have very low resistance.

The meters used for measurement of direct current are called permanent magnet moving coil (PMMC) instruments. These instruments have uniform scale but in our laboratories, the ammeters used for a.c. are. Moving iron type. These can be attraction type or repulsion type. These instruments have non-uniform scale which is cramped in its lower portion.

When a high current is to be measured, then the coil need not to be made of thick wire to carry the full load high current, but a low resistance shunt is connected across the meter coil as shown in fig.

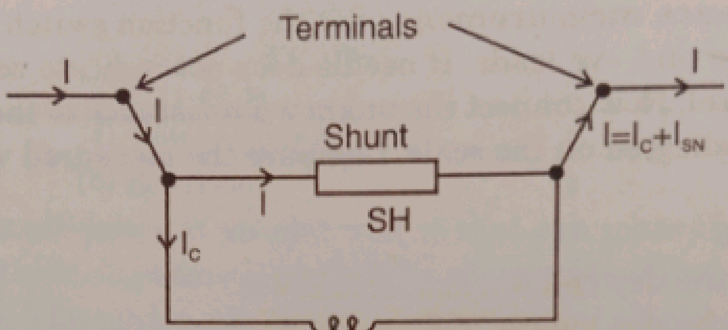


Fig. P-4

CKT. Diagram

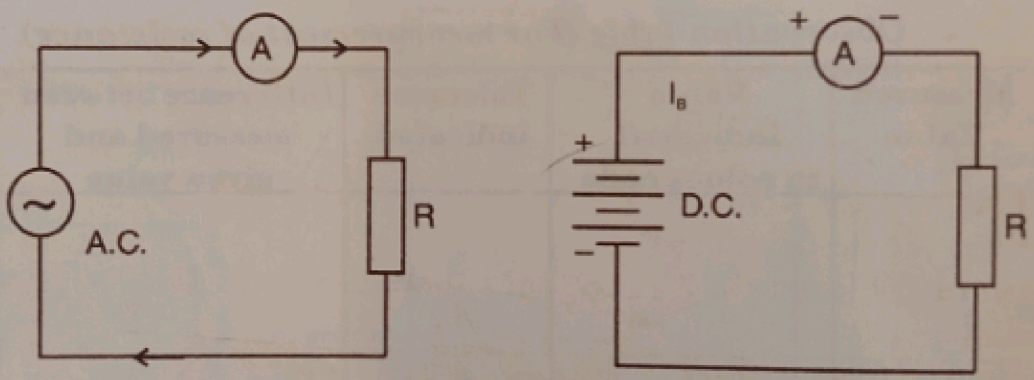


Fig. P-5 A.C./D.C. ammeters

Connections of Ammeters : An ammeter is always connected in series with the ckt. so that the circuit current to be measured passes through it.

Observations : Value of d.c. current = ...A

Value of a.c. current = ...A

Objectives (d) To study the operation of voltmeters.

Apparatus :

	Name of apparatus	No.
(1)	Voltmeter a.c. (0–5V)	1
(2)	Voltmeter d.c. (0.10V)	1
(3)	Connecting wires	

Theory : Voltmeters are used to measure voltage or potential difference between two points. These can be of a.c. or d.c. type. These can be used to measure wide range of voltages from few mV to 500 V.

The A.C. voltmeters are of the moving iron type with a non linear scale and no polarity marking for it's terminals. The principle of operation of voltmeters is same as that of ammeters.

The D.C. voltmeters are the permanent magnet moving coil type having polarities marked on it's terminals and having a uniform scale.

The voltmeters have marking on the dial to indicate the type of meter. These markings are for D.C. and ≃ for A.C./D.C. To extend the range of a voltmeter, a high resistance is connected in series with it which is called multiplier resistance. A voltmeter should have high resistance.

CKT. Diagram

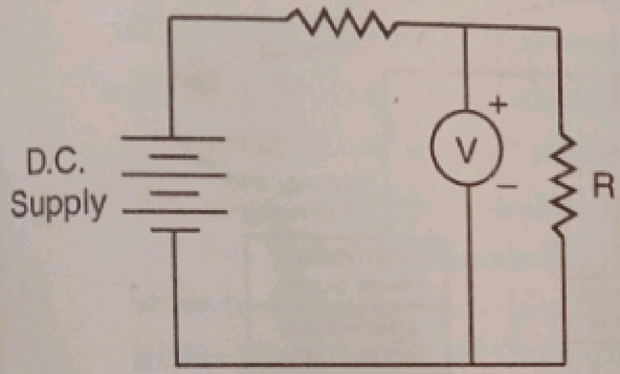


Fig. P-6 D.C. Voltmeter

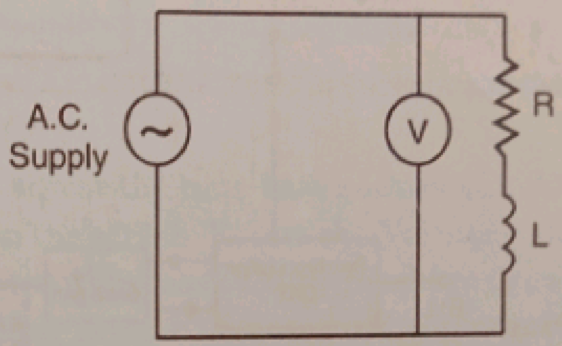


Fig. P-7 A.C. Voltmeter

D.C./A.C. voltmeter

Connections of voltmeter : A voltmeter is always connected in parrallel across the ckt. whose voltage is to be measured.

Observations :

Value of a.c. voltage measured = ...V

Value of d.c. voltage measured = ...V

Objective (d) To study the operation of a Cathode Ray Oscilloscope (C.R.O.)

Apparatus :

S.No.	Name of apparatus	Range	Total No.
(1)	C.R.O.	—	1
(2)	Signal generator	—	1
(3)	Connecting leads	—	—
(4)	C.R.O. probe	—	—
(5)	Voltmeter (A.C.)	0–5 V	1

Theory : The main purpose of a C.R.O. in electronic circuits is to display waveshapes. The heart of a C.R.O. is Cathode Ray Tube C.R.T. To operate the C.R.T., the oscilloscope has a sweep generator, deflection amplifiers, power supply circuit and a number of control, switches and input terminals on the front panel.

An electron beam produced by the electron gun in the CRT strikes the flourescent screen. As a result, a bright spot is observed on the screen of the CRT. By applying voltages to the horizontal and vertical deflection plates, the beam is deflected in any desired direction. To display a wave shape, it is connected to the vertical input of the scope. To the horizontal deflection plates, a sawtooth wave shape is applied internally. If we connect sine wave voltages to both the vertical and horizontal inputs, we get a display called lissajous pattern. The shape of this pattern depends upon the frequency ratio of two sine waves.

