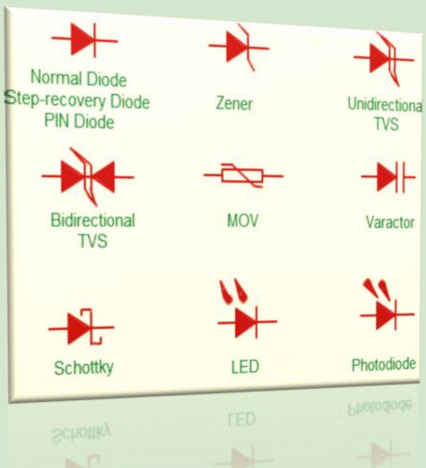
Lec (11)



Electronic Fundamentals

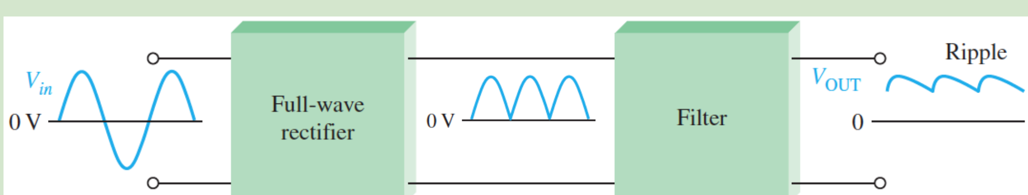
Circuits, Devices, and Applications

Diodes and Applications

Power Supply Filters and Special-Purpose Diodes

Power supply filters

- A power supply filter ideally eliminates the fluctuations in the output voltage of a half-wave or full-wave rectifier and produces a constant-level dc voltage.
- In most power supply applications, the standard (60 Hz or 50 Hz) ac power line voltage must be converted to an approximately constant dc voltage.

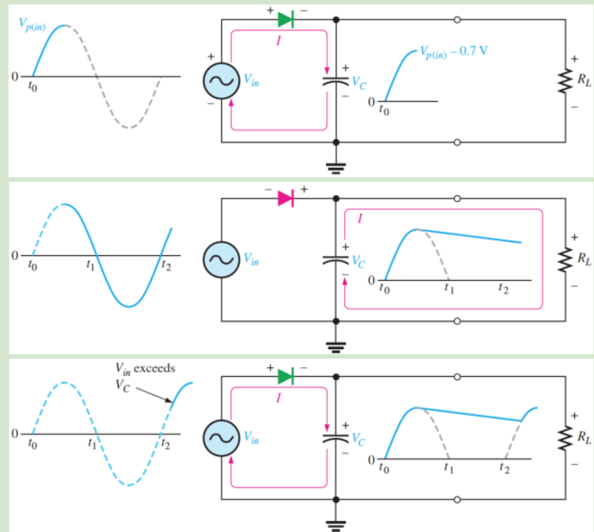


Capacitor-Input Filter

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

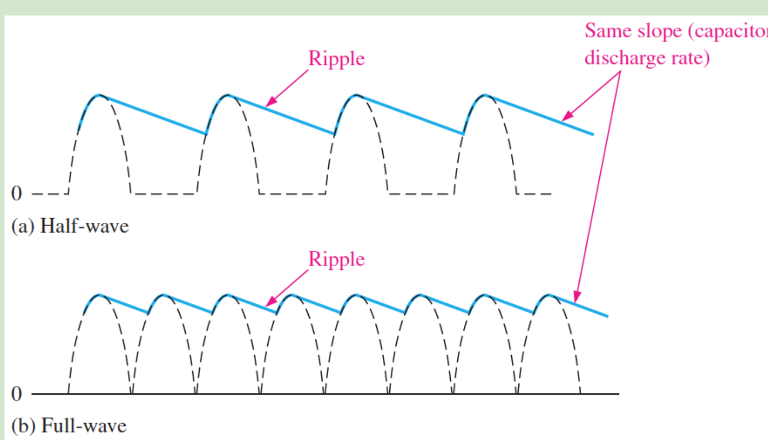
The capacitor discharges through R_L after peak of positive alternation when the diode is reverse-biased.

