BEE Experiments Record.

8. WAVE-SHAPING CIRCUITS (FULL-WAVE, HALF-WAVE RECTIFIERS & CLIPPERS).

☆ PRE-LAB QUESTIONS (Rectifiers) ⟹

① What is the necessity of rectifiers?

→ As we know, all electrical appliances use a DC power supply from AC power. Rectifiers are used inside the power supplies of almost all electronic equipment. In power supplies, the rectifier is normally placed in series following the transformer.

② What is PIV of a diode in Full-wave Rectifier (FWR) and Half-wave Rectifier?

→ Peak Inverse Voltage (PIV) is the maximum voltage that the diode can withstand during reverse-biased condition. If a voltage is applied more than the PIV, the diode will be destroyed.

③ What is ripple factor? Why it is required?

→ RIPPLE FACTOR ⟹

It is defined as the ratio of RMS value of AC component to the DC component in rectifier output.

$$\therefore \text{Ripple Factor} = \frac{\text{RMS Value of AC Component}}{\text{DC Component}}$$

SIGNIFANCE ⟹

1) When fluctuation occurs within the output of the rectifier then it is known as ripple.
2) So, this factor is essential to measure the rate of fluctuation within the resolved output.
3) The ripple within output voltage can be reduced by using filters like capacitive or another kind.

④ Why are filters connected at the output of rectifiers?

→ The filter is a device that allows passing the DC component of the load and blocks the AC component of rectifier output. Thus, the output of filter circuit will be steady DC voltage. Capacitor is used so as to block the AC and allow DC to pass.

⑤ What are the types of rectifiers of filters? And which is better and why?

→ The types of filters are:

1) Series Inductor Filter.
2) Shunt Capacitor Filter.
3) L-C Filter.
4) π - Filter.

The better filter among the four is π - filter as several identical circuits (sections) can also be added to this, according to requirement. Also, we get desired pure DC output at the load.

Ⓐ SINGLE PHASE HALF - WAVE RECTIFIER.

★ AIM ⟹

To construct a half-wave rectifier using diode and to draw its performance characteristics.

★ APPARATUS REQUIRED ⟹

1) Transformer = 230/(6-0-6) V → 1
2) R.P.S = (0-30) V → 2

★ COMPONENTS REQUIRED ⟹

1)	Diode	= IN 4007	⟶	1
2)	Resistor	= 1K Ω	⟶	1
3)	Bread board	= -	⟶	1
4)	Capacitor	= 100 μF	⟶	1
5)	CRO	= -	⟶	1

★ FORMULAE ⟹

• Without Filter :

1) $V_{rms} = \frac{V_m}{2}$

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

3) Ripple factor $= \sqrt{(V_{rms} / V_{dc})^2 - 1}$

4) Efficiency $= \left(\frac{V_{dc}}{V_{rms}}\right)^2 \times 100$

• With Filter :

1) $V_{rms} = \sqrt{(V_{rms}^2 + V_{dc}^2)^2}$

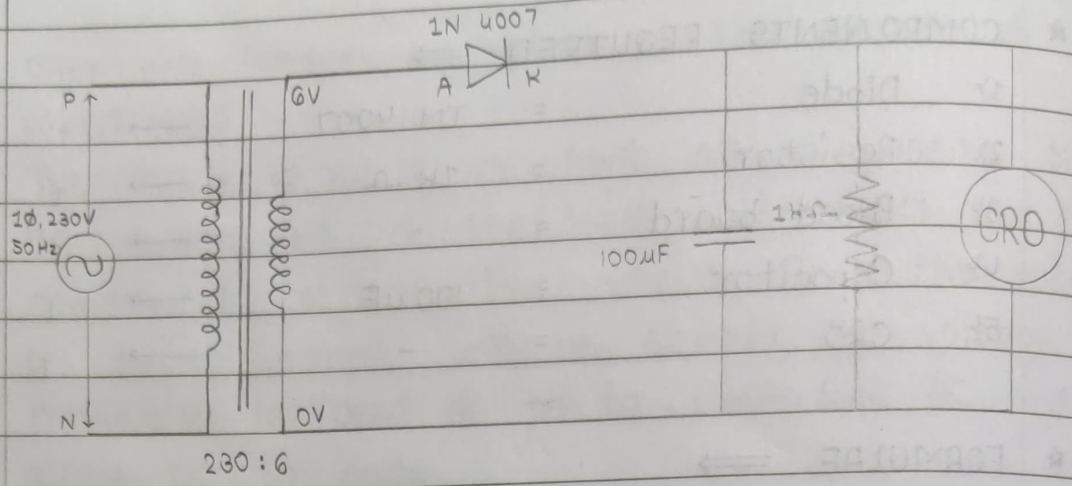
2) $V_{rms} = V_{rpp} / (\sqrt{3} \times 2)$