CKT. Diagram

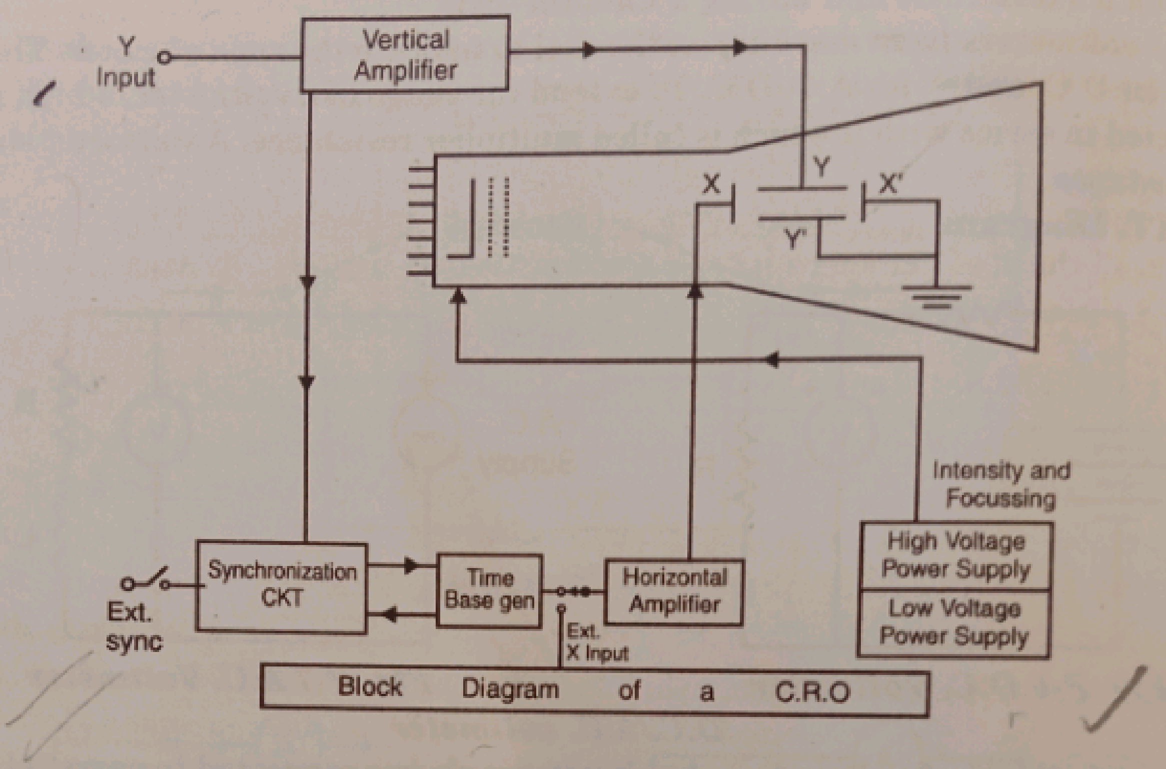


Fig. P-8 Block diagram of a

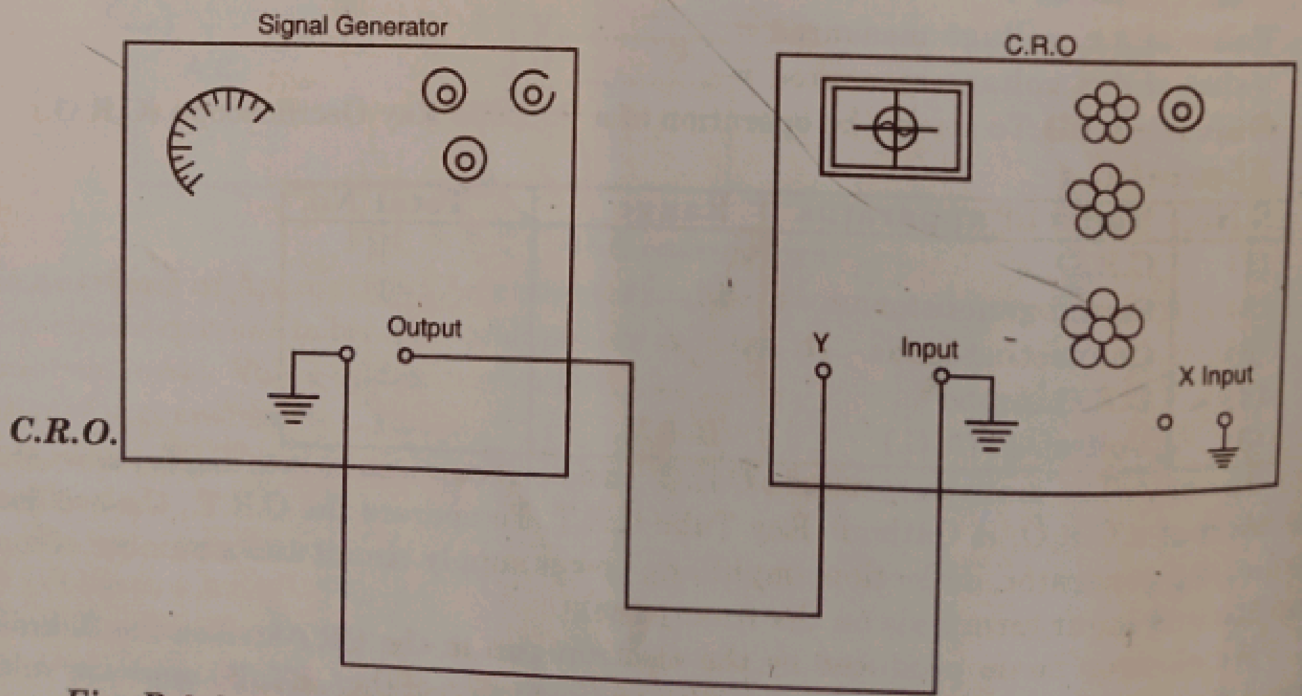


Fig. P-9 Connection of C.R.O. to observe O/P of a signal generator.

Procedure :

1. Sketch the front panel diagram of C.R.O. and mark function of each knob.
2. Switch on C.R.O. rotate the intensity control clockwise. After sometime you see a bright spot on the screen.
3. Operate the Intensity and Focus controls to observe the effects on spot. Adjust them suitably.
4. Connect the O/P from audio signal generator to the Y-input terminals of the C.R.O.
5. To measure the O/P voltage of signal generator, adjust the vertical amplifier sensitivity suitably so as to get a sufficient large display. On the calibrated scale, read the vertical length of the display. This corresponds to peak to peak value of the signal. Multiply this length by sensitivity (V/cm). Dividing this result by $2\sqrt{2}$ gives R.M.S. value of signal voltage. Repeat the measurements for two or three other values of output signal voltage.
6. For measuring frequency of signal adjust the time base control suitably so as to get 2-3 cycles of signals displayed on the screen. Rotate the Vernier control clockwise to CAL position. Multiply it by the time base setting (in ms/cm or µs/cm). This gives time period of the signal. Taking inverse of this gives the frequency of the signal $f = 1/T$ Hz

Observations :

(1) To measure the voltage

S.No.	Signal generator O/P (Measured by Voltmeter)	Measurement on CRO		
		P–P Value in Cm	Sensitivity in V/cm	R.M.S. Value

(2) To measure the frequency

S.No.	Frequency of Signal generator	Measurement on CRO			
		Length of one wave in cm (l)	Sensitivity in ms/cm (t)	Time period $T = l \times t$	Frequency in kHz $f = 1/T$

Objectives (e) To study the operation of a signal generator

Apparatus reqd :

	Name of instrument	No.
(1)	Signal generator	1
(2)	C.R.O.	1
(3)	Connecting leads	

Theory : The signal generator is an instrument that generates an electrical signal in either audio or radio frequency range. Audio signal generator produces audio frequencies (sine triangular or square wave shapes). It is generally used for testing amplifiers.