The capacitor charges back to peak of input when the diode becomes forward-biased.



Ripple Voltage

Ripple voltage is the variation in the capacitor voltage due to the charging and discharging.



Ripple Factor

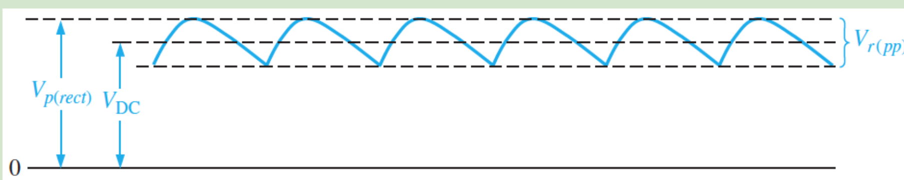
The **ripple factor (*r*)** is an indication of the effectiveness of the filter

$$r = \frac{V_{r(pp)}}{V_{DC}}$$

$V_{r(pp)}$ is the peak-to-peak ripple voltage
V_{DC} is the dc (average) value of the filter's output voltage

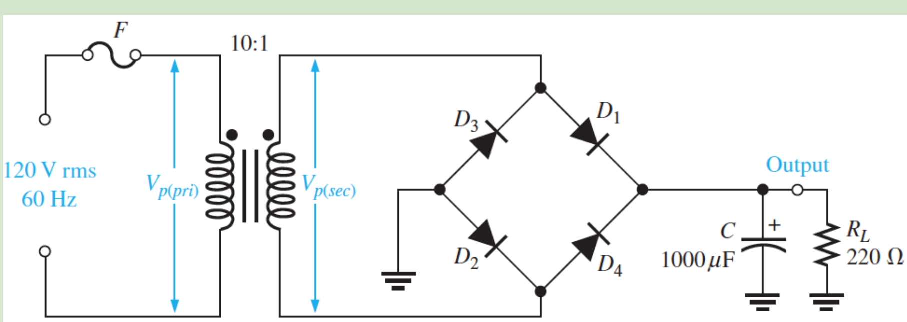
$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)} \qquad V_{DC} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$

When R_L or C increases, the ripple voltage decreases and the dc voltage increases.



Example

Determine the ripple factor for the filtered bridge rectifier with a load as indicated in the Figure



Solution

- The transformer turns ratio is $n = 1/10 = 0.1$. The peak primary voltage is

$$V_{p(pri)} = 1.414V_{rms} = 1.414(120\text{ V}) = 170\text{ V}$$

- The peak secondary voltage is

$$V_{p(sec)} = nV_{p(pri)} = 0.1(170\text{ V}) = 17.0\text{ V}$$

- The unfiltered peak full-wave rectified voltage is

$$V_{p(rect)} = V_{p(sec)} - 1.4\text{ V} = 17.0\text{ V} - 1.4\text{ V} = 15.6\text{ V}$$

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)} = \left(\frac{1}{(120\text{ Hz})(220\ \Omega)(1000\ \mu\text{F})}\right)15.6\text{ V} = 0.591\text{ V}$$

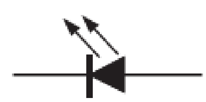
$$V_{DC} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)} = \left(1 - \frac{1}{(240\text{ Hz})(220\ \Omega)(1000\ \mu\text{F})}\right)15.6\text{ V} = 15.3\text{ V}$$

- The resulting ripple factor is

$$r = \frac{V_{r(pp)}}{V_{DC}} = \frac{0.591\text{ V}}{15.3\text{ V}} = \mathbf{0.039}$$

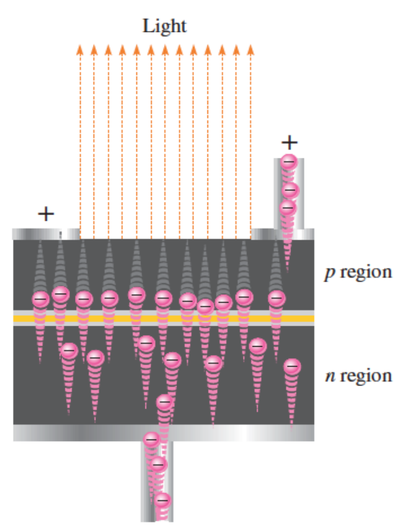
The percent ripple is 3.9%.

