EEE-2103: Electronic Devices and Circuits

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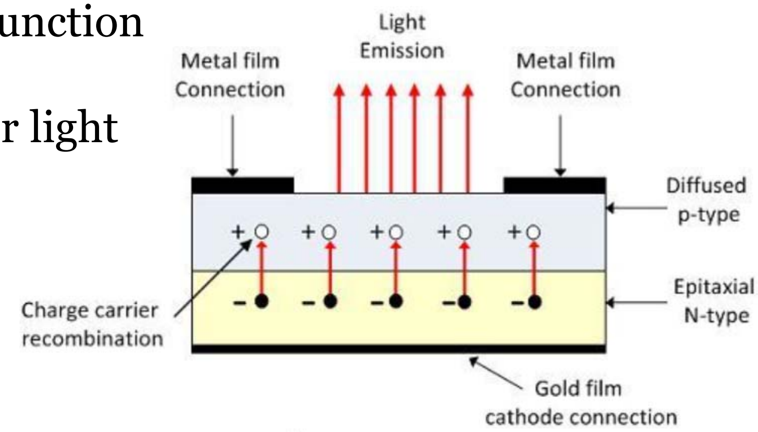
Light Emitting Diodes

Charge carrier recombination occurs at forward-biased *pn*-junction
Energy levels → electrons > holes
e-*h* recombination → electron energy – hole energy = heat or light