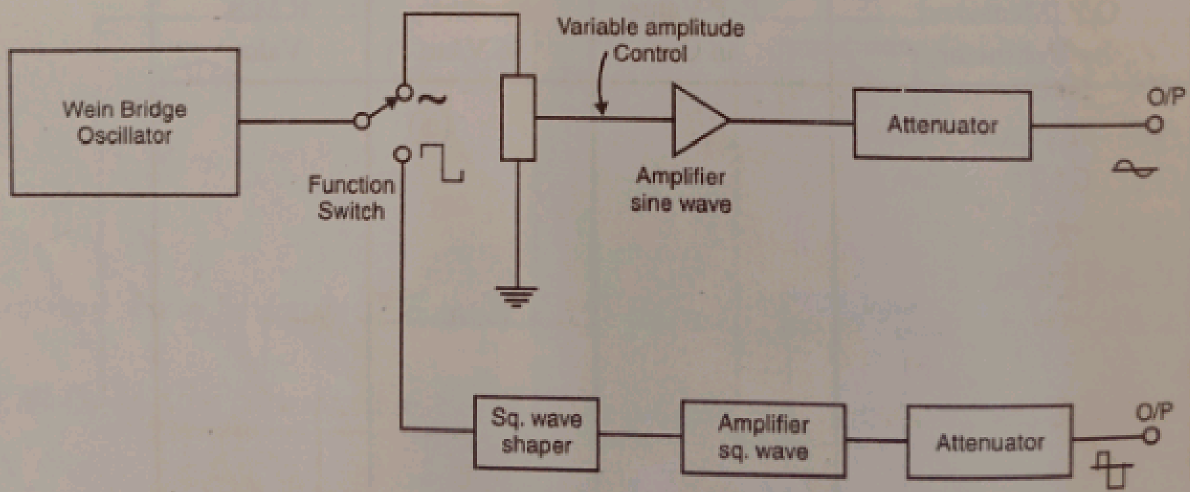


Fig. P-10 Block diagram of an audio sine-square wave oscillator

The heart of the generator is the weinbridge oscillator. The frequency of oscillations can be easily changed by changing the capacitors in the oscillator. The O/P of the wein bridge oscillator goes to the 'function switch'. It directs the oscillator O/P either to the sine wave amplifier or to the square wave shaper. At the O/P we get either a sine wave or square wave. The O/P is varied by an attenuator.

FRONT PANEL CONTROLS OF A FUNCTION GENERATOR

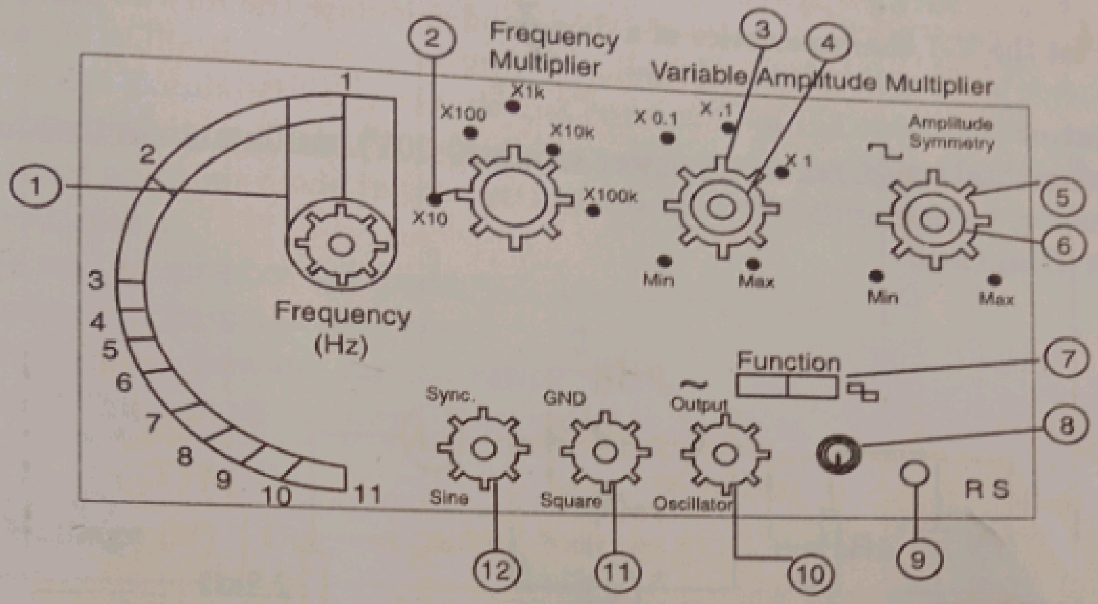


Fig. P-11 Front panel controls of sine square oscillator

(1) Frequency selector
(2) Frequency Multiplier
(3) Amplitude multiplier
(4) Variable amplitude
(5) Symmetry
(6) Amplitude
(7) Function
(8) On power
(9) Neon lamp
(10) Output
(11) GND
(12) Sync

Procedure :

1. Sketch the front panel diagram of function generator and mark function of each knob.

2. Check the amplitude and output of the function generator with help of a C.R.O. as in exp. 1 (d)

Observation :

Frequency range of function generator: ....

Whether O/P variable = ...

(Give details)

EXPERIMENT NO. 2

AIM: Plot the V-1 characteristics of a diode and calculate the forwad state Dynamic resistance.

Apparatus :

(i) Experimental board, regulated power supply (0-30V), milliammeter (0-30mA), electronic multimeter, voltmeter (0-3 V)

Circuit Diagram:

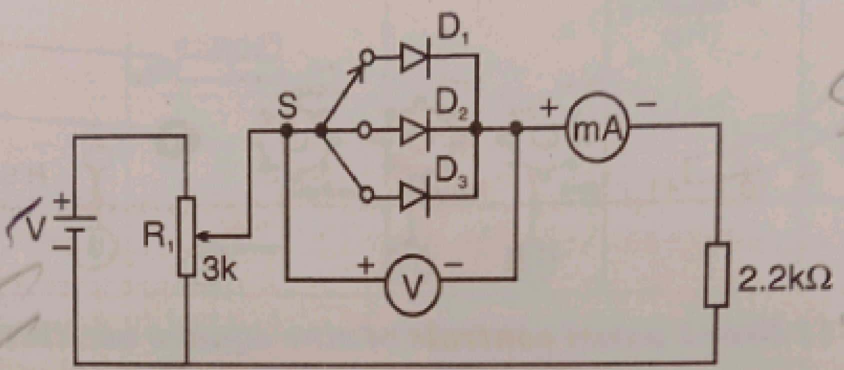


Fig. P-12. Circuit for diode characteristics.

Brief Theory : A diode conducts in forward bias (*i.e.*, when potential of anode is higher than that of cathode). It does not conduct in reverse biased condition. In a forward-biased diode, the barrier potential reduces. The majority carriers diffuse across the junction. This causes current to flow through the diode. In reverse bias, the barrier potential increases, and almost no current can flow through the diode.

The external battery is connected so that its positive terminal is connected to the anode and its negative terminal is connected to cathode. The diode is thus forward biased. The forward bias voltage can be varied by changing the external applied voltage. As shown in fig. P12, the external voltage across the diode can be varied by potentiometer R_1. A series register (2.2kΩ) is connected in the ckt. so that excessive current does not flow through the diode.

Note down different values of the current through the diode for various values of the voltage across it. A plot between this voltage and current gives the diode characteristics.

The static resistance of diode is the ratio of D.C. voltage to D.C. current. *i.e.*,

$$R_d = V/I$$

The dynamic resistance of diode is the ratio of a small change in voltage to a small change in current. *i.e.*,

$$r_d = \Delta V/\Delta I$$

Procedure :

1. Find the type and number of the diodes connected in the experimental board.
2. Trace the circuit and identify different components used in the circuit.

3. Connect the milli-ammeter and voltmeter of suitable ranges.
4. Switch on the power supply. Increase the voltage slowly, with the help of a potentiometer R_1.
5. Note the milliammeter and voltmeter readings for each setting of the potentiometer.
6. Draw the graph between voltage and current from the observations made.
7. At a suitable point,calculate the static and dynamic resistance of the diode.
8. Connect an other diode in the ckt. and repeat the above steps.

