2.5

Regular Session & GROUP :	Wednesday, Afternoon (L8)
EXPT. NO:	FIVE (5)
DATE OF EXPT:	17/2/2016
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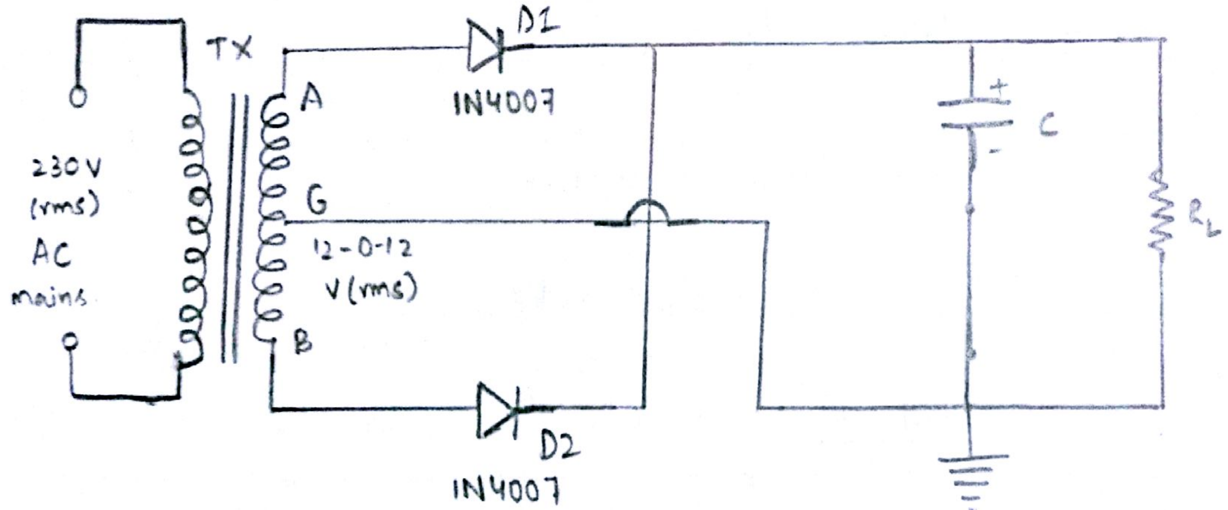
STUDENT-2:	K. Indramani (150107028)
TABLE NO:	FOURTEEN (14)

Objective→ Design and analysis of full-wave rectifier and Zener regulator.

Materials Required→ Beard Board, Oscilloscope, Transformer (230v). Diodes (2); Zener diode, Resistance (3); Capacitor.

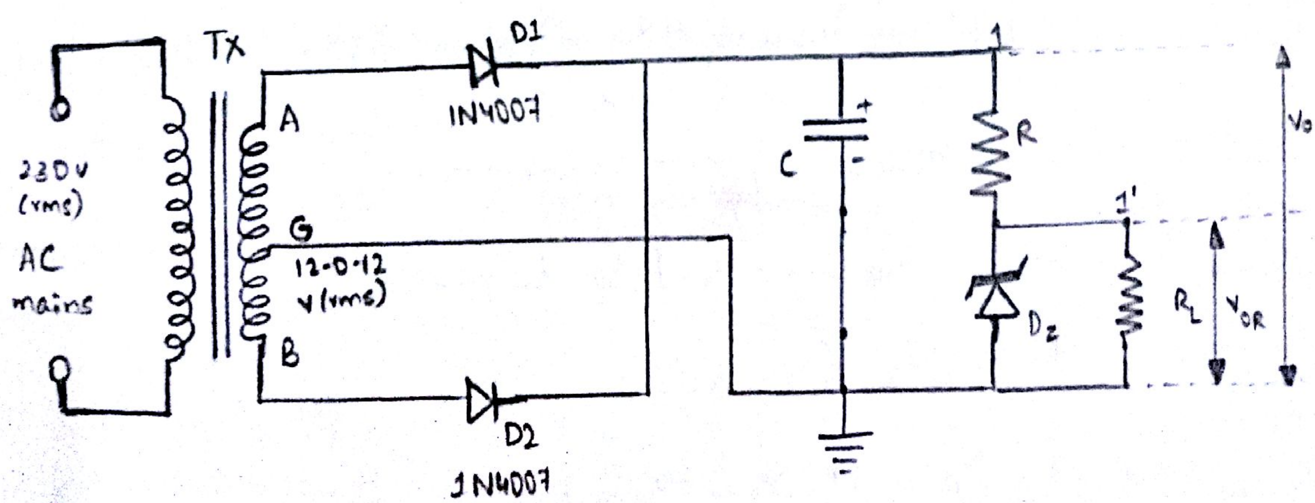
Circuit Diagrams→

PART-A



Power Supply using a Centre tapped transformer and full-wave rectifier.