3) $V_{dc} = \frac{V_m - V_{rpp}}{2}$

4) Ripple factor $= \frac{V_{rms}}{V_{dc}}$

★ CIRCUIT DIAGRAM ⟹

⟶



★ TABULAR COLUMN ⟹

· Without Filter :

Vm (V)	Vrms (V)	Vdc (V)	Ripple Factor	Efficiency
6	3	1.91	1.21	39.69

· With Filter :

Vrpp (V)	Vrms (V)	Vdc (V)	Ripple Factor
4.561	1.31	0.4315	3.035

★ CALCULATIONS ⟹

1) Ripple Factor (without filter).

So, $R \cdot F = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$

$\therefore$ R.F $= \sqrt{\left(\frac{3}{1.91}\right)^2 - 1} = \sqrt{(1.57)^2 - 1}$

$= \sqrt{2.4649 - 1} = \sqrt{1.4649} = 1.21$

2) Efficiency (without filter).

so, Efficiency $= \left(\frac{V_{dc}}{V_{rms}}\right)^2 \times 100$

$= \left(\frac{1.91}{3}\right)^2 \times 100 = (0.63)^2 \times 100$

$= 0.3969 \times 100 = 39.69$

☆ RESULT $\Longrightarrow$

Thus, a half-wave rectifier using diode and its performance characteristics are studied and its efficiency (without filter) is 39.69

(B) SINGLE PHASE FULL-WAVE RECTIFIER.

☆ AIM $\Longrightarrow$

To construct a single phase full-wave rectifier using diode and to draw its performance characteristics.

☆ APPARATUS REQUIRED $\Longrightarrow$

1) Transformer = 230/(6-0-6) V $\longrightarrow$ 1
2) R.P.S = (0-30) V $\longrightarrow$ 2

☆ COMPONENTS REQUIRED $\Longrightarrow$

1)	Diode	= IN 4007	$\longrightarrow$ 2
2)	Resistor	= 1kΩ	$\longrightarrow$ 1
3)	Bread Board	= -	$\longrightarrow$ 1
4)	Capacitor	= 100μF	$\longrightarrow$ 1
5)	CRO	= 1Hz - 20MHz	$\longrightarrow$ 1

☆ FORMULAE ⟹

- Without Filter :