Observations :

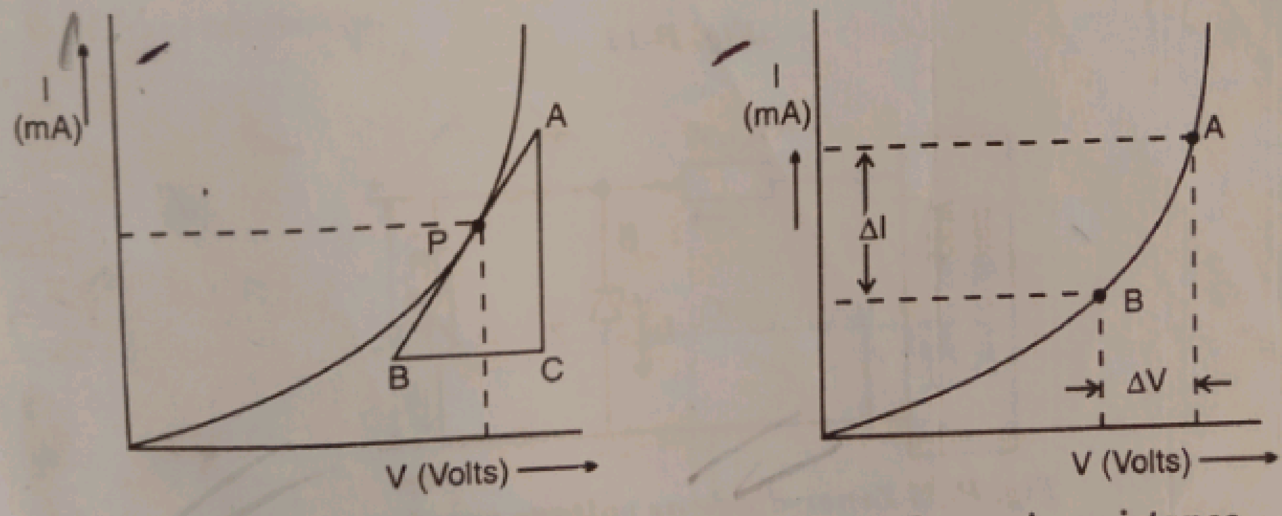
1. Type and number of the diode = ...
2. Information from the data book:
   (a) Maximum forward current rating = ...mA
   (b) Maximum peak inverse voltae rating = ...V

S.No.	Type No.		Type No.	
	Voltage (V)	Current (mA)	Voltage (V)	Current (mA)
1.				
2.				
3.				

Calculations :

1. Static resistance, $R_d = V/I$ = ...Ω

2. Dynamic resistance, $r_d = \Delta V/\Delta I$ = ...Ω



(a) Static resistance   *(b) Dynamic resistance*

Fig. P-13

Results :

1. The V/I characteristics of the diodes are shown in the graph.
2. The values of static and dynamic resistance of different diodes is as given below

	Diode type No..........	Diode type No.........
R_d r_d		

3. Value of knee voltage for G_e=0.7 V and for S_i=0.3V

EXPERIMENT NO. 3

Aim : Zener Diode Characteristics

(1) V-I characteristics of zener diode under reverse biased conditions.

(2) Use of zener diode as voltage regulator.

Apparatus required :

Experimental board, milliammeter (0-30mA), electronic multimeter, regulated power supply (0-30V)

Circuit diagram :

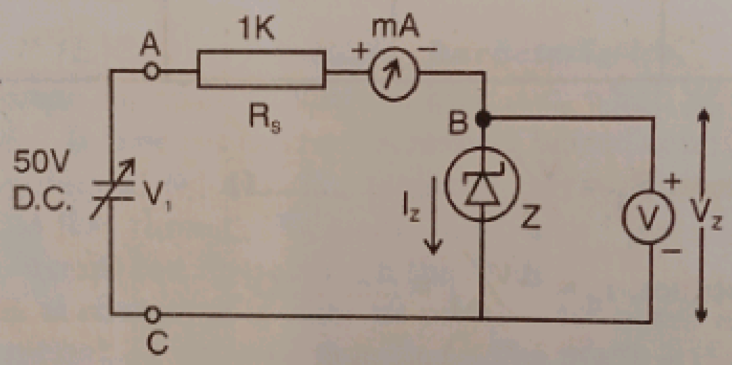


Fig. P-14

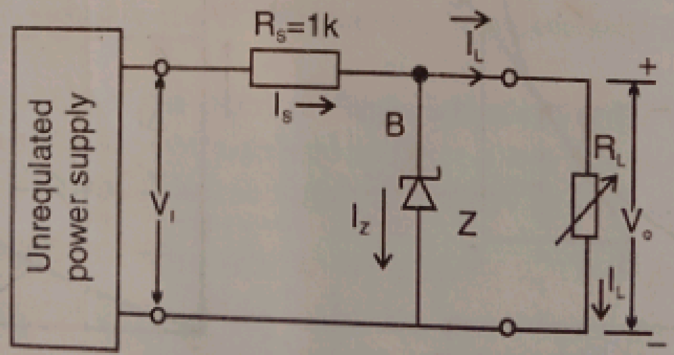


Fig. P-15 Zener-diode as voltage regulator.

Brief Theory : A PN junction diode normally does not conduct when reverse biased. But if the reverse bias is increased, at a particular voltage it starts conducting heavily due to avalanche/zener break down. High current through diode can permanently damage it.

To avoid high current a current limiting resistor is connected in series with it. Once the zener diode starts conducting, it maintains almost constant voltage V_Z across its terminals. It has very low dynamic resistance. A zener diode is specially made to work in the break-down region. It is used in voltage regulators.

Procedure :

1. Connect the milliammeter and voltmeter of suitable range.

2. Connect the negative lead of the voltmeter to point C. By connecting positive lead to point 'A', read the input dc voltage. By connecting positive lead to point B, read the voltage V_Z across the zener diode.

3. Switch on the power supply. Increase slowly the supply voltage in steps. Measure the voltages V_I and V_Z and current I_Z. Once break down occurs, V_Z remains fairly constant even through V_1 increases. However I_Z will also increase with rise in input voltage.

4. Plot the graph between V_Z and I_Z, to obtain V-I characteristics of the zener diode. A typical zener diode characteristics are shown in fig. P-16.

Observations :

S.No.	V_I (Volts)	V_Z (Volts)	I_Z (mA)
1.			
2.			
3.			
4.			

V-I Characteristics :

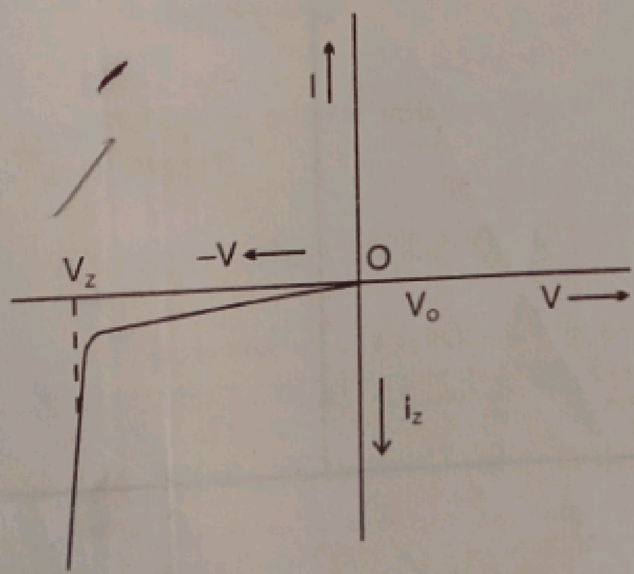


Fig. P-16 VI characteristics of zener diode.

Part B. **Use of zener diode as voltage regulator**

Brief Theory : Circuit for use of zener diode as a voltage regulator is shown in fig. P-14. As a voltage regulator zener diode gives a constant D.C. output with variations in input voltage and/or load.