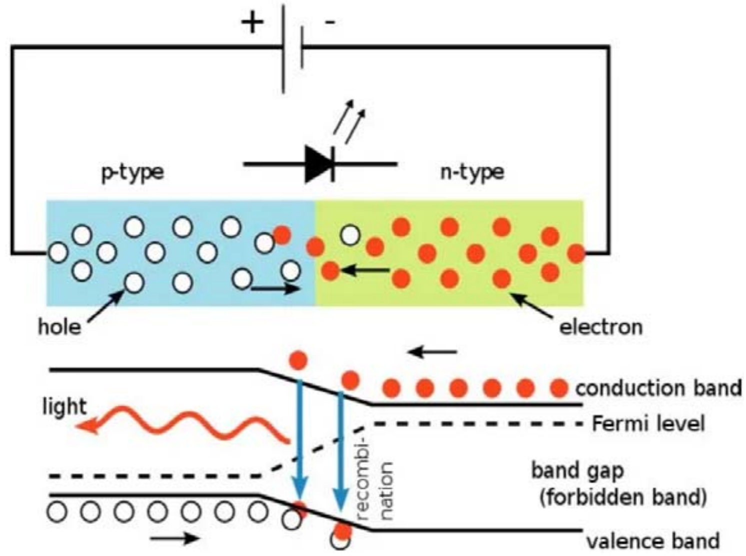
Semiconductor materials for LED →

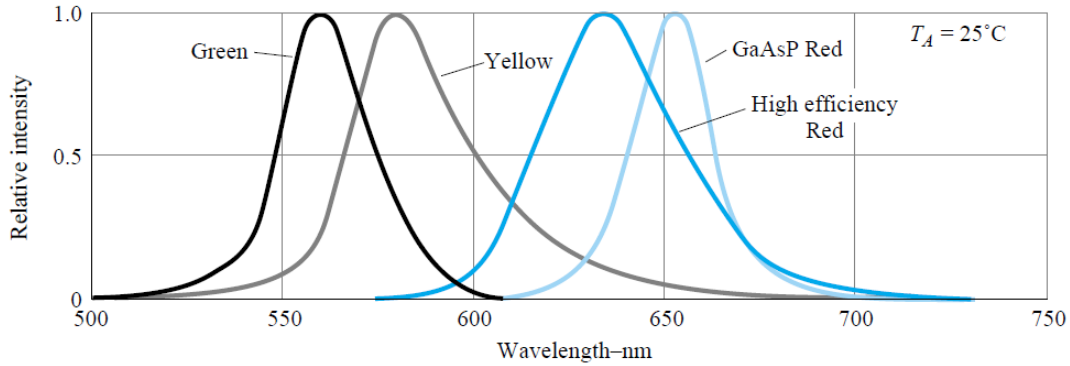
GaAs = IR

GaAsP = red or yellow

GaP = red or green

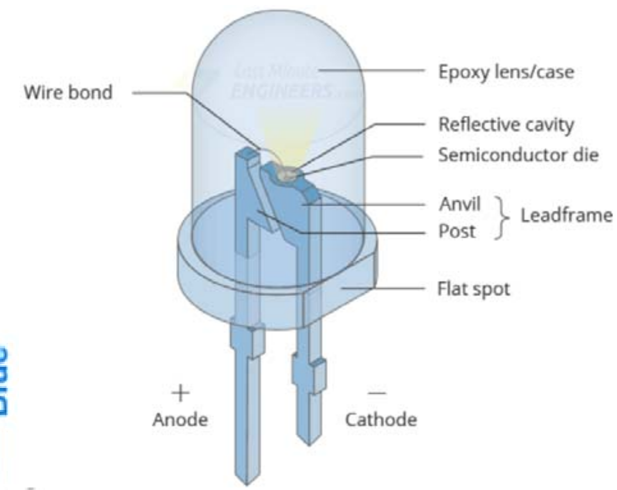
Substrate → *n*-type epilayer → diffused *p*-region
Anode → allow most of light to be emitted
Gold film → reflect as much light as possible toward surface





Light Emitting Diodes

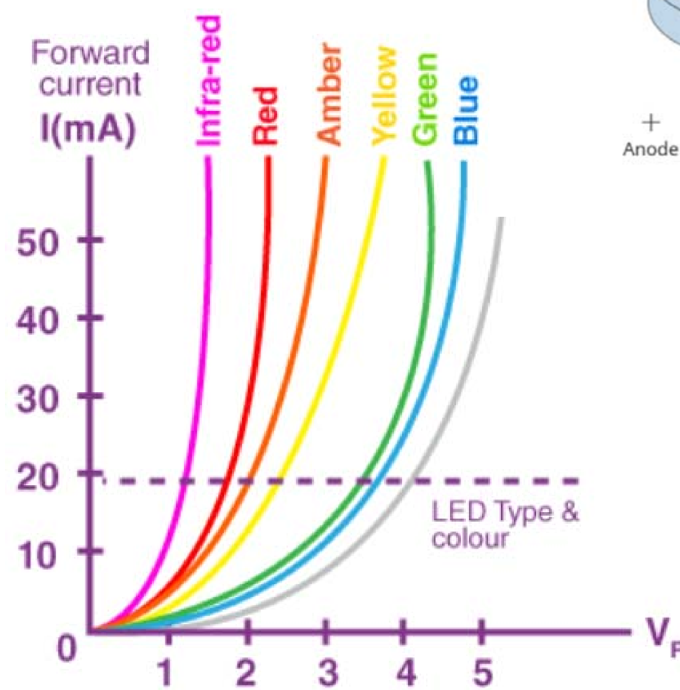
pn-junction is mounted on cup-shaped reflector
Wires for anode and cathode connections
Device is encapsulated in colorless or colored epoxy lens



LED characteristics = semiconductor diodes

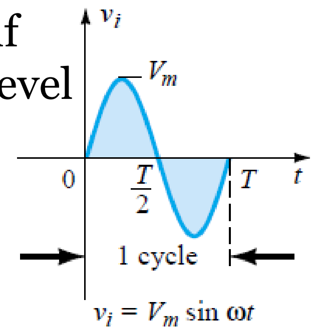
Forward voltage drop = 1.2 to 4.0 V
Reverse breakdown voltage = 3 V
Forward current = 10 to 20 mA

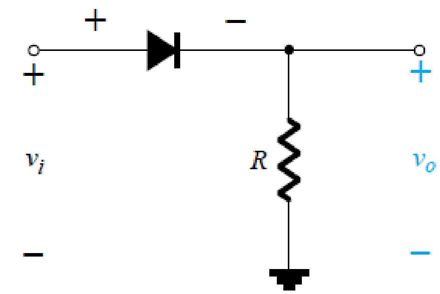
Typical LED Characteristics			
Semiconductor Material	Wavelength	Colour	V_F @ 20mA
GaAs	850-940nm	Infra-Red	1.2v
GaAsP	630-660nm	Red	1.8v
GaAsP	605-620nm	Amber	2.0v
GaAsP:N	585-595nm	Yellow	2.2v
AlGaP	550-570nm	Green	3.5v
SiC	430-505nm	Blue	3.6v
GaInN	450nm	White	4.0v