PART-B



Regulated Power Supply with Zener diode.

OBSERVATIONS →

PART-A

Input peak voltage = **18v**

For rectifier peak voltage = 18V

Peak to peak ripple voltage of FWR with Capacitor (100 μF) Connected = 1.2V.

Peak to peak voltage at HWR = 2.4V.

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{18}{\sqrt{2}} = 12.72\text{v}.$$

$$\text{Ripple frequency (FWR)} = \frac{1}{10\text{ms}} = 100\text{ Hz}.$$

$$\text{Ripple frequency (HWR)} = \frac{1}{21\text{ms}} = 47.6\text{ Hz}.$$

PART-B

R_L	V_o max	V_r	V_{OR} max	V_{rR} (mv)	V_o av	V_{OR} av	I_R	I_L	I_Z	P_Z	P_R	% Reg
∞	15	1.04	6.2	2.4	14.48	6.2	14.46	0	14.46	89.6	209	0
1 KΩ	15	1.06	6.2	2.4	14.47	6.2	14.46	6.2	8.26	51.21	119	32%.
220KΩ	15	1.25	4	3.8	14.38	5.82	15.2	26.45	11.25	65.47	218	36%.

$$\% Reg = \left[\{(V_{OR\,av})_{NO\text{-}LOAD} - (V_{OR\,av})_{LOADED}\} / (V_{OR\,av})_{NO\text{-}LOAD}\right] \times 100$$

$$V_{o\,av} = V_{o\,max} - V_r/2$$

$$V_{OR\,av} = V_{OR\,max} - V_{rR}/2 \approx V_{OR\,max}$$

$$P_Z = V_Z I_Z \quad (V_Z = V_{OR\,av})$$

$$P_R = V_R I_R \quad (R = V_{o\,av} - V_{OR\,av})$$

ST. Experimental Analysis:

1) In the 1^{st} Part, while taking output voltage reading across R_L (without Capacitor filter) the observed waveform was coming out in the rectified form because the (+ve) terminal of the 1^{st} channel of Oscilloscope was connected and the (+ve) side of diode rather than an the (+ve) side which gave the required output.

2) While finding the ripple voltage, after setting the circuit for Capacitor filter, there where difference between peak to peak voltage of the wave because the (RO was set with 10v/div which was relatively high to observe this ripple voltage) after reducing V/div; the peaks were visible for Calculating the voltage difference.

RESULT→ % Reg for $R_L = \infty$ → % Reg = 0%.

= 1KΩ → % Reg = 32%

= 220kΩ → % Reg = 36%

Conclusion→

1) The output produced after Center tapping transformers V_{AG} & V_{BG} were 180° out of phase.

2) There was a difference (a little bit) in the Peek value at V_{in} & V_o (across R) FWR.

3) The ripple frequency of FWR was almost double at HWR.

4) Reg was decreased for increasing resistance in given love (Except ∞) or loaded (∞).

5) For loaded Cases . P_R Was higher . for small resistance.

Precautions →

1) Switch on the main supply . to the transformer, only after you have . made . all other . Connections.

2) While making . any change in . Circuit . switch the main supply to transformer.

3) Connect the .. Capacitor . with Correct polarity.

4) Connect the diode with Correct polarity.

5) . Ground the . probes of CRO while . measuring the voltage across . transformers as it may get changed . due to short Circuit .

6) Adjust the dc level of CRO prior . to peaks of the Circuit.

7) Discharge the Capacitor every time as it may gets charging and show Wrong peaks in the CRO.

Questions :-

1) The peak . amplitude . may be different because . the Centre top transformer may be . unsymmetric and the . no. of turns . across AG and BG . might be different . giving to different voltages.

2) The ripple voltage Was higher for HWR . as Compared . to a FWR.