Procedure:

1. Connect the circuit as shown in fig P-14.
2. Connect the input D.C. supply.
3. As input voltage is increased, the output voltage is equal to input voltage till zener break down takes place. Zener break down voltage depends upon the zener diode used. Note down this voltage.
4. After zener breakdown takes place, the output voltage will become constant, even after increasing input voltage. Note change in voltage (if any).
5. With change in input voltage, change the value of load resistance. Note down change in output voltage with new value of load resistance. Keeping input voltage constant.

Observations :

(a) When $R_L = 1k$

Zener break down voltage of diode= volts

S.No.	Input DC voltage	Output voltage
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

S.No.	Input DC voltage	Output voltage
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Note : Repeat the experiment with R_L=10k for same value of input voltage.

Calculation :

$$\% \text{ voltage regulation} = \frac{\text{(Change in output voltage after zener break down)}}{\text{Input voltage}}$$

$$\% \text{ Load regulation} = \frac{\text{(Change in output voltage with Change in } R_L \text{ from 1k to 10k)}}{\text{Input voltage}} \times 100$$

Results:

It will be observed that change in output voltage due to change in input voltage or change in load resistance is very small.

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EXPERIMENT NO. 4

Aim : (i) Calculate the ripple factor and observe the waveshape of following (a) Half wave rectifier (b) Centre tap full wave rectifier (c) Bridge rectifier

(ii) Plot the output wave form of half wave & full wave rectifier with and without the following filters.

(1) Shunt capacitor filter

(2) Series inductor filter

(3) π–filter

(i) (a) Half wave rectifier:

Apparatus required:

Half wave rectifier circuit, a CRO, an electronic/analog multimeter.

Circuit diagram:

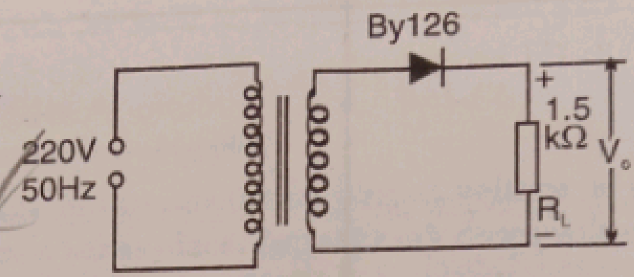


Fig. P-17

Brief theory: A diode is a unidirectional device. It conducts only when its anode is at a higher voltage with respect to cathode. In half wave rectifer, circuit conducts during positive half cycle of the input. The diode gets forward biased and conducts. Current flows through the load resistor R_L and voltage is developed across it. During negative half cycle of the input, diode gets reverse biased. No current (except a smalleakage current) flows. The voltage across the load resistance during this period of input cycle is zero.

$V_{dc} = \frac{V_m}{\pi}$ where, V_{dc} is the output dc voltage and V_m is peak ac voltage at the input of rectifier circuit.

$$\text{Ripple factor} = \frac{\text{ac voltage at the output}}{\text{dc voltage at the output}} = 1.21$$

Procedure:

1. Connect the primary side of the transformer to the ac mains. Connect the CRO probe to the output points. Adjust different knobs of the CRO so that a good and stable waveform is visible on its screen. Plot this wave form. Connect the CRO probes at the input points of the rectifier. Note the waveshape of the signal. Compare.

2. Connect a multimeter to measure the ac RMS voltage at the secondary terminals of the transformer. Also measure the AC and DC voltages at the output points using multimeter/voltmeter. Peak value of AC can also be measured on CRO.

3. Multiply this rms value by $\sqrt{2}$ to get the peak value. Calculate the theoretical value of dc voltage using relation.

$$V_{dc} = \frac{V_m}{\pi}$$

Compare this value with the measured value of output dc voltage. Note the difference.

4. Using the measured values of dc and ac output voltages, calculate ripple factor. This value should be nearly 1.21.

Observations:

(a) AC voltage at the input = ...V

(b) DC voltage at the output = ...V

(c) AC voltage at the output = ...V

Verification of theoretical formula:

Quantity	Theoretical Value	Practical Value
1. Output dc voltage		
2. Ripple factor	1.21	

Wave shapes

Fig. (i) P-18

Fig. (ii) P-19

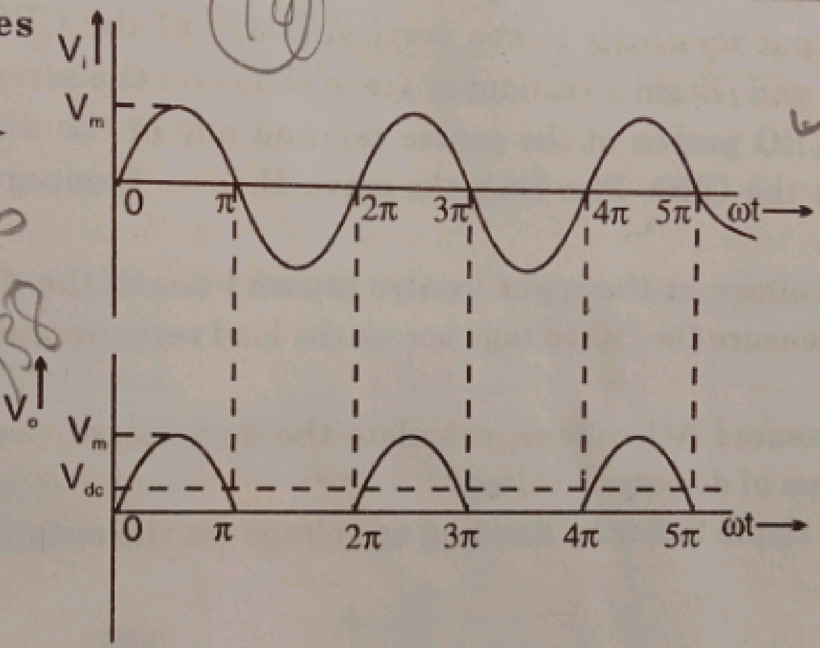


Fig. P-18 Input voltage wave form; Fig. P-19 Output voltage waveform.

(b) Centre tapped full wave rectifier :

Apparatus required:

Full wave rectifier circuit CRO, an electronic/analog multimeter.

Circuit diagram:

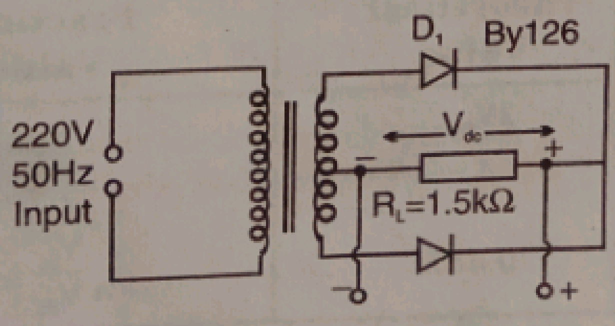


Fig. P-20

Brief theory : In a full wave rectifier, there are two diods, a transformer and a load resistor. The transformer has a centre tap at the centre of secondary winding.

Current flowing through the load resistor R_L flows in the same direction in both the half-cycles. The dc voltage obtained at the output is given as:

$$V_{dc} = \frac{2V_m}{\pi}$$

Where V_m is peak value of the ac voltage between the centre tap point and one of the ends of transformer. Ripple factor of a full wave rectifier is 0.482.