1) $V_{rms} = \frac{V_m}{\sqrt{2}}$

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

3) Ripple Factor $= \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$

4) Efficiency $= \left(\frac{V_{dc}}{V_{rms}}\right)^2 \times 100$

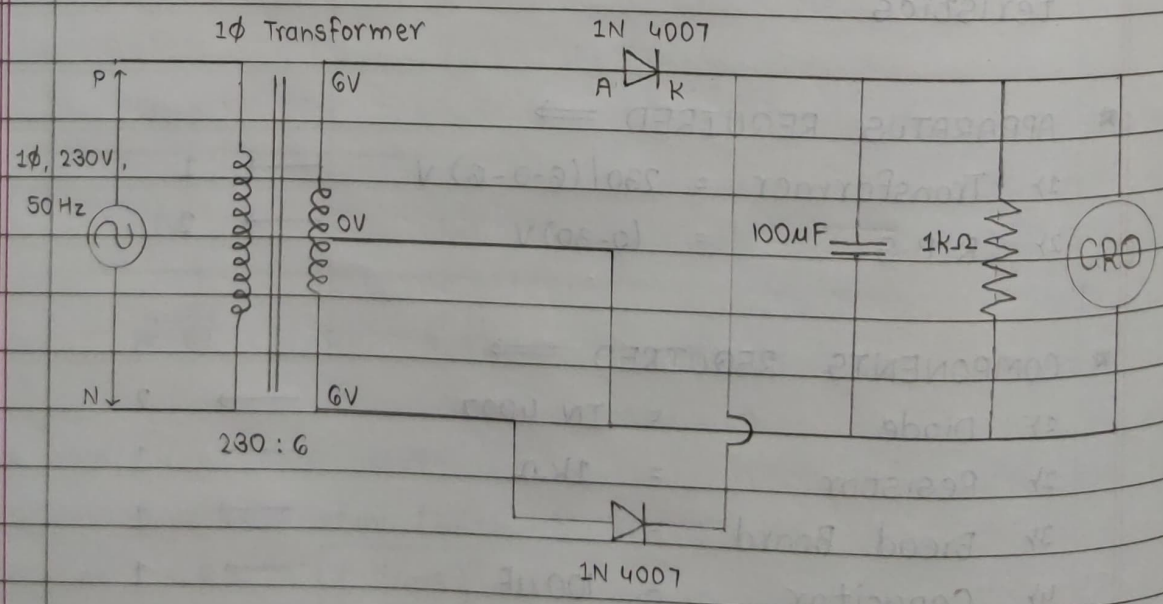
- With Filter :

1) $V_{rms} = \frac{V_{rpp}}{2\sqrt{3}}$

2) $V_{dc} = V_m - V_{rpp}$

3) Ripple factor $= \frac{V_{rms}}{V_{dc}}$

☆ CIRCUIT DIAGRAM ⟹



☆ TABULAR COLUMN ⟹

• Without Filter :

Vm (V)	Vrms (V)	Vdc (V)	Ripple Factor	Efficiency
6	4.25	3.82	0.4817	79.21

• With Filter :

Vrms (V)	Vrpp (V)	Vdc (V)	Ripple Factor
0.645 2.284	2.234	0.161	4.006

☆ CALCULATIONS ⟹

1) Ripple Factor (without filter).

So, $R.F = \sqrt{\left(\frac{Vrms}{Vdc}\right)^2 - 1}$

$= \sqrt{\left(\frac{4.25}{3.82}\right)^2 - 1}$ $= \sqrt{(1.11)^2 - 1}$

$= \sqrt{1.2321 - 1}$ $= \sqrt{0.2321}$ $= 0.4817$

2) Efficiency (without filter).

So, $Efficiency = \left(\frac{Vdc}{Vrms}\right)^2 \times 100$

$= \left(\frac{3.82}{4.25}\right)^2 \times 100$ $= (0.89)^2 \times 100$

$= 0.7921 \times 100$ $= 79.21$

☆ RESULT ⟹

Thus, a single phase Full-wave rectifier using diode and its performance characteristics is studied and its efficiency (without filter) is 79.21

☆ POST-LAB QUESTIONS ⟹

① What is Transformer Utilization Factor (TUF)?

→ The transformer Utilization Factor of rectifier circuit is defined as the ratio of DC power available at the load resistor to the AC rating of the secondary coil of a transformer.

$$TUF = \frac{P_{dc}}{V_A \text{ rating of transformer}}$$

The V_A rating of transformer can also be defined as: $V_A = V_{rms} \cdot I_{rms}$ (for secondary coil).
TUF for half-wave rectifier is 0.287 or 0.300

② Mention the value of ripple factor for half-wave rectifier, full-wave rectifier and rectifier with center tapped transformer.

→ The value of ripple factor for rectifiers is as follows:

1) Half-wave rectifier = 1.21
2) Full-wave rectifier = 0.48
3) Center-tapped transformer = 1.11

③ State the average and peak value of output voltage and current for full-wave rectifier and half-wave rectifier.

→ • Full-wave rectifier ⟹

1) Average Value = 3.82 V
2) Peak Value = 6V

• Half-wave Rectifier ⟹
1) Average Value = 1.91 V
2) Peak Value = 6V

④ What is the difference between uncontrolled rectifier and controlled rectifier? Which is advantageous and why?