$V_{R(P-P)}$. for FWR = 1.2V

$V_{R(P-P)}$ for HWR = 2.4V

Ripple frequency . in HWR = 47.6Hz

Ripple frequency in FWR = 100 Hz

We observed poor regulation for some I_L, because the current through the Zener was less than the minimum current at which the Zener diode break-down took place. Hence; it cannot maintain a constant voltage and it doesn't function as a regulator.

5) Given that;

$I_{Z(min)} = 5 mA$ $\quad P_{Z(max)} = \frac{1}{2} W$ $\quad V_Z = 6.2 V$

$$I_R = \frac{V_0 - V_Z}{R} = \frac{14 - 6.2}{560} \approx \underline{15.7 mA}.$$

6) For an even higher I_L. R & P_L are to be further reduced greatly.

$P_{Z(max)} = 0.5 W \Rightarrow V_Z I_{Z(max)} = 0.5 W \Rightarrow I_Z = 80.64 mA$

$I_R = I_Z$ max. (when $I_L = 0$) $= 80.64 mA$

$$R = \frac{15 - 6.2}{80.64 mA} \Leftarrow \frac{V_0 - V_Z}{R} \Rightarrow 109 \Omega$$

$I_R = I_{Z(min)} + I_{(max)} \Rightarrow 80.64 - 5 = \underline{75.64 mA}.$

7) When $R_2 \cdot l$;

$$\left[P = \frac{V^2}{R} = \frac{8.8 \times 8.8}{109} = \underline{710.4} \; mW\right]$$

8) Yes; we used the correct wattage resistances as the maximum power assumed by resistance was less than power wattage.

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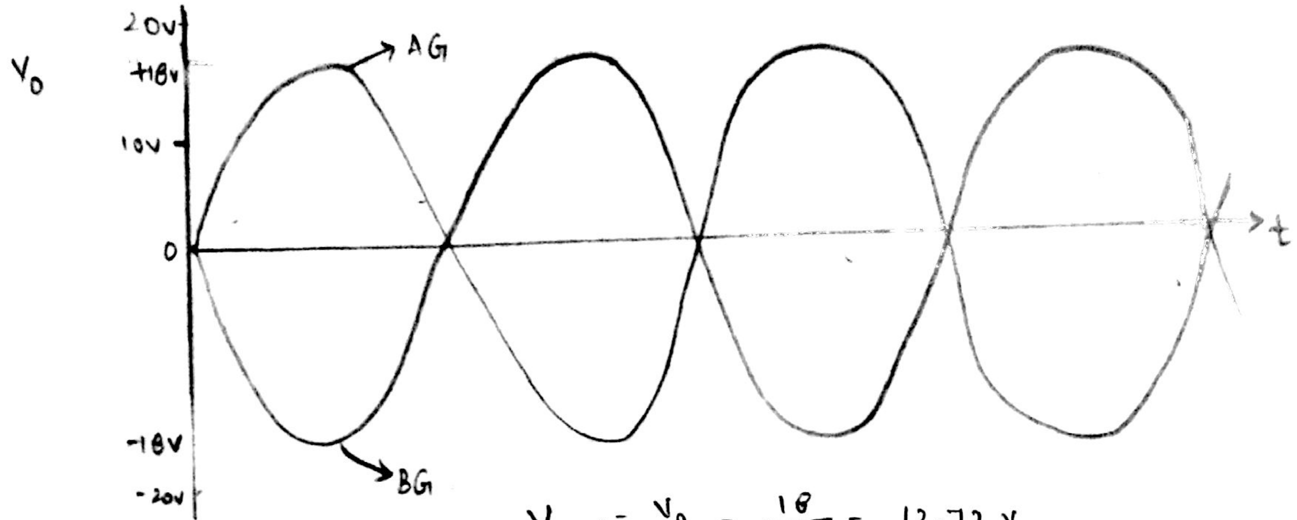
~~RE~~ OBSERVATIONS:

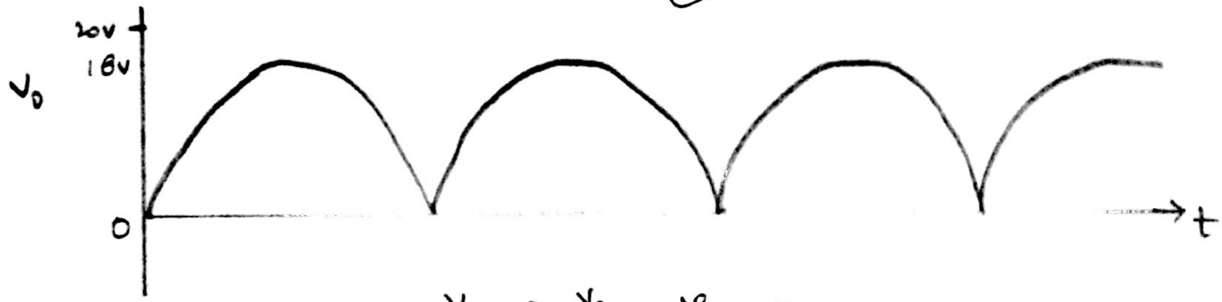
PART A →

i) Full-Wave rectifier (FWR)



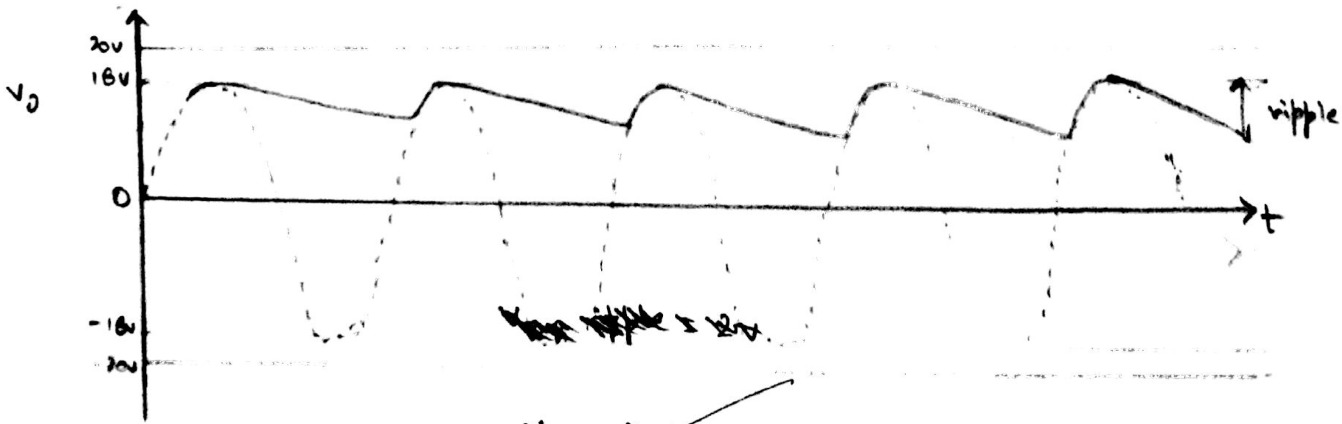
$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{18}{\sqrt{2}} = \underline{\underline{12.72\ V}}.$

v_0 Across R_L; without Capacitor;



$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{18}{\sqrt{2}} = \underline{\underline{12.72\ V}}.$

v_0 Across R_L with Capacitor;



V_{p-p} ripple $= \underline{\underline{1.2\ V}}$

Ripple frequency (FWR) $= \frac{1}{10ms} = \underline{100\ Hz}.$

ii) Comparision with Half-Wave rectifier (HWR):

a) $V_{ripple\ p-p}$ of HWR = 2.4 v.

b) Ripple frequency = $\frac{1}{T} = \frac{1}{21}$ = 47.6 Hz

PART-B:

R_L	$V_{o\ max}$	V_r	$V_{OR\ max}$	V_{rR} (mV)	$V_{O\ av}$	$V_{OR\ av}$	I_R	I_L	I_Z	P_Z	P_R	% Reg
∞	15V	1.04 V	6.2V	2.4mV								
1kΩ	15V	1.06 V	6.2V	2.4mv								
220Ω	15V	1.25 V	4V	3.8								

