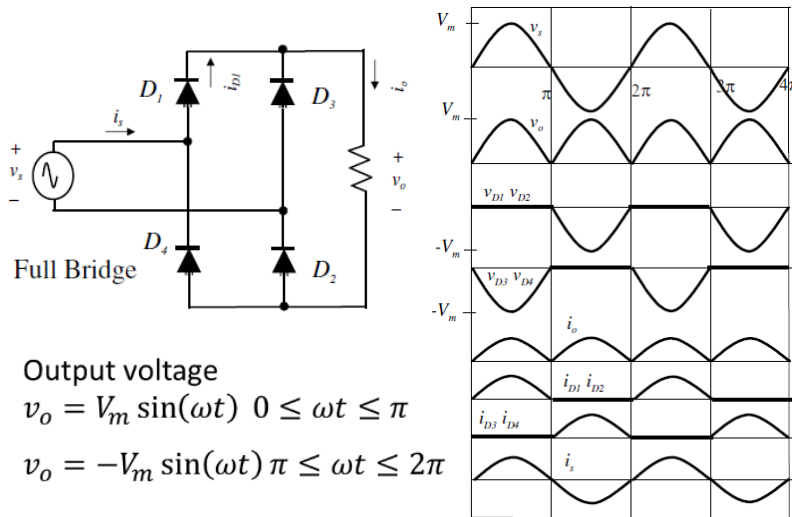


Power Supplies and Converters

Rectifier is an electrical device that converts alternating current (AC) into single-direction direct current (DC).

Types of Rectifiers

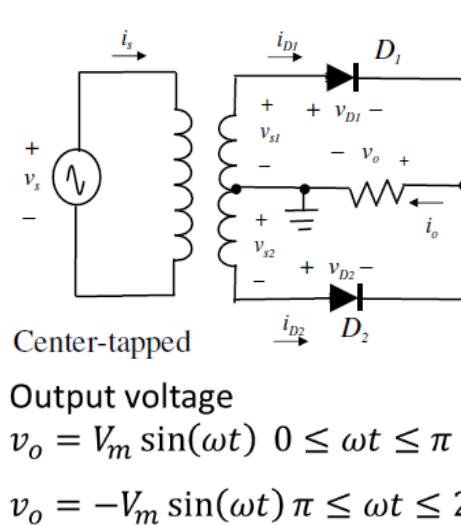
Single-phase full-wave uncontrolled rectifier (Full Bridge)



Output voltage
 $v_o = V_m \sin(\omega t) \quad 0 \leq \omega t \leq \pi$
 $v_o = -V_m \sin(\omega t) \quad \pi \leq \omega t \leq 2\pi$

Output average voltage
 $V_{o,avg} = \frac{1}{\pi} \int_0^\pi V_m \sin(\omega t) d\omega t = \frac{2V_m}{\pi} = 0.637V_m$
 $V_n = \frac{2V_m}{\pi} \left(\frac{1}{n-1} + \frac{1}{n+1} \right) \quad v_o(t) = \frac{2V_m}{\pi} + \frac{2V_m}{\pi} \sum_{n=2,4..}^\infty \cos(n\omega_o t + \pi)$

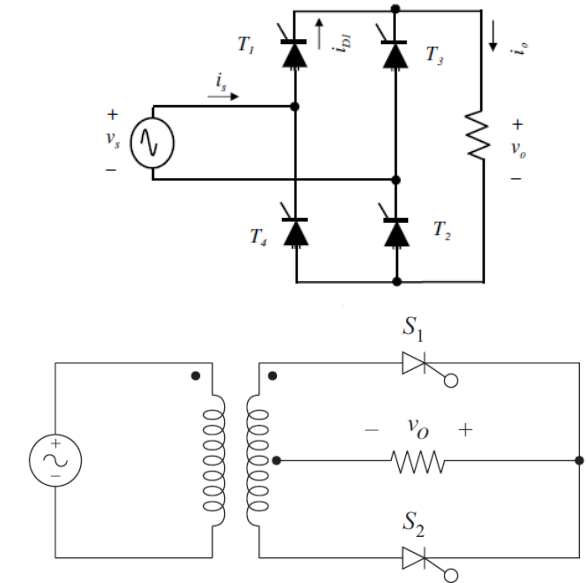
Single-phase full-wave uncontrolled rectifier (Center-Tapped)



Center-tapped
 Output voltage
 $v_o = V_m \sin(\omega t) \quad 0 \leq \omega t \leq \pi$
 $v_o = -V_m \sin(\omega t) \quad \pi \leq \omega t \leq 2\pi$

Output average voltage
 $V_{o,avg} = \frac{1}{\pi} \int_0^\pi V_m \sin(\omega t) d\omega t = \frac{2V_m}{\pi} = 0.637V_m$

Single-phase full-wave controlled rectifier



Output average voltage
 $V_{o,avg} = \frac{1}{\pi} \int_\alpha^\pi V_m \sin(\omega t) d\omega t = \frac{V_m}{\pi} (1 + \cos \alpha)$

Output RMS voltage
 $V_{o,RMS} = \sqrt{\frac{1}{\pi} \int_\alpha^\pi (V_m \sin(\omega t))^2 d\omega t} = V_m \sqrt{\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\sin(2\alpha)}{4\pi}}$

Full Bridge uncontrolled rectifier	Center-tapped rectifier
Does not require transformer	Requires transformer
4 diodes required	2 diodes required
2 diode voltage drop per half-cycle	1 diode voltage drop per half-cycle
Conduction losses are higher	Conduction losses are half of full-bridge
Diode ratings can be lower	Diode rating needs to be 2 x full-bridge