→ The rectifier circuit using diodes only are called uncontrolled rectifier circuit. When SCRs (thyristor) are used to convert AC to DC, they have a controlled output voltage so it is called a controlled rectifier output. Unlike diodes, SCRs does not become conducting immediately after its voltage has become positive. So, of course, controlled rectifier is better as compared to uncontrolled rectifier.

★ PRE-LAB QUESTIONS (Clippers) ⟹

① What is wave shaping?

→ 1) A wave-shaping circuit is the one which can be used to change the shape of waveform from alternating current or direct current.
2) eg. a clipper circuit, is used to prevent waveform voltage from exceeding the predetermined voltage without affecting the remaining part of the waveform. This is nothing but waveshaping.

② What is the necessity of wave shaping?

→ The wave shaping is required for following purpose:

1) To hold the waveform to a particular D.C. level.
2) To generate one wave from the other.
3) To cut-off the positive and negative portions of the input waveform.
4) To limit the voltage level of the waveform of some presenting value and suppressing all other voltage levels in excess of the present level.

③ What are the differences between linear and non-linear wave shaping circuit?

→ • NON-LINEAR WAVE SHAPING CIRCUIT :

1) The non-linear elements like diodes are used in non-linear wave shaping circuits to get required altered outputs.
2) The process of producing non-sinusodial output waveforms from sinusodial input, using non-linear elements is called as nonlinear wave shaping.

• LINEAR WAVE SHAPING CIRCUIT:

1) Linear elements such as resistors, capacitors and inductors are employed to shape a signal in this linear shaping circuit.
2) A sine wave input has a sine wave output and hence the nonsinusodial inputs are more prominently used to understand the linear wave shaping.

④ Mention the applications of clipper and clamper.

→ The applications of clipper are as follows:

1) Clippers can be used as voltage limiters and amplitude selectors.
2) For the generation of new waveforms or shaping the existing waveform, clippers are used.
3) They are frequently used for the seperation of synchronizing signals from the composite picture signals.

The applications of clamper are as follows :
1) Clampers are frequently used in test equipment, sonar and radar systems.
2) They can be used for removing distortions.
3) For improving the overdrive recovery time clampers are used.
4) They can be used as voltage multipliers or voltage doublers.

© CLIPPERS.

★ AIM ⟹

To study the clipping circuits for different reference voltages and to verify the responses.

★ APPARATUS REQUIRED ⟹

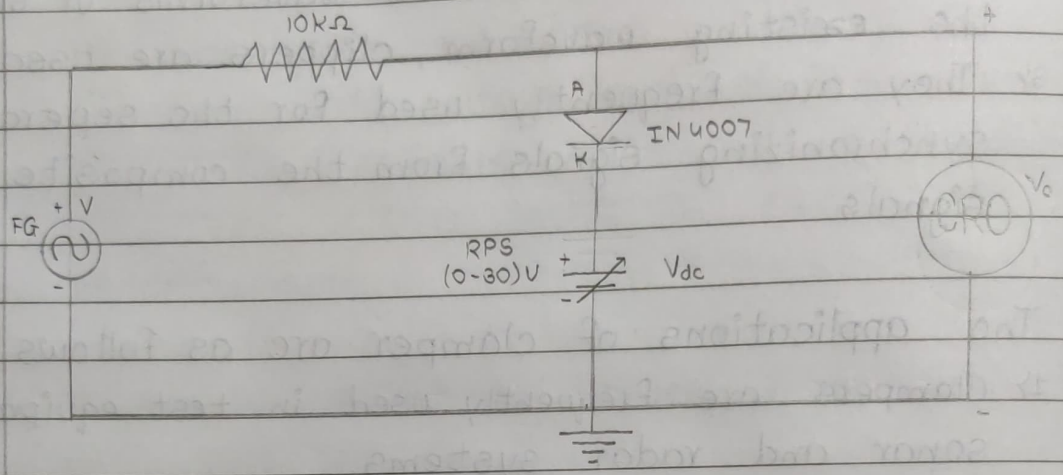
1)	CRO	=	1Hz - 20MHz	→ 1
2)	R.P.S	=	(0-30)V	→ 1
3)	Bread Board	=	-	→ 1
4)	Function Generator	=	1Hz - 1MHz	→ 1
5)	Connecting Wires	=	-	→ Req.