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17/02/2016

1) Full Wave Rectifier (FWR) →

Scale:
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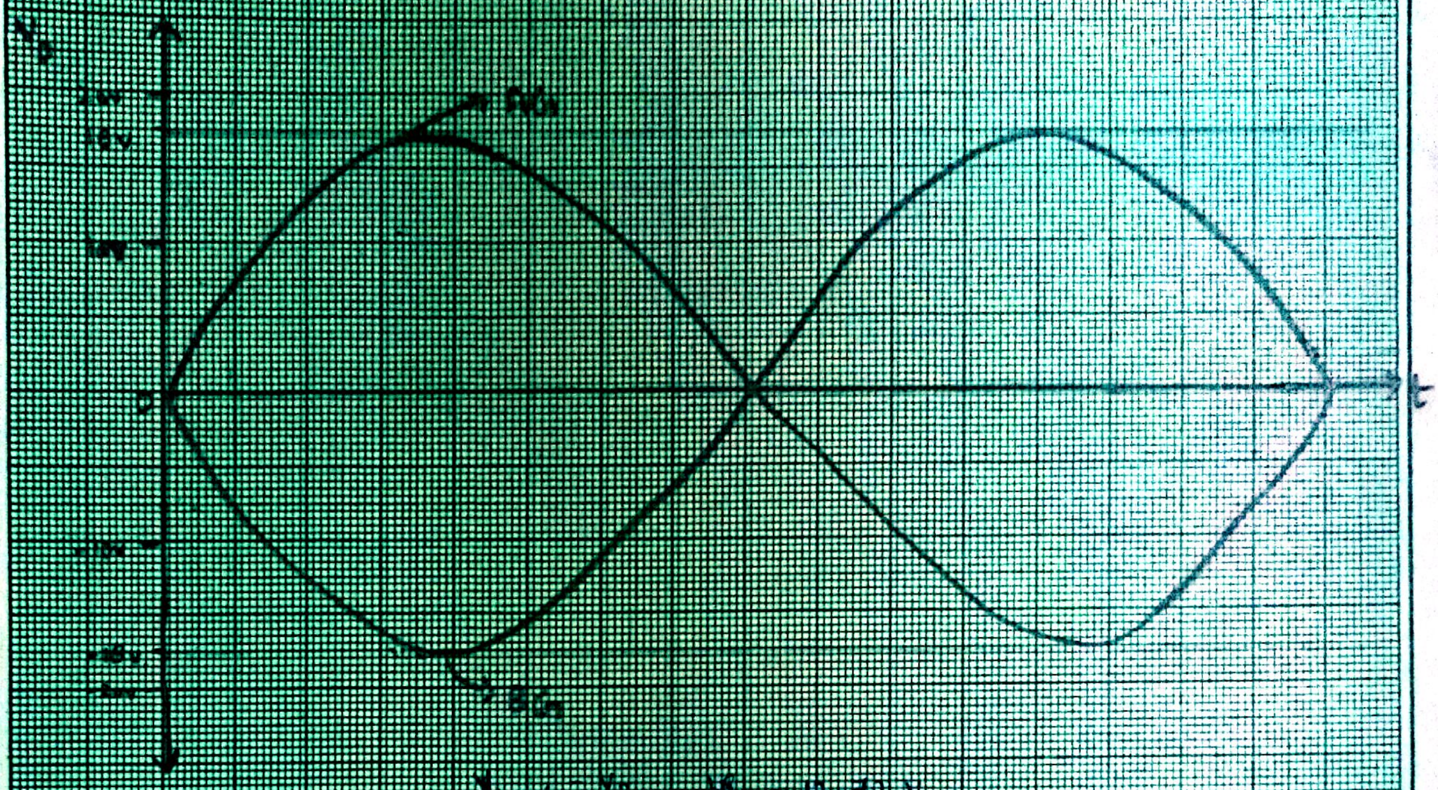
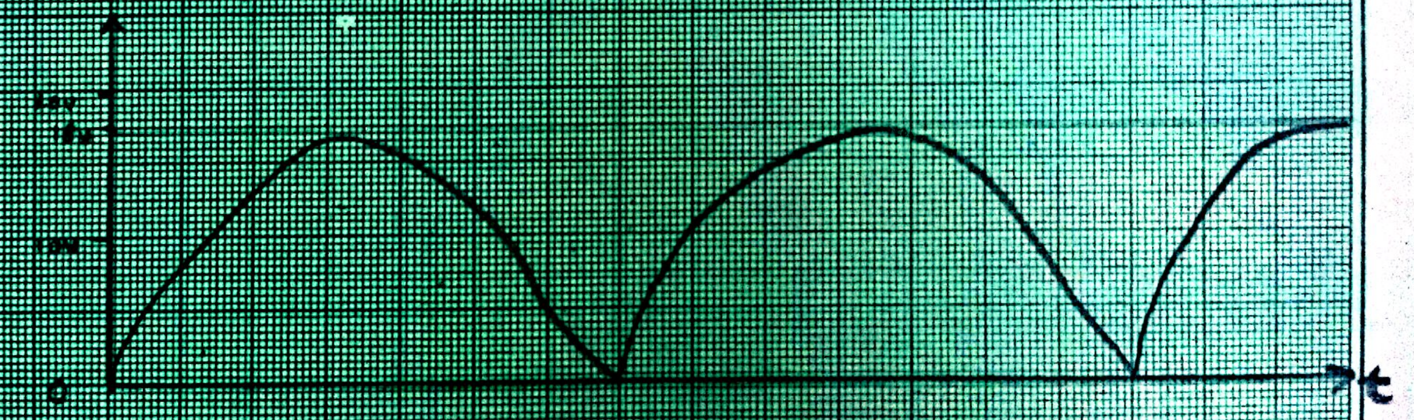


