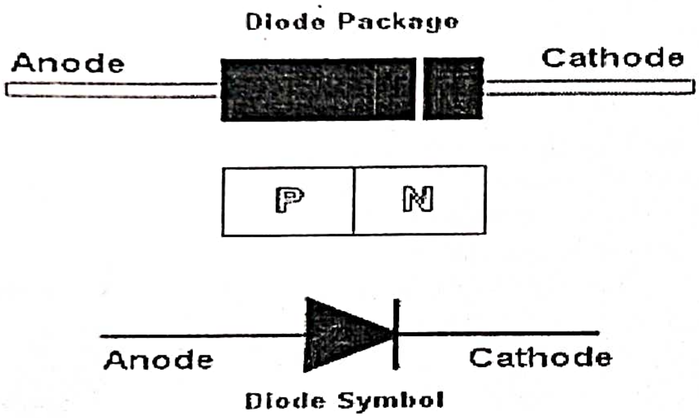
EXPERIMENT 5(ECS51)

Rectifier Circuits and Filters

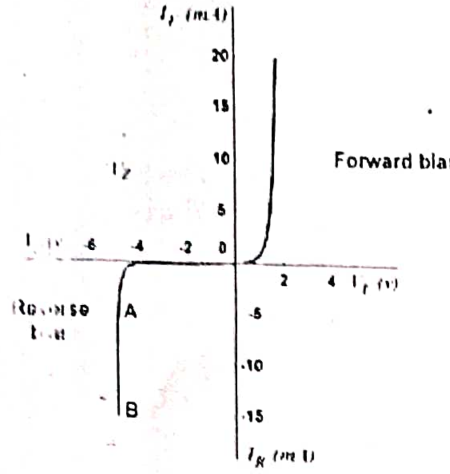
Objectives:

1. To understand how diodes can rectify AC voltage to obtain a pulsating DC voltage.
2. To build the basic types of rectifier circuits and determine the advantages and disadvantages of each type.
3. To understand the effects of capacitors connected across the output of these rectifier circuits (Filters).

Parts and Equipment required :
Stepdown transformer (5V) ,1N4001 (04) diodes (or equivalent)
Electrolytic capacitors, Resistors, Oscilloscope, Multimeter, Breadboard and wire.



DIODES:
A diode is a non-ohmic two-terminal device. Its resistance is *not* constant, but is a function of the diode's current. Fig. 2 shows the relation between diode voltage and current, the *characteristic curve* of the diode.
The diodes used in this experiment are solid state junction diodes. They allow easy passage of current in one direction while blocking current in the reverse direction. When diodes are used to convert AC to DC, the process is called *rectification*.The diode's characteristic curve is very different for the two directions of current. In the *forward* direction of current, the resistance is very low. [The conduction threshold in the forward direction is approximately 0.2 volt for germanium diodes and 0.6 volt for silicon diodes, at room temperature.]In the *reverse* direction of current, the resistance is very high, so high that there is practically no conduction in that direction. If the reverse voltage is high enough, the diode begins to conduct in the reverse direction. This 'Zener' threshold voltage is used in specially designed diodes for voltage regulation. In this experiment the reverse voltages do not reach the Zener breakdown voltage, so we can assume that no significant conduction occurs in the reverse direction.]The resistance of the diode is the *slope* of the V vs. I curve, that is □V/□I. It is *not* simply V/I, since the voltage is *not* a linear function of I. Diode curves are usually shown as I vs. V, so be careful to interpret the slope correctly.In the preliminary design and analysis of a circuit, it is helpful to think of each diode in the circuit as capable of conduction only in the direction of the arrow of its symbol, and not capable of conduction in the reverse direction. If an alternating voltage is applied to the circuit, consider each half-cycle separately. During each half-cycle the voltage source supplies current in one particular direction. Draw all conduction paths for that situation. Then consider what happens when the source supplies current in the opposite direction. Draw all conduction paths for that case, using a different color of pencil or ink.



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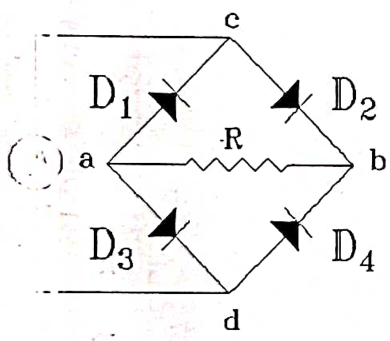
g C shows a *full wave rectifier* circuit. The signal generator produces a sine wave whose polarity (positive or egat ve) changes sign each half cycle. When the direction of the current is from the generator *into* the bridge at oi c, the only available current path through the bridge is cbad, through the resistor from right to left in the iag m. During the next half cycle, the current direction is from the generator into the bridge at point d. Then the nl vailable path is dbac, but again the current direction is from right to left through the resistor. Therefore the ur t through the resistor always has the same direction, as shown in the plot below.



Half-Wave Rectifiers. An easy way to convert ac to pulsating dc is to simply allow half of the ac cycle to pass, il blocking current to prevent it from flowing during the other half cycle. The figure to the right shows the su ing output. Such circuits are known as *half-wave rectifiers* because they only work on half of the incoming ac ave.

u - Wave Rectifiers. The more common approach is to manipulate the incoming ac wave so that both halves are s d to cause output current to flow in the same direction. The resulting waveform is shown to the right. Because these circuits operate on the entire incoming ac wave, they are known as *full-wave rectifiers*.

