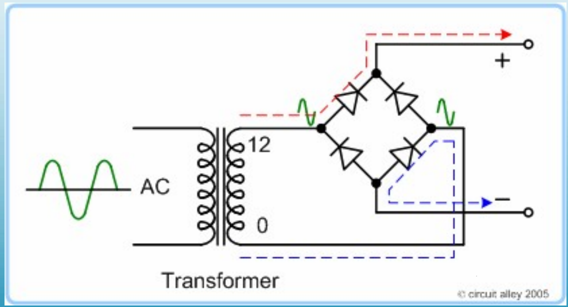
Bridge Rectifier

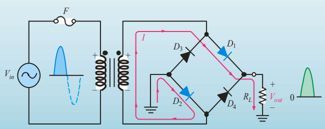
Full wave rectifier

Suitable for applications where large powers are required



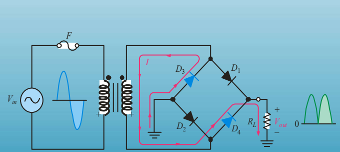
The Bridge Full-wave rectifiers

- The Bridge Full-Wave rectifier uses four diodes connected across the entire secondary as shown.

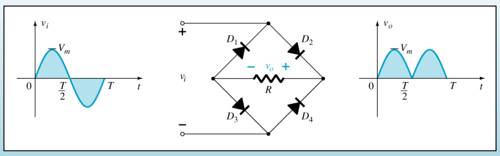


Conduction path for the positive half-cycle.

Conduction path for the negative half-cycle.



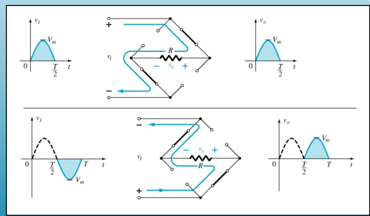
Full-Wave Bridge Rectification



Bridge Rectifier

A full-wave rectifier with four diodes that are connected in a bridge configuration

$V_{DC} = 0.636V_m$



Summary of Rectifier Circuits

In the center tapped transformer rectifier circuit, the peak AC voltage is the transformer secondary voltage to the tap.

Rectifier	Ideal V_{DC}	Realistic V_{DC}
Half Wave Rectifier	$V_{DC} = 0.318V_m$	$V_{DC} = 0.318V_m - 0.7$
Bridge Rectifier	$V_{DC} = 0.636V_m$	$V_{DC} = 0.636V_m - 2(0.7\text{ V})$
Center-Tapped Transformer Rectifier	$V_{DC} = 0.636V_m$	$V_{DC} = 0.636V_m - 0.7\text{ V}$

V_m = the peak AC voltage

The Bridge Full-Wave Rectifier

Example:

Determine the peak output voltage and current in the 3.3 kΩ load resistor if V_{sec} = 24 V_{rms}. Use the practical diode model.

Solution:

The peak output voltage is:

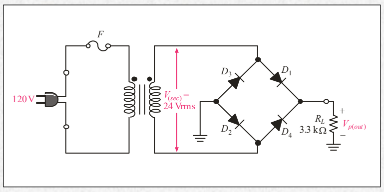
$$V_{p(sec)} = 1.41V_{rms} = 33.9\text{ V}$$

$$V_{p(out)} = V_{p(sec)} - 1.4\text{ V}$$

$$= 32.5\text{ V}$$

Applying Ohm's law,

$$I_{p(out)} = 9.8\text{ mA}$$



Power Supply Filters

Objective:

- Explain & Analyze the operation & characteristic of power supply filters & Regulators
- Explain the purpose of a filter
- Describe the capacitor-input filter
- Define ripple voltage & calculate the ripple voltage
- Discuss surge current in capacitor-input filter
- Discuss voltage regulation & integrated circuit regulator

Power Supply Filters

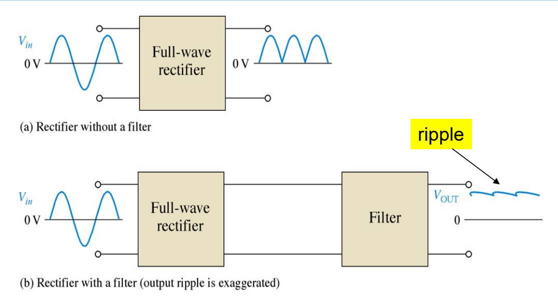
- To reduce the fluctuations in the output voltage of half / full-wave rectifier – produces constant-level dc voltage.
- It is necessary – electronic circuits require a constant source to provide power & biasing for proper operation.
- Filters are implemented with *capacitors*.

Power Supply Filters

•In most power supply – 60 Hz ac power line voltage is converted to constant dc voltage.

•60Hz pulsating dc output must be filtered to reduce the large voltage variation.