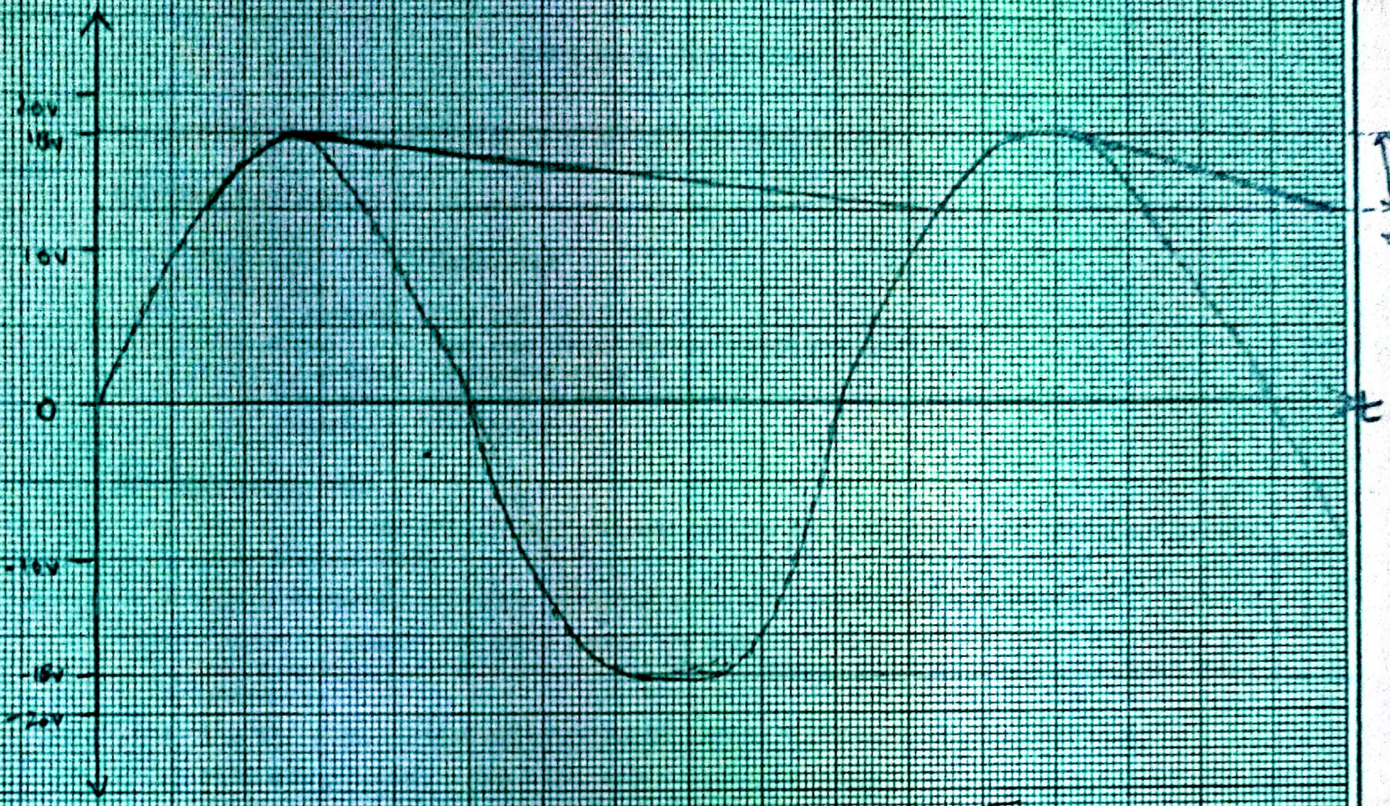
$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{18}{\sqrt{2}} = 12.72\,V$