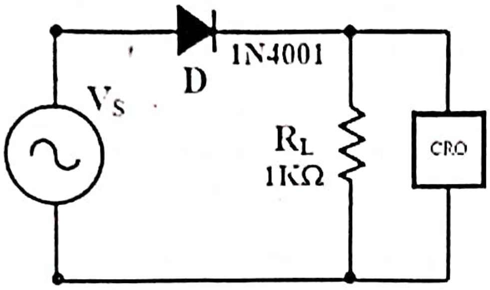


Fig.1

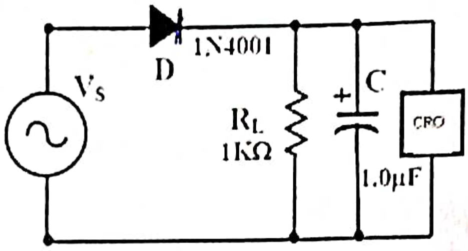


Fig. 2

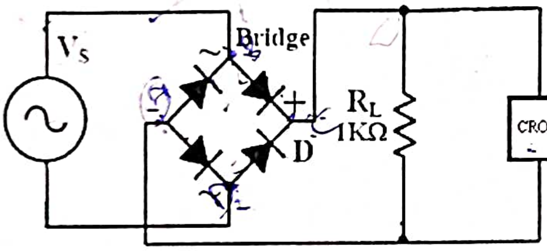


Fig.3

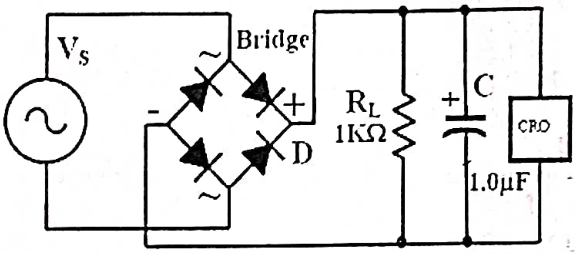


Fig. 4

In this experiment you will investigate the half wave rectifier and bridge rectifier circuits with and without filtering. You should become familiar with exactly what is required to convert an AC voltage to a good DC voltage with negligible ripple.

Procedure 1: Half-wave Rectification (unfiltered)

1. Build the following circuit (Fig. 1). Connect the oscilloscope to observe the voltage waveforms at the i/p of the circuit.. 2. Adjust the vertical sensitivity controls for maximum on screen display on both channels with zero at the center of the screen. Draw the waveforms and measure the ac voltage across the secondary of the transformer and DC voltage across R with DMM. 3. calculate the theretical value of the dc o/p voltage by using the formula $V_{dc} = V_m / \pi$ where V_m is the peak secondary voltage ($V_{dc} = 2V_m / \pi$ for full wave). Compare this value with the measured dc value of o/p. Connect the CRO across R_L. You must use DC coupling to properly show the output waveform, Note down its amplitude, V_o. 4. Increase the vertical sensitivity for maximum on screen display of the **positive part** of the waveforms. Set the horizontal sweep control for a display of two or three output pulses. **Draw the waveforms.** Measure ac voltage across the load resister, R_L, with the DMM .
5. Note the frequency of I/P & O/P signals. 6. Leave the circuit intact for the next procedure.

Procedure 2: Half-wave Rectification with Capacitor Filter

1. Disconnect the power to the transformer and add a 10 μF electrolytic capacitor, C_F, in parallel with the resistor R_L, **making sure that the correct polarity is observed (Negative to ground)**.
2. After all the connections are checked, connect the power to the transformer and observe the input and output waveforms. 3. Draw the **load voltage** waveform and take measurements using DMM. Show the correct voltage and time scales on the waveform graph. DC coupling must be used on the oscilloscope to obtain the actual voltage levels of the waveform. Use the multimeter to measure the DC voltage and the rms AC voltage across R_L.

3 Observe the ripple waveform across the load using AC coupling with the zero reference level set to the middle of the screen, adjust the vertical sensitivity control for maximum on screen display. **Draw the ripple waveform** .Remember that on ac coupling the center of the screen (zero reference level) is actually the dc voltage level not zero volts.

Procedure 3: Full-wave Bridge Rectifier : *Follow the above mentioned procedure for Bridge Rectifier.*

CALCULATIONS/GRAPHS

Ripple factor with 'C' , $\gamma = 1 / (2\sqrt{3}fRC)$ ... H/W, $\gamma = 1 / (4\sqrt{3}fRC)$ ... Bridge, f = I/P frequency (50 Hz)

Parameters	Half Wave	Bridge
I/P Voltage(Peak) V_p (CRO)		5.7V
Peak O/P voltage, V_m (CRO)		~~5.~~ 5.8V
DC O/P Voltage (Measured) (DMM)		3.51V
DC O/P Voltage (Calculated)	$(V_{dc} = V_m / \pi) =$	$(V_{dc} = 2V_m / \pi) =$ 3.692V
RMS Voltage, V_{rms} (O/P) (DMM)		4.101V
Ripple factor (V_{rms}/V_{dc}) With out C (DMM) — Theoretial / Practical	1.21 /	0.48 / 0.55 ~~1.16~~
Frequency (I/P)		50.001Hz
Frequency (O/P)		99.995 ~~100~~ Hz
DC O/P Voltage (Measured) With C (DMM)		+ 4.63V
RMS Voltage, V_{rms} (O/P) With C (DMM)		0.868V
Ripple factor (V_{rms}/V_{dc}) With C (DMM) — Theoretial / Practical	.... /	0.288 / 0.187