The Light-Emitting Diode (LED)



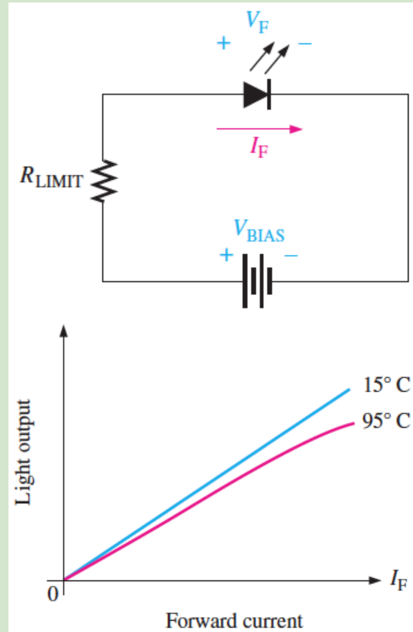
The basic operation of an LED (light-emitting diode) is as follows:

- When the device is **forward biased**, electrons cross the pn junction from the n-type material and recombine with holes in the p-type material.
- When recombination takes place, the recombining electrons release energy in the form of heat and **light**.

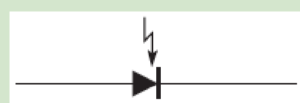


LED Biasing

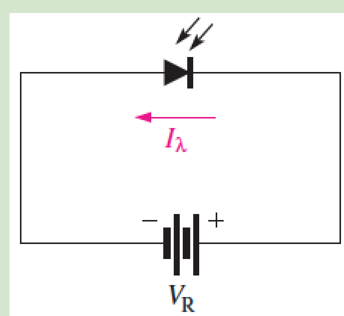
- The amount of power output translated into light is directly proportional to the forward current.
- An increase in I_F corresponds proportionally to an increase in light output.
- The light output (both intensity and color) is also dependent on temperature. Light intensity goes down with higher temperature as indicated in the figure.



The Photodiode



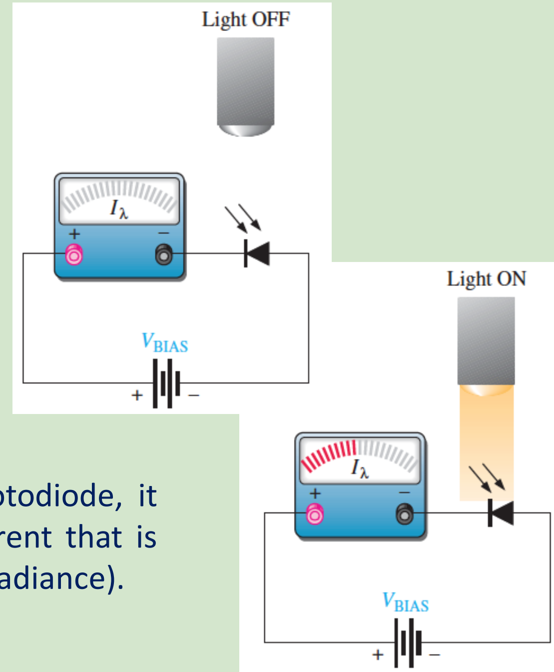
The **photodiode** is a device that operates in reverse bias, where I_λ is the reverse light current. The photodiode has a small transparent window that allows light to strike the *pn* junction.



A photodiode differs from a rectifier diode in that when its *pn* junction is exposed to light, the reverse current increases with the light intensity. When there is no incident light, the reverse current, I_λ, is almost negligible and is called the **dark current**.

An increase in the amount of light intensity, expressed as irradiance (mW/cm^2), produces an increase in the reverse current

The photodiode allows essentially no reverse current (except for a very small dark current) when there is no incident light.



When a light beam strikes the photodiode, it conducts an amount of reverse current that is proportional to the light intensity (irradiance).

Self-test

Try to solve the Self-test in your text book

Electronic Devices

by

Floyd

9th Edition

Pages 99-105

Pages 161-169