Procedure :

1. Connect the circuit as shown in the diagram above.
2. Connect the mains voltage to the primary of centre tapped transformer.
3. Connect the output terminals to the vertical plates of the CRO.Adjust different knobs of CRO and obtain a stationary wave shape on the screen.
4. Connect the CRO probes at the centre tap and one of the diodes. Observe the waveshape on the CRO. Plot both the wave shapes. Compare the two voltage wave shapes.
5. Measure AC voltage at the input (centre tap and one of the diodes) and output points. Also measure the DC voltage across the load resistor using multimeter/d.c. voltmeter.
6. From the measured AC voltage, calculate the dc voltage. Compare it with the measured value of dc output voltage.
7. Calculate the ripple factor by dividing ac voltage (at the output) by dc voltage at the output.

Observations :

(a) AC voltage at the input points (between centre tap and one of the diodes) = ...V

(b) AC voltage at the output points = ...V

(c) DC voltage at the output points = ...V

Verification of the formula

Quantity	Theoretical Value	Practical Value
1. Output dc voltage	$\frac{2V_m}{\pi} =$	
2. Ripple factor	0.482	$\frac{V_{ac}}{V_{dc}} =$

Wave Shapes :

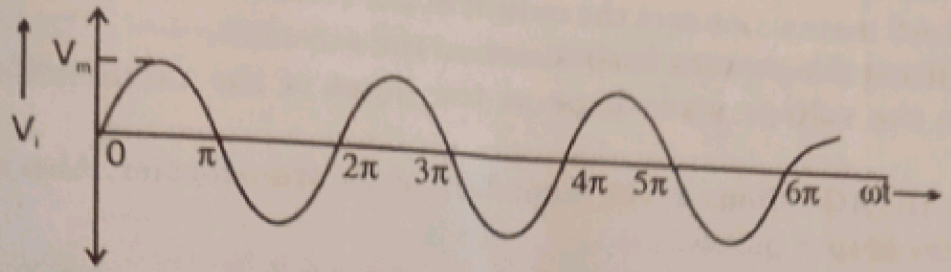


Fig. P-21. (i) Input voltage wave form;

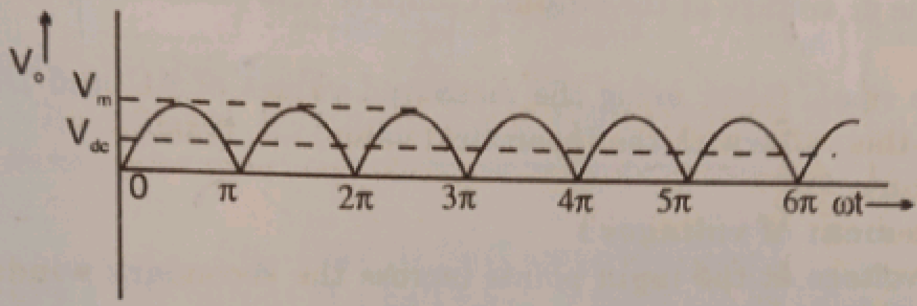


Fig. P-21 (ii) Output voltage waveform.

(c) Bridge rectifier :

Apparatus required:

Bridge rectifier circuit, CRO and electronic multimeter.

Circuit diagram:

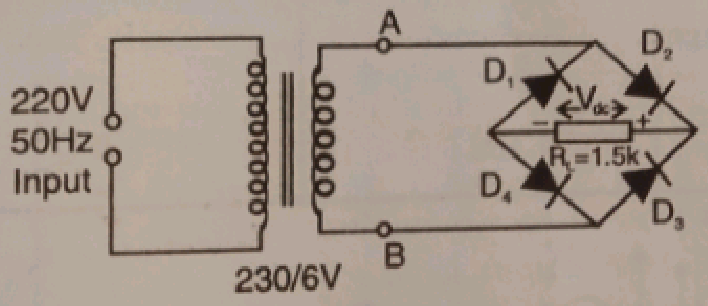


Fig. P-22 Bridge ractifier circuit.

Brief theory : Bridge rectifier circuit uses four diodes, transformer and a load resistor. When the input voltage is positive at point A, diodes D_2 and D_4 conduct. The current passes through the load resistor R_L. During the -ve half of the input signal, the diodes D_1 and D_3 conduct. The current passes through the load resistor in the same direction as it was in the positive half-cycle. DC voltage is developed across the load. Output dc voltage

$$V_{dc} = \frac{2V_m}{\pi}$$

Where V_m is the peak ac voltage at the input of the rectifier. For full wave rectifier ripple factor = 0.482.

Procedure :

1. Connect AC mains. Connect the output of the rectifier to the CRO. Adjust different knobs of CRO till a stable pattern is obtained on the screen.

2. Observe the voltage waveshape at the input of the ractifier.Compare the two waveshapes.

3. Measure the AC voltage at the secondary of the transformer. Also measure AC and DC voltages at the output points.

4. Using $V_{dc} = \frac{2V_m}{\pi}$

Calculate the dc voltage at the output. Compare this value with the measured value of dc voltage.

5. Calculate ripple factor using the measured values of AC and DC voltage at the output. Compare this value with the theoretical value, *i.e.*, 0.482.

Observations:

1. Measurement of voltages :

(a) AC voltage at the input points (across the secondary winding terminals) = ...V

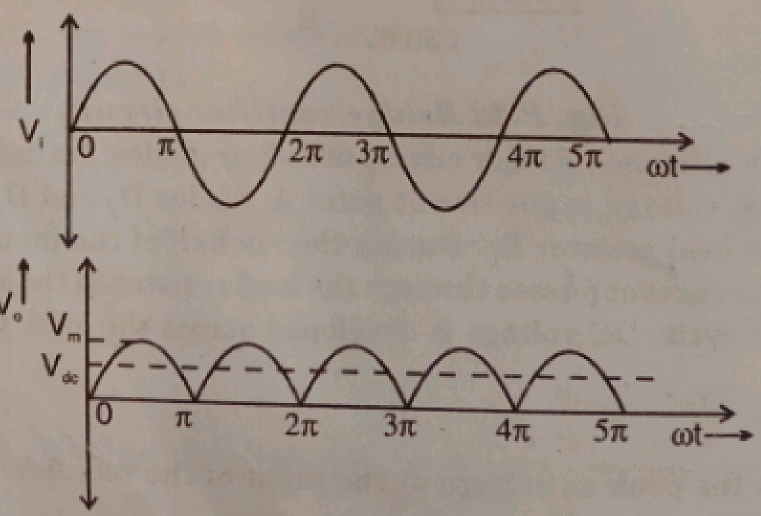
(b) AC voltage at the output points = ...V

(c) DC voltage at the output points = ...V

2. Verification of the formula :

Quantity	Theoretical Value	Practical Value
1. Output dc voltage	$\frac{2V_m}{\pi} =$	
2. Ripple factor	0.482	$\frac{V_{ac}}{V_{dc}} =$

3. Wave shapes :



P-23. Waveshape of input & output voltages.

(ii) Waveshapes with different filters in circuit :

Apparatus required:

Rectifier circuit with different filters, a CRO and an electronic/analog multimeter.

Circuit diagram:

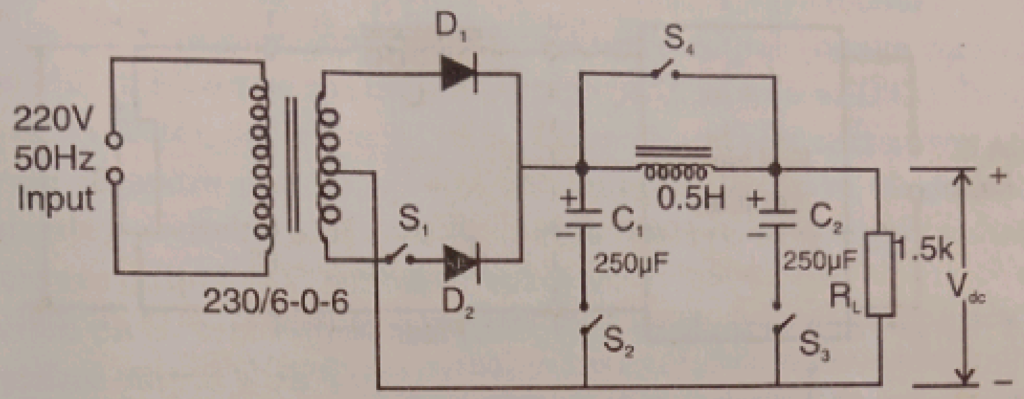


Fig. P-24 (i) Full wave rectifier.