Half-Wave Rectification

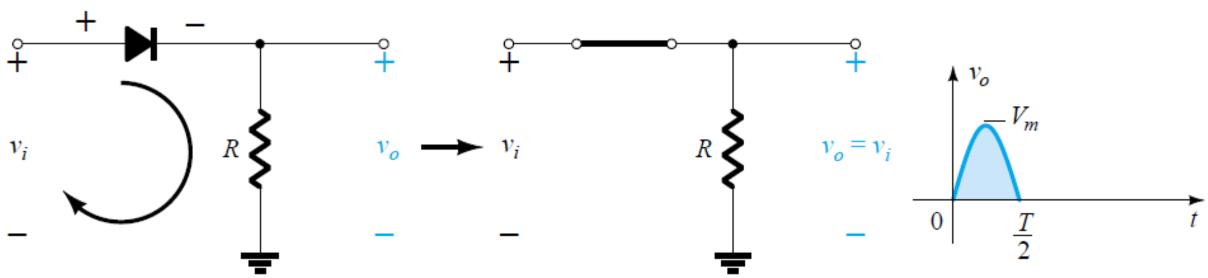
Half-wave rectification → process of removing one-half input signal to establish dc level



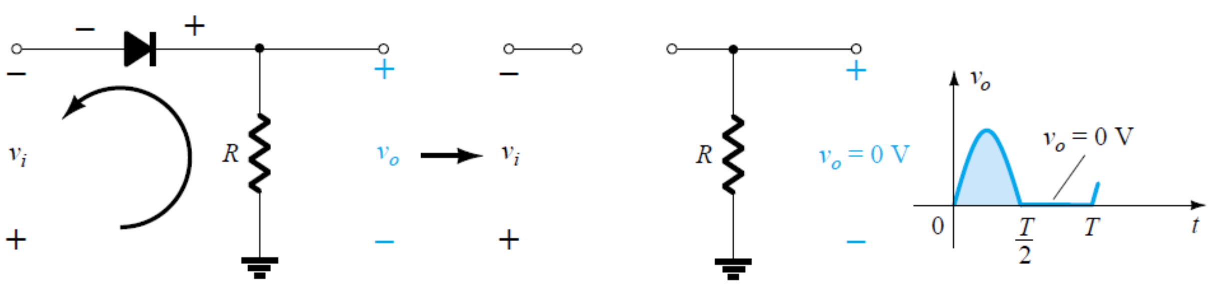


Ideal diode model:

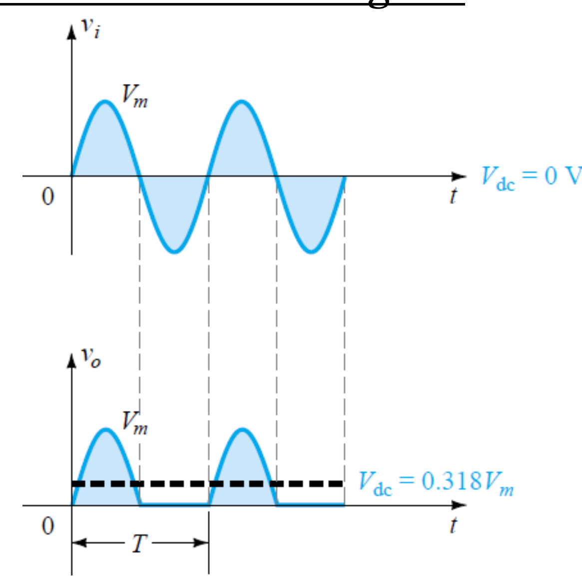
Conduction region (0 → $T/2$) →



Nonconduction region ($T/2$ → T) →



Half-wave rectified signal:



Half-Wave Rectification

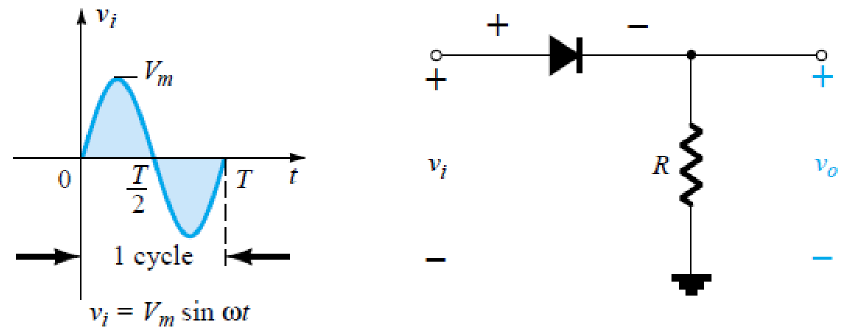
Effect of V_T on half-wave rectified signal:

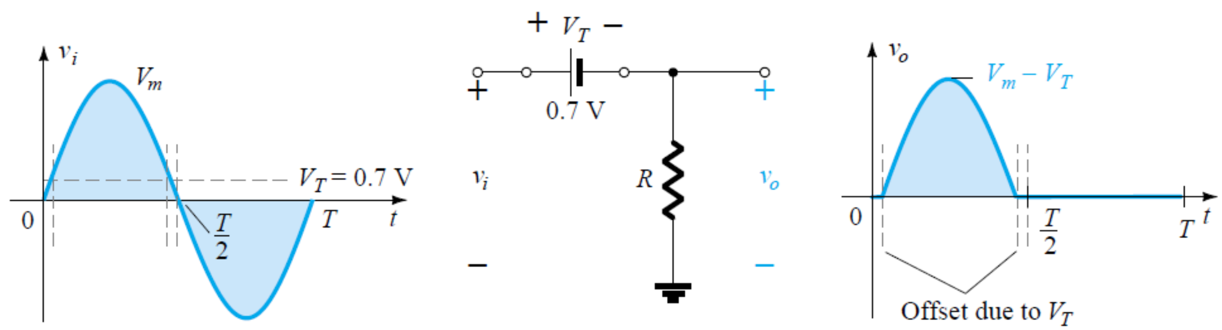
For ideal diode model →

Average value, $V_{dc} = 0.318V_m$

With V_T →

$V_{dc} \approx 0.318(V_m - V_T)$

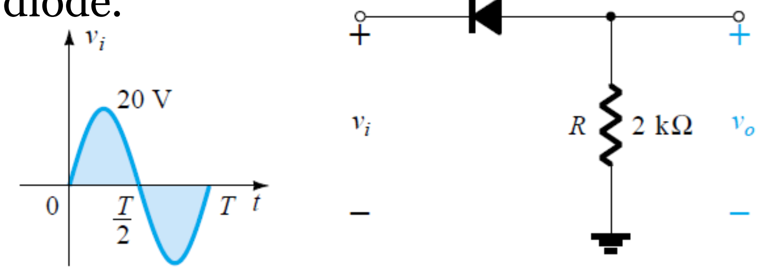




Half-Wave Rectification

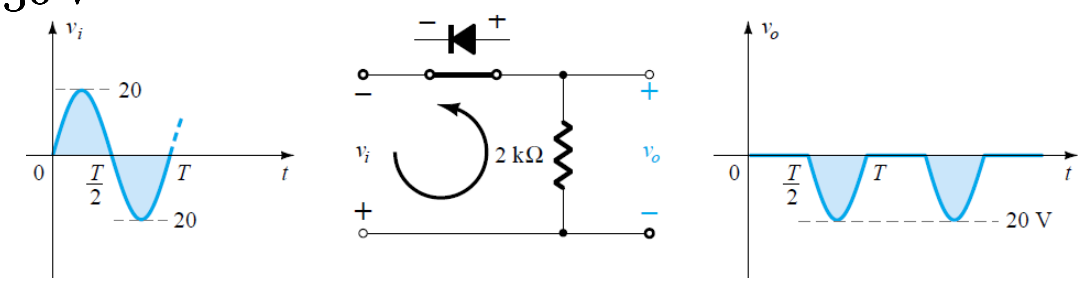
Problem-5:

(a) Sketch the output v_o and determine the dc level of the output for the network of Fig. 5.
(b) Repeat part (a) if the ideal diode is replaced by a silicon diode.



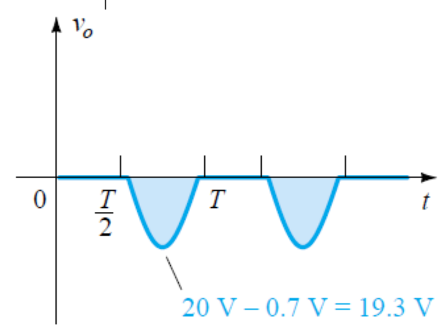
(a) Diode will conduct during negative part of input, and v_o will appear as shown in figure.
For full period, dc level is

$$V_{dc} = -0.318V_m = 0.318(20\text{ V}) = -6.36\text{ V}$$



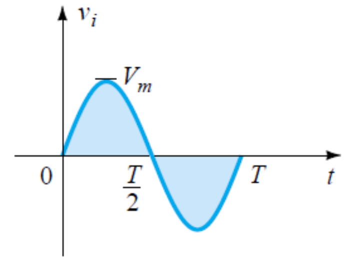
(b) Using a silicon diode, output has appearance as shown in figure.