•Small amount of fluctuation in the filter o/p voltage - ripple



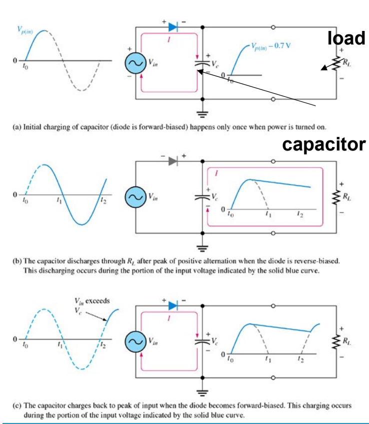
(a) Rectifier without a filter

(b) Rectifier with a filter (output ripple is exaggerated)

Power Supply Filters

Capacitive Filter

- Capacitive filter is simply a *capacitor* connected in *parallel* with the *load* R_L
- During the ***positive first quarter-cycle*** of the input, the diode is forward-biased, allowing the capacitor charges rapidly
- When the input begins to go ***negative***, the diode is reverse-biased, and the capacitor **slowly discharges** through the load resistance. As the output from the rectifier drops below the charged voltage of the capacitor, the capacitor acts as the ***voltage source*** for the load.
- During first quarter of the next cycle, as illustrated in part (c), the diode will again become forward-biased when the input voltage exceeds the capacitor voltage.



(a) Initial charging of capacitor (diode is forward-biased) happens only once when power is turned on.

(b) The capacitor discharges through R_L after peak of positive alternation when the diode is reverse-biased. This discharging occurs during the portion of the input voltage indicated by the solid blue curve.

(c) The capacitor charges back to peak of input when the diode becomes forward-biased. This charging occurs during the portion of the input voltage indicated by the solid blue curve.

Ripple

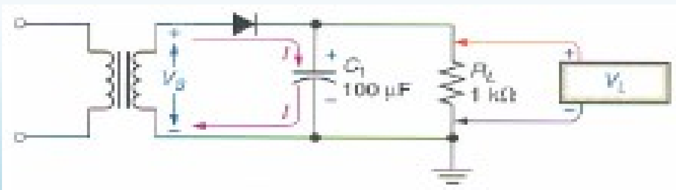
Ripple voltage is the *fluctuation* in the *capacitor voltage* due to the difference between the charge and discharge times.
The difference between the charge and discharge times is caused by two distinct *RC time constant* in the circuit. One time constant is found as:

$$\tau = RC$$

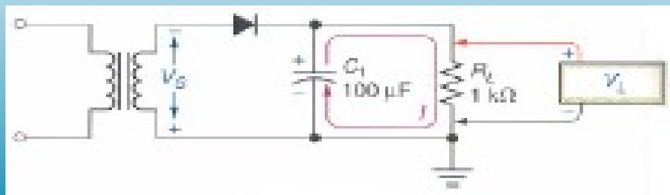
where R and C are the total circuit resistance and capacitance, respectively.
Since it takes ***five*** time constants for a capacitor to charge or discharge fully, this time period (T) can be found as:

$$T = 5RC = 5\tau$$

Power Supply Filters



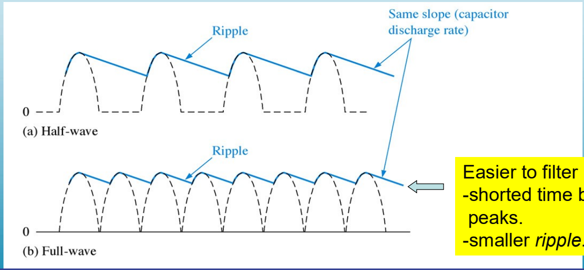
(a) Charge circuit



(b) Discharge circuit

Ripple Voltage: the variation in capacitor voltage due to the charging and discharging times.

The advantage of a full-wave rectifier over a half-wave is quite clear. The capacitor can more effectively reduce the *ripple* when the time between peaks is *shorter*.



Easier to filter
-shorted time between peaks.
-smaller *ripple*.

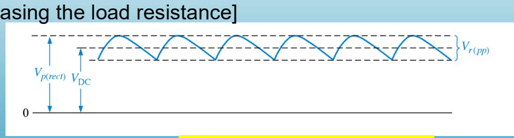
Power Supply Filters

Ripple factor: indication of the effectiveness of the filter

$$r = \frac{V_{r(pp)}}{V_{DC}}$$ [half-wave rectifier]

$V_{r(pp)}$ = peak to peak ripple voltage; $V_{DC} = V_{AVG}$ = average value of filter's output voltage.

•Lower ripple factor → better filter
[can be lowered by increasing the value of filter capacitor or increasing the load resistance]



•For the full-wave rectifier:

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

$$V_{DC} = V_{AVG} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$

$V_{p(rect)}$ = unfiltered peak.