[illegible]



$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{18}{\sqrt{2}} = 12.72\,V$

V_o Across R_L with Capacitor;



$V_{p\text{-}p}$ ripple = 1.2V

Ripple frequency (FWR) = $\frac{1}{10ms}$ = 100 Hz.

HWR ?

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EXPT. No. 5 : POWER SUPPLY

OBJECTIVES : Design and analysis of full-wave rectifier and zener regulator.

MATERIALS REQUIRED

- Breadboard
- Equipment : Oscilloscope
- Components :
  - Transformer : One: 230 V to 12–0–12 V
  - Diode : Two: Type 1N4007 (Forward voltage drop V_F = 0.7V)
  - Zener Diode : One: (Zener voltage V_Z = 6.2 V)
  - Resistance : Three: 220 Ω, 560 Ω, 1 kΩ
  - Capacitor : One: 100 μF.

GENERAL GUIDELINES

1. Switch on the mains supply to the transformer only after you have made all other connections (in order to avoid electric shock).
2. Also, while making any changes in the circuit, switch off the mains supply to the transformer.
3. Connect the capacitor with correct polarity. The capacitor being of electrolytic type, it is polarized, and will be damaged if connected with incorrect polarity. Similarly, confirm the polarity of the diodes before connecting.
4. Use "*line*" as the source of triggering in the oscilloscope. Put the oscilloscope in *CHOP* mode.
5. Never ever **ground** the probes of CRO while measuring the voltage cross transformer as it may get damaged due to shot-circuit. Adjust the dc level of CRO prior to connecting the probes to the circuit.

PART A : Unregulated Power Supply : Using center tapped Transformer and Full - Wave Rectifier (FWR)

i) Full-wave rectifier (FWR)

1. Set up the circuit as shown in Fig. 5.1 without the capacitor *C*. The transformer TX has rating of 230 V to 12-0-12 V,1 A. Take R_L = 1 kΩ. Connect transformer primary to the mains and switch on the mains. Display the secondary voltages V_{AG} and V_{BG} (V_{AG} to Ch-1, V_{BG} to Ch-2) on the oscilloscope. Make sure that both the "probe grounds" are connected to the circuit ground. Sketch the waveforms overlapping, with the same time and amplitude axes. They should be 180° out of phase.
2. Display and sketch the full-wave rectified output V_o across R_L. Measure the peak voltages in both halves.

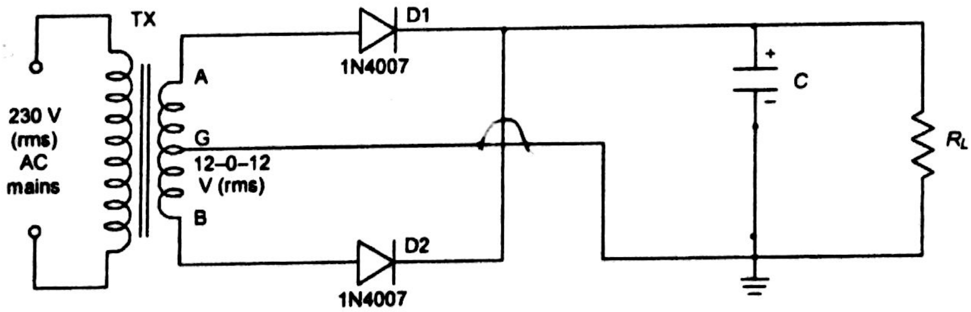

Fig. 5.1 Power supply using a centre tapped transformer and full-wave rectifier.