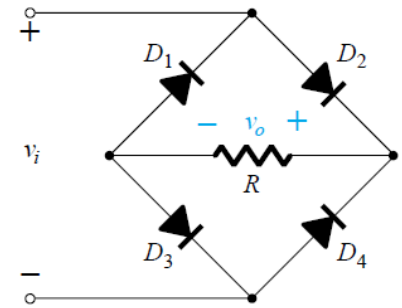
$$V_{dc} \approx -0.318(V_m - 0.7\text{ V})$$
$$= -0.318(19.3\text{ V}) = -6.14\text{ V}$$



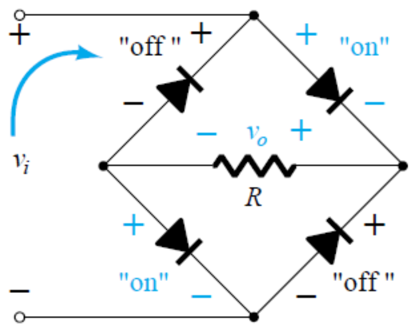
Full-Wave Rectification

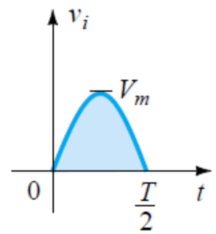
Full-Wave Bridge Rectifier:

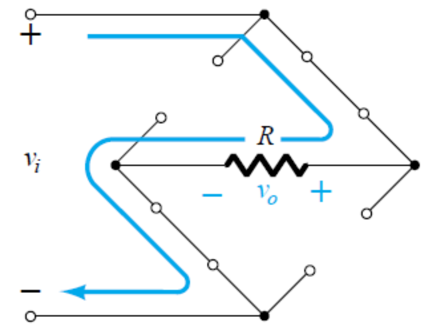


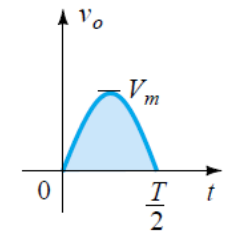


For period 0 → $T/2$ of v_i:

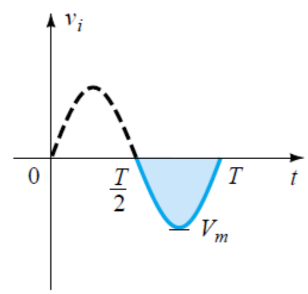


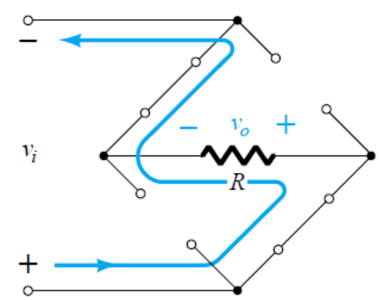


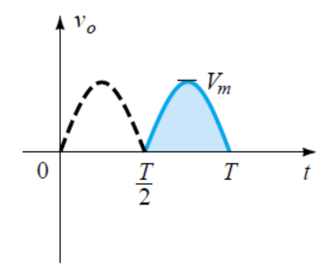




For negative region of v_i:

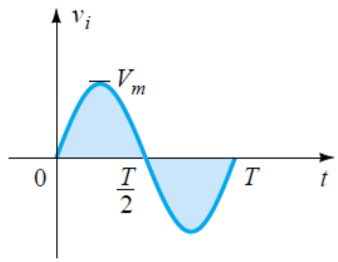


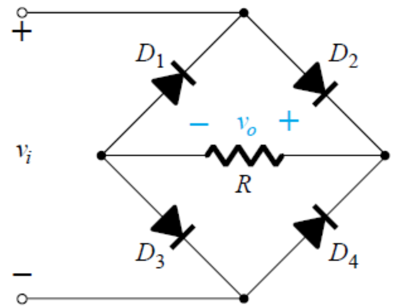


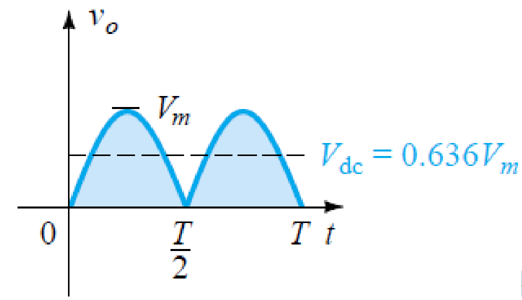


Full-Wave Rectification

Input and output waveforms:







dc level of full-wave rectifier:

$$V_{dc} = 2(0.318V_m) = 0.636V_m$$

Full-wave rectifier with silicon diode:

From Kirchhoff's voltage law

$$v_i - V_T - v_o - V_T = 0$$

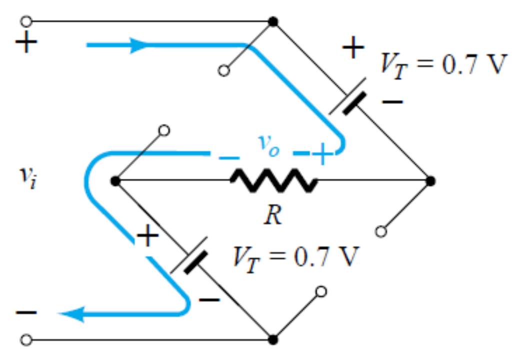
$$v_o = v_i - 2V_T$$

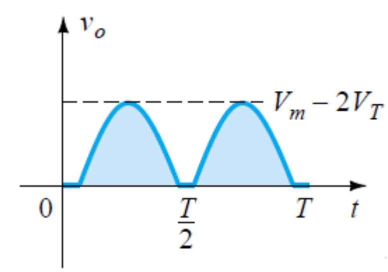
Peak value of output voltage v_o is therefore

$$V_{omax} = V_m - 2V_T$$

Average value is therefore

$$V_{dc} \approx 0.636(V_m - 2V_T)$$

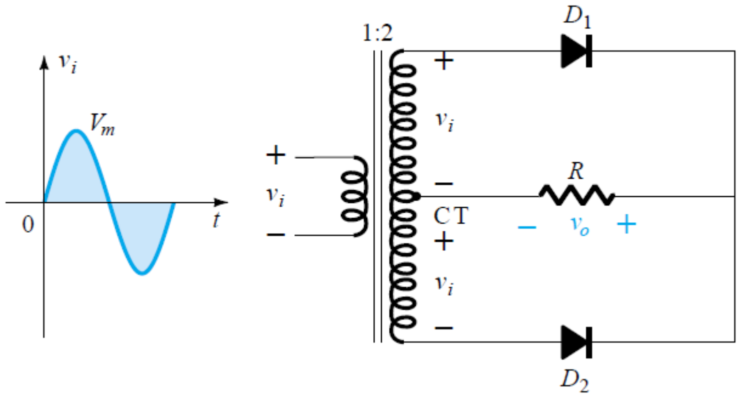




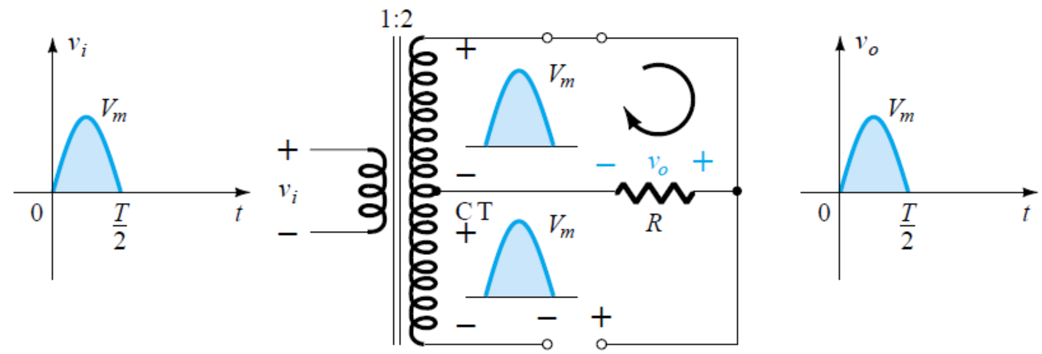
Full-Wave Rectification

Center-tapped transformer:

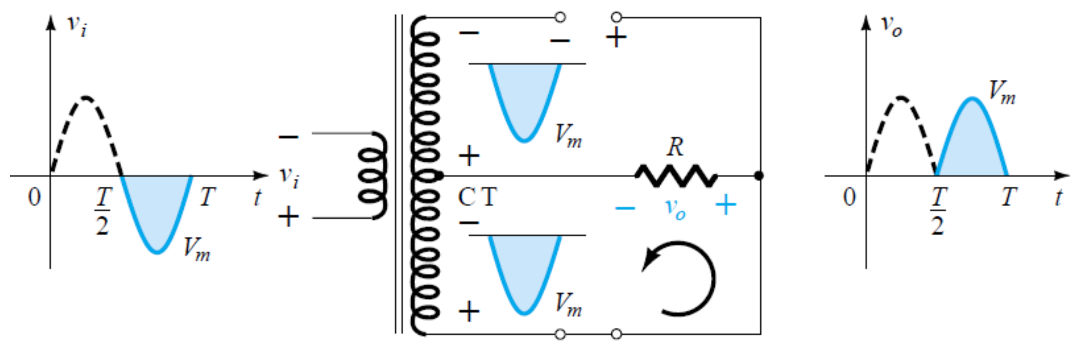
Full-wave rectifier with only two diodes but requiring center-tapped (CT) transformer.



For positive region of v_i:



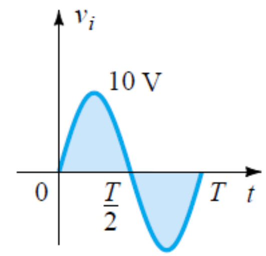
For negative region of v_i:

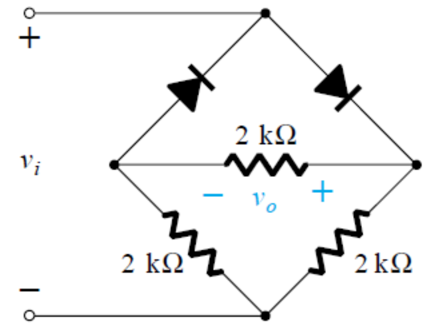


Full-Wave Rectification

Problem-6

Determine the output waveform for the network of Fig. 6 and calculate the output dc level.

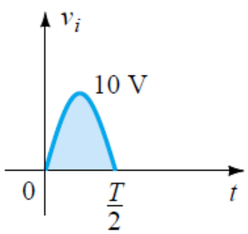


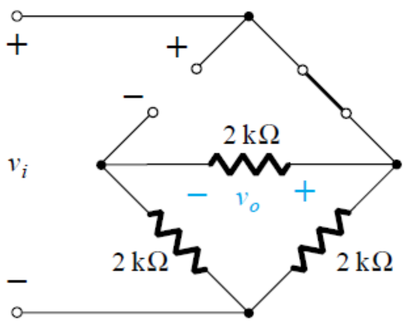


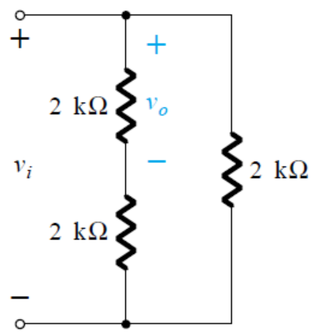
For positive region of input voltage

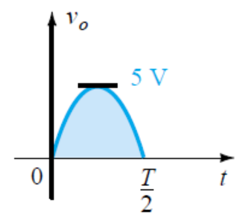
$$v_o = ½v_i$$

$$V_{omax} = ½V_{imax} = ½(10\text{ V}) = 5\text{ V}$$

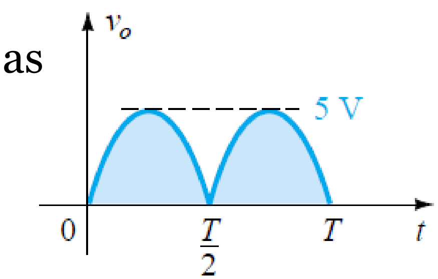








For negative part of v_i roles of diodes will be interchanged and v_o will appear as



Available dc level will be therefore

$$V_{dc} = 0.636(5\text{ V}) = 3.18\text{ V}$$