Brief theory : The output of a half wave or full wave rectifier contains an apprec able amount of AC voltage in addition to dc voltage. But, it should be pure dc without an ac voltage in it. The AC variations can be filtered out or smoothed out from the rectifie voltage by filter circuits.

In a shunt capacitor filter, a high value capacitor in shunted with the load. Capacit offers a low impedance path to the ac components of current. Most of the AC current passe through the shunt capacitor. All the dc current passes through the load resistor. The c pacitor maintains a constant output voltage at output.

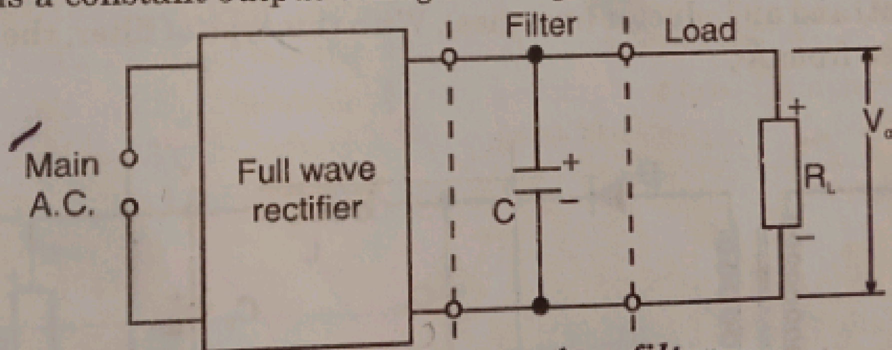


Fig. P-24 (ii) Capacitor filter.

Wave shape :

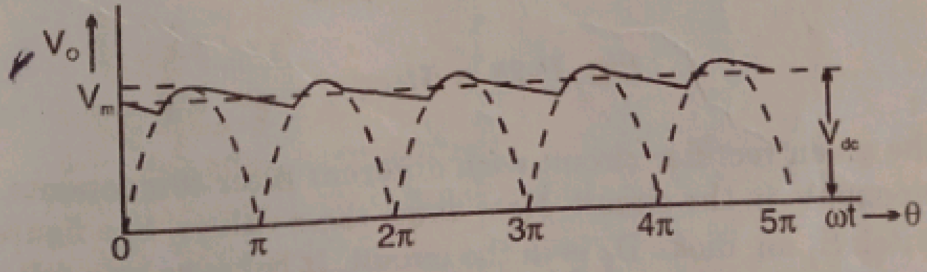


Fig. P-25 Full wave rectifier with shunt capacitor filter.

In a series inductor filter, an inductor is connected in series with the load. The inductor offers high impedance to ac variations of current and low resistance to D.C. Hence output across the load has very low ac content. The output becomes better D.C. still it is not exact D.C.

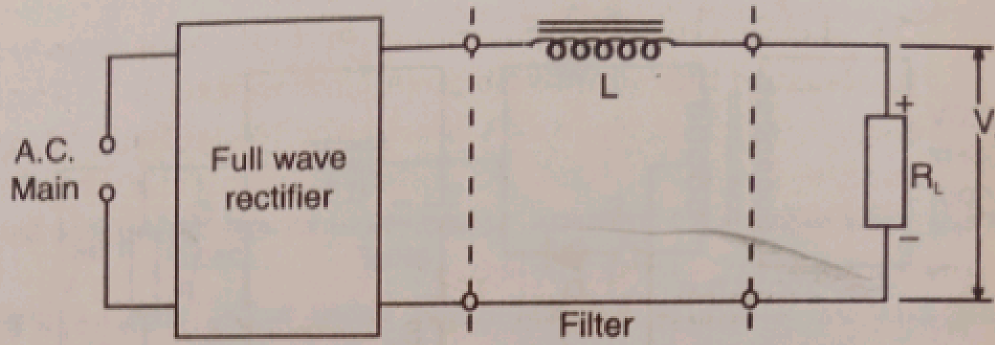


Fig. P-26 L Filter circuit.

Wave shape :

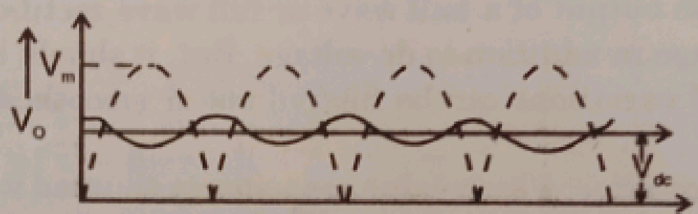


Fig. P-27 Full wave rectifier output with series inductor filter.

A π-filter utilizes the filtering properties of both the inductor and capacitor. It has two capacitors (in shunt) and an inductor (in series). With this type of filter, the rectified output becomes almost free from AC.

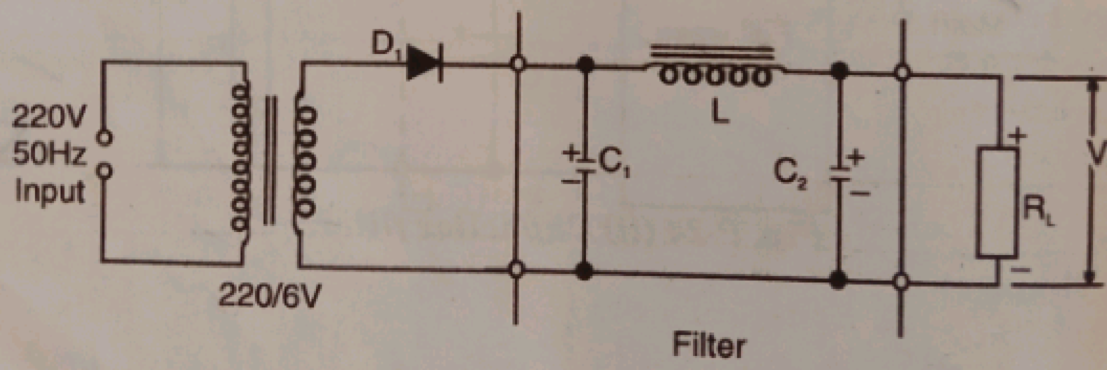


Fig. P-28 π filter.

Procedure :

1. Trace the given rectifier circuit with different filter components. Identify various components in the circuit. Note down their values. See figure P-24(i)
2. With switch S_1 on, diode D_2 is in the circuit. It behaves as a full wave rectifier. When switch S_1 is open, it becomes a half wave rectifier. By closing switches S_2

and S_3, the capacitors C_1 and C_2 respectively can be connected into the circuit. If the switch S_4 is closed, the inductor L becomes out of circuit (the whole of the current passes through the closed switch S_4). When S_4 is open, the inductor comes in series with the load resistor R_L.