★ COMPONENTS REQUIRED ⟹

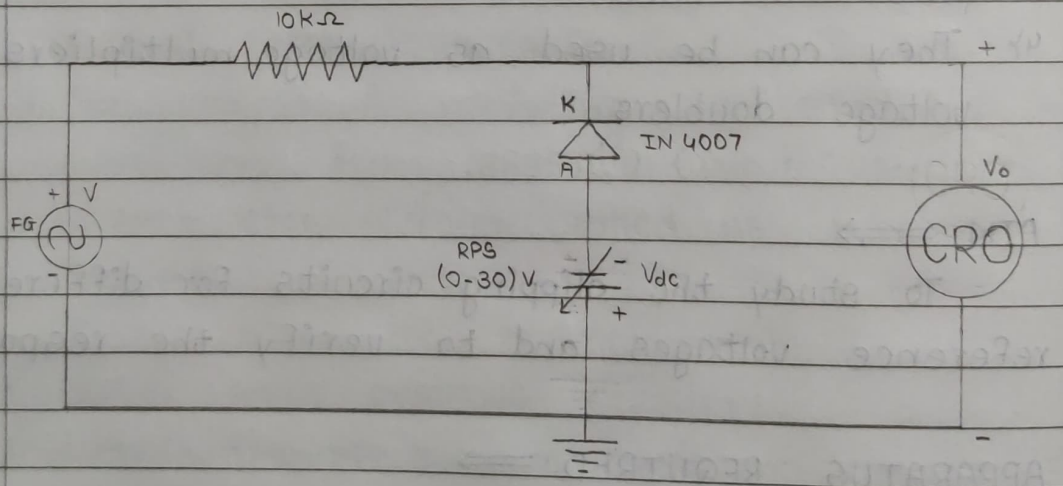
1)	Resistor	=	10kΩ	→ 1
2)	Diode	=	IN 4007	→ 1

☆ CIRCUIT DIAGRAM ⟹

1) Positive Clipper.



2) Negative Clipper.



☆ TABULAR COLUMN ⟹

Positive Clipper — Negative Clipper

Unbiased Clipper

Vref = 0V		Vref = 0V	
Output Voltage (V)	Time Period (ms)	Output Voltage (V)	Time Period (ms)
0.001715	–	9.554	–

Biased Clipper

Vref = 3V		Vref = 3V	
Output Voltage (V)	Time Period (ms)	Output Voltage (V)	Time Period (ms)
0.001715	-	6.573	-

☆ RESULT ⟹

The clipping circuits for different reference voltages are studied and its responses are verified.

☆ POST - LAB QUESTIONS ⟹

① What is the function of clampers?

→ A clamper is an electronic circuit that fixes either the positive or the negative peak excursions of a signal to a defined value by shifting its DC value. The clamper does not restrict the peak-to-peak excursion of the signal, it moves the whole signal up or down so as to place the peaks at reference level.

② Write the classification of clippers and clampers.

→ • Clippers can be broadly classified into two basic types of circuits.

1) Series clippers.
2) Parallel clippers.
3) Shunt clippers.

• Clampers can be broadly classified into two basic types of circuits.

1) Positive clampers.
2) Negative clampers.

③ Distinguish between +ve and -ve clippers.

→

	PARAMETERS	CLIPPERS	CLAMPERS
1.	Definition	Clipper delimit the amplitude of the output voltage.	Clamper shifts the DC level of the output voltage.
2.	Output Voltage	Less than the input voltage.	Multiples of input voltage.
3.	DC level	Remains same	DC level gets shifted.
4.	Shape of output waveform	Shape changes (rectangular, sinusodial, triangular, etc)	Shape remains same as input waveform.

④ What is the need of wave shaping circuit?

→ 1) The process by which nonsinusodial waveforms are altered in passing through the circuit elements (such as diodes, resistors, inductors and capacitors) is called waveshaping.

2) Waveshaping is important is most of the signal process systems and is performed by the circuits known as limiters, clippers, clampers, integrators and differentiators.