Q. 1 : If the peak amplitudes are not equal, what could be the reason?

3. Now connect *C* = 100 μF as shown in Fig. 5.1. Sketch V_o and measure V_r (peak-to- peak ripple voltage). Set the oscilloscope channel to *AC coupling* and increase vertical sensitivity (decrease V/div) while measuring V_r.

II) Comparison with half-wave rectifier (HWR)

1. Remove diode D2. The circuit is now a HWR with C-filter.
2. Compare V_r values in FWR and HWR.

Q. 2 : What are the ripple frequencies in FWR and HWR?

PART B : Regulated Power Supply : FULL - WAVE RECTIFIER WITH ZENER REGULATOR

1. Connect a zener diode D_Z with series resistance $R = 560\ \Omega$ as shown in Fig. 5.2. The voltage across D_Z will now be the desired (regulated) output voltage V_{oR} which will supply current I_L to the external load R_L.
2. With $R_L = \infty$, using the oscilloscope measure $V_{o\,max}$, the maximum of V_o (the unregulated DC along with ripple) & V_r (peak to peak ripple) at point 1 (unregulated output). Similarly obtain $V_{oR\,max}$, the maximum of V_{oR} (the regulated DC along with ripple) & V_{rR} at point 1' (regulated output). You will find V_{rR} to be very small, hence you may have to increase the oscilloscope sensitivity suitably.

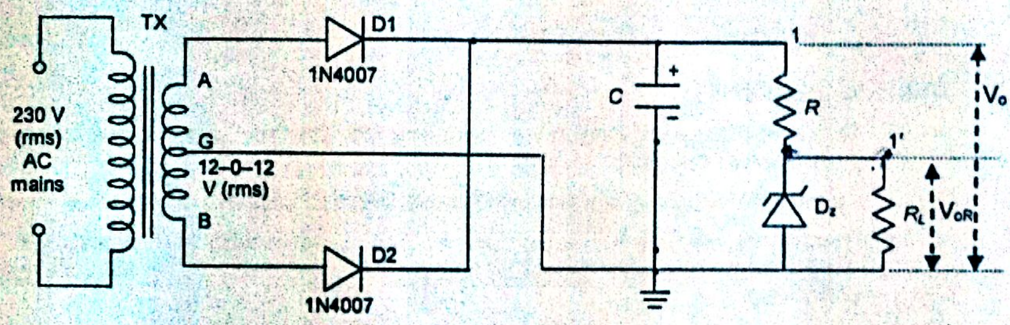

Fig. 5.2 Regulated Power Supply with zener diode.

3. Calculate : $V_{o\,av} = V_{o\,max} - V_r / 2$, and $V_{oR\,av} = V_{oR\,max} - V_{rR} / 2 \approx V_{oR\,max}$. You will notice that the average regulated voltage $V_{oR\,av} \approx V_{oR\,max}$ (almost equal since V_{rR} is very small).
4. Compute I_R, I_Z, and I_L (all average values), and the power dissipations : $P_Z = V_Z\, I_Z$, ($V_Z = V_{oR\,av}$), and $P_R = V_R\, I_R$, (V_R = voltage across R = $V_{o\,av} - V_{oR\,av}$).
5. Repeat step 2 and 3 for R_L = 1 kΩ and 220 Ω. Enter the measured and calculated values in a tabular form as shown below :

R_L	$V_{o\,max}$	V_r	$V_{oR\,max}$	V_{rR}	$V_{o\,av}$	$V_{oR\,av}$	I_R	I_L	I_Z	P_Z	P_R	%Reg
∞												
1 kΩ												
220 Ω												

% Regulation is defined as :

% Reg = [{ ($V_{oR\,av}$)NO-LOAD – ($V_{oR\,av}$)LOADED } / ($V_{oR,av}$)NO-LOAD] X 100

Q. 4 : Do you observe poor regulation for some I_L? Why does it occur?

Q. 5 : What is the maximum load current the zener regulator (under test) can supply? Given that $I_{Z\,min}$ = 5 mA and the maximum power dissipation in the zener is ½ W.

Q. 6 : How would you modify the circuit to provide an even higher I_L? What is this maximum value?

Q. 7 : What are the wattage ratings of the resistances you will use in the modified circuit for the maximum I_L value obtained in Q.6? (Standard wattage ratings : ¼ W, ½ W, 1 W, 2 W, 5 W etc.)

Q. 8 : Have you used the correct wattage resistances for the circuit under test?