3. When switch S_1 is open, the circuit becomes a half wave rectifier, open the switches S_2 and S_3, and close the switch S_4. Observe output voltage waveshape on CRO and plot it. Measure the output voltage (A.C. as well as D.C.). To obtain a shunt capacitor filter, switch on S_2 or S_3. Observe and plot output voltage waveshape. Again measure output AC and DC voltages. To have larger values of shunt capacitor, switch on S_2 and S_3. Again observe the output voltage waveform. Measure output D.C. and A.C. voltages.
4. Switch on S_1 and repeat the above step to observe wave shape for a full wave rectified output with filters.
5. Switch off S_1, also switch off S_2, S_3 and S_4. It becomes a half wave rectifier with series inductor filter. Observe and plot the output wave form. Measure the output voltages (A.C. as well as D.C.).
6. Switch on S_1 and repeat the above.
7. Switch off S_1 and switch on S_2 and S_3. It becomes a half wave rectifier with P-filter. Observe and plot the output-voltage wave form. Measure output voltage (AC as well as DC).
8. Switch on S_1 and repeat the above.
9. Measure the ac voltage between the centre tap and one of the end terminals of the secondary of the transformer. From this, calculate the peak value V_m of the input voltage. Keeping the switch S_1 open, make a shunt capacitor filter by switching on S_2. Measure the output d.c. voltage. Compare it with V_m. Now switch on S_3. Again measure the output dc voltage.
10. Switch on S_1 and repeat the above steps.

Observations:

1. Filters :

Rectifier Type	Type of Filter	V_{ac} (Volts)	V_{dc} (Volts)
Half wave	1. No filter 2. Shunt capacitor filter 3. Series inductor filter 4. π-filter		
Full wave	1. No filter 2. Shunt capacitor filter 3. Series inductor filter 4. π-filter		

2. Input ac voltage, V_{rms} = ...V (rms)

Peak value, V_m = ...$V_{rms} \times \sqrt{2}$ = ...V

Output dc voltage when shunt capacitor filter is used in half wave rectifier circuit = ...V

Output dc voltage when shunt capacitor filter is used in full wave rectifier = ...V

EXPERIMENT NO. 5

Aim : Plot the input and output characteristics of transistor in common base configuration and calculate the input resistance. Output resistance, DC current gain and AC current gain from the characteristics curves.

Apparatus :

Experimental board, transistors, power supply (0-30V), Two milliammeters (0 to 50 mA), two electronic multimeters, voltmeter 0-1.5V, 0-10V.

Circuit diagram :

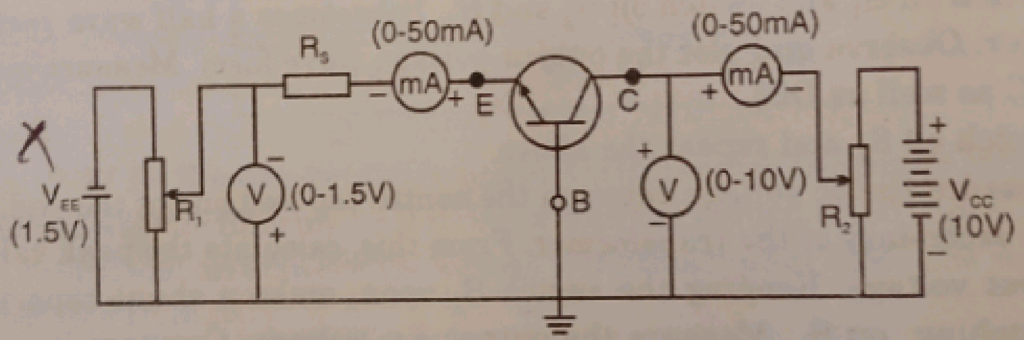


Fig. P-29 CB Transistor Characteristics

Brief theory : A transistor is a three terminal device named emitter, base and collector. In common base configuration, base is common to both input and output. The emitter base junction is forward biased and the collector base junction is reverse biased.

The input characteristics is a plot between I_E and V_{EB} keeping voltage V_{CB} constant. This characteristic is similar to that of a forward biased diode. The input dynamic resistance is calculated using the formula

$$r_i = \left.\frac{\Delta v_{EB}}{\Delta i_E}\right| V_{CB} = \text{constant}$$

The output characteristic curves are ploted between I_C and V_{CB}, keeping I_E constant. These curves are almost horizontal.

The output dynamic resistance is very high

$$r_o = \left.\frac{\Delta V_{CB}}{\Delta I_C}\right| I_E = \text{constant}$$

The collector current I_C is almost equal to the emitter current. The current I_E divides into I_C and I_B.

$$I_E = I_C + I_B$$

When the output side is open, $I_E = 0$, the collector current is not zero. It has a small value. This value of collector current is called collector reverse saturation current, I_{CBO}.

At a given operating point, the DC and AC current gains (alpha) as follows:

dc current gains, $\alpha_{dc} = I_C / I_E$

ac current gain, $\alpha = \left.\dfrac{\Delta I_C}{\Delta I_E}\right| V_{CB} = \text{constant}$

Procedure :

1. From the experimental board, note down the type and number of the transistor. Note the important specifications of the transistor from the data book. Identify the terminals of the transistor and trace the circuit.
2. Make the circuit connections as shown in diagram.
3. For input characteristics, fix the voltage V_{CB}, say at 4V. Now vary the voltage V_{EB} slowly and note the current I_E for each value of V_{EB}.
4. Repeat step 3 for another value of V_{CB} say, 8V.
5. For output characteristics, fix the collector voltage, say at 6V. Open the input circuit. Measure the collector current by using a micro-ammeter. Vary the collector voltage in steps and note collector current for each value of collector voltage. Draw curve for reverse saturation current. Close the input circuit. Adjust the emitter current I_E to, say 1mA with the help of potentiometer R_1. Vary the voltage V_{CB} in steps. Note current I_C for each value. Repeat this process for 3 to 4 different values of emitter current (say 2mA, 3mA etc.). Donot exceed the maximum ratings of the transistor as seen from data book.
6. Plot the input and output characteristics by using the reading taken above.
7. Select a suitable operating point well within the active region (say $V_{CB} = 6V$, I = 3mA). At this operating point draw a tangent to the curve of input characteristics. The slope of this curve gives the input dynamic resistance. Similarly, by drawing tangent to the output characteristics curve gives the output dynamic resistance.
8. To determine DC alpha, divide the DC collector current at the selected operating point by the DC emitter current as taken from curve.
9. To determine ac alpha, draw a vertical line through the selected operating point on the output characteristics. Take a small change in I_E (say 1mA) around the operating point and from the graph, measure corresponding change in I_C. Divide the change ΔI_C by ΔI_E.

Observations :

1. Type number of the transistor = ...
2. Information from data book:

(a) Maximum collector current rating = ...mA

(b) Maximum collector to emitter voltage rating = ...V

(c) Maximum collector dissipation power = ...W

3. Input characteristics:

S.No.	V_{CB} = 6V	
	V_{EB} in V	I_E in mA
1.		
2.		
3.		

V_{CB} = 10V	
V_{EB} in V	I_E in mA

4. Output characteristics :

S.No.	$I_E = 0$		I_E = 1 mA		I_E = 2mA		I_E = 3mA	
	V_{CB} (V)	I_C (mA)	V_{CB} (V)	I_C (mA)	V_{CB} (V)	I_C (mA)	V_{CB} (V)	I_C (mA)
1.								
2.								
3.								
4.								

Calculations:

1. Input dynamic resistance,

$$r_i = \left.\frac{\Delta V_{EB}}{\Delta I_E}\right| V_{CB} = \text{.............V}$$

2. Output dynamic resistance,

$$r_o = \frac{\Delta V_{EB}}{\Delta I_C} = \text{.............k}\Omega$$

I_E = ...mA

3. DC current gain, $\alpha_{dc} = \frac{I_C}{I_E} =$ ....

4. AC current gain, $\alpha = \frac{\Delta I_C}{\Delta i_E} =$ ....

V_{CB} = ...V