POWER SUPPLY

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

MATERIALS REQUIRED

1. **Components** :

Transformer	: One: 230 V to 12–0–12 V (rms)
Diode	: Two: Type 1N4007
	: One: (Zener voltage V_Z = 6.2 V)
Resistance	: Three: 220 Ω, 560 Ω, 1 KΩ
Capacitor	: One: 100 µF25V.

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.

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. 3.1 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 DSO. 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 degree out of phase.

2. Display and sketch the full-wave rectified output V_O across R_L . Measure the peak voltages in both half.

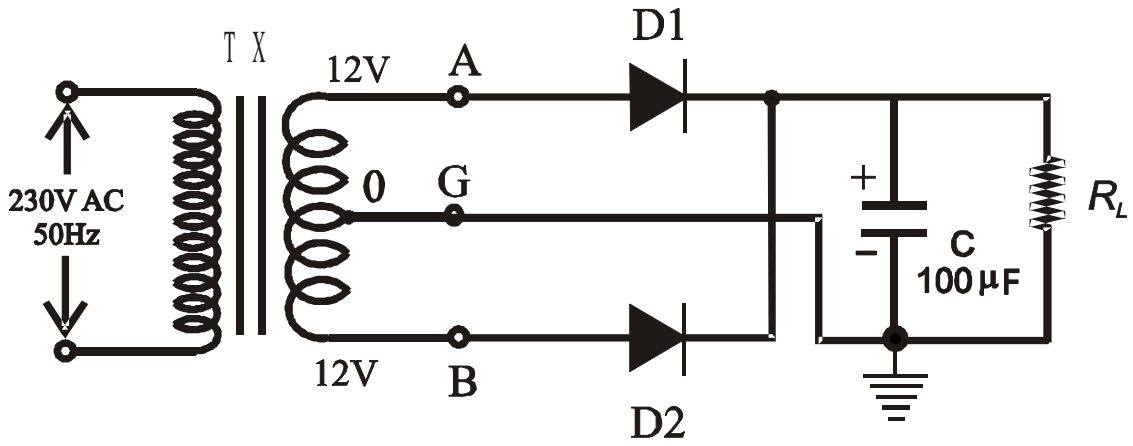

Fig: 3.1 :-Power Supply Using a center tapped Transformer and Full - Wave Rectifier

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. 1 : 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 Ω as shown in Fig. 3.2. 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.

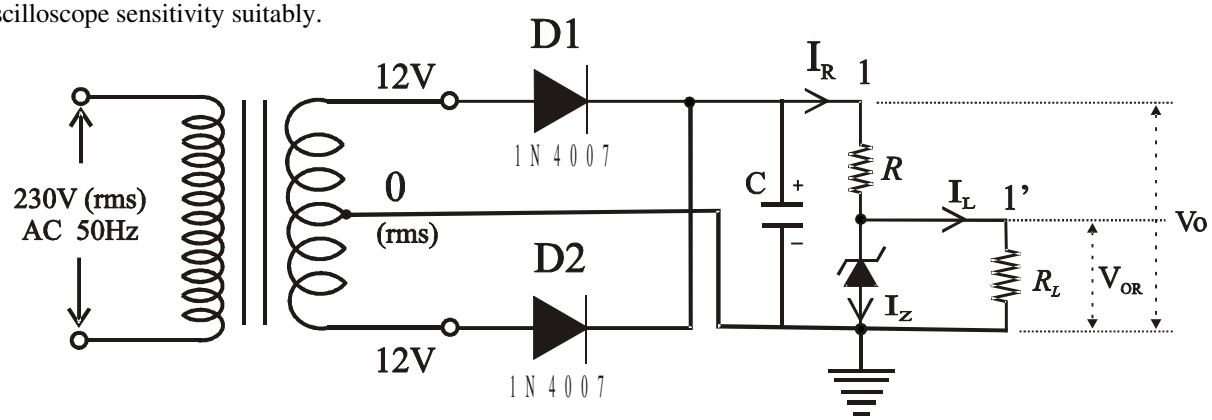

Fig. 3.2 Regulated Power Supply with zener diode.

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	$V_{o\,max}$ (DC Coupling)	V_r (AC Coupling)	$V_{oR\,max}$ (DC Coupling)	V_{rR} (AC Coupling)	Vo av	VoR av	I_R	I_L	I_Z	P_Z	P_R	% Reg
∞												
1KΩ												
220Ω												
560Ω												

% Regulation is defined as:

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

Q. 2 : Do you observe poor regulation for some I_L? Why does it occur?

Q. 3 : 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. 4 : How would you modify the circuit to provide an even higher I_L ? What is this maximum value?

Q. 5 : 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. 6 : Have you used the correct wattage resistances for the circuit under test?