Last Lecture → Rectifiers

Half Wave

- **Diode Ratings**

$$I_{max} = \frac{V_S - V_D}{R}$$

$$PIV = V_S$$

- **Average Output**

$$\overline{V_0} \approx \frac{V_S}{\pi} - \frac{V_D}{2}$$

$$\overline{I_L} \approx \frac{\overline{V_0}}{R}$$

Full Wave

Center-Tap

- **Diode Ratings**

$$I_{max} = \frac{V_S - 2V_D}{R}$$

$$PIV = V_S - V_D$$

- **Average Output**

$$\overline{V_0} = \frac{2V_S}{\pi} - 2V_D$$

$$\overline{I_L} = \frac{\overline{V_0}}{R}$$

Bridge

- **Diode Ratings**

$$I_{max} = \frac{V_S - 2V_D}{R}$$

$$PIV = V_S - V_D$$

- **Average Output**

$$\overline{V_0} = \frac{2V_S}{\pi} - 2V_D$$

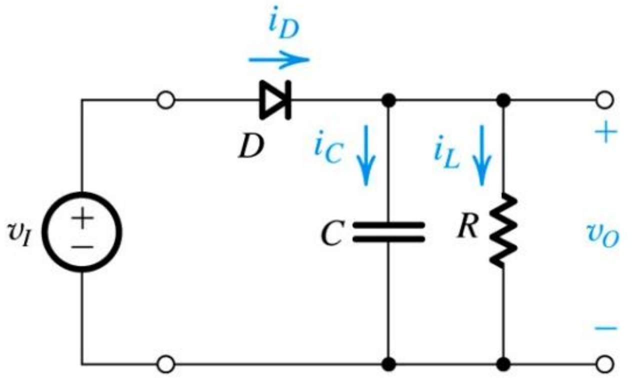
$$\overline{I_L} = \frac{\overline{V_0}}{R}$$

- **Conduction Angle**

$$\theta = \sin^{-1}\left(\frac{V_D}{V_S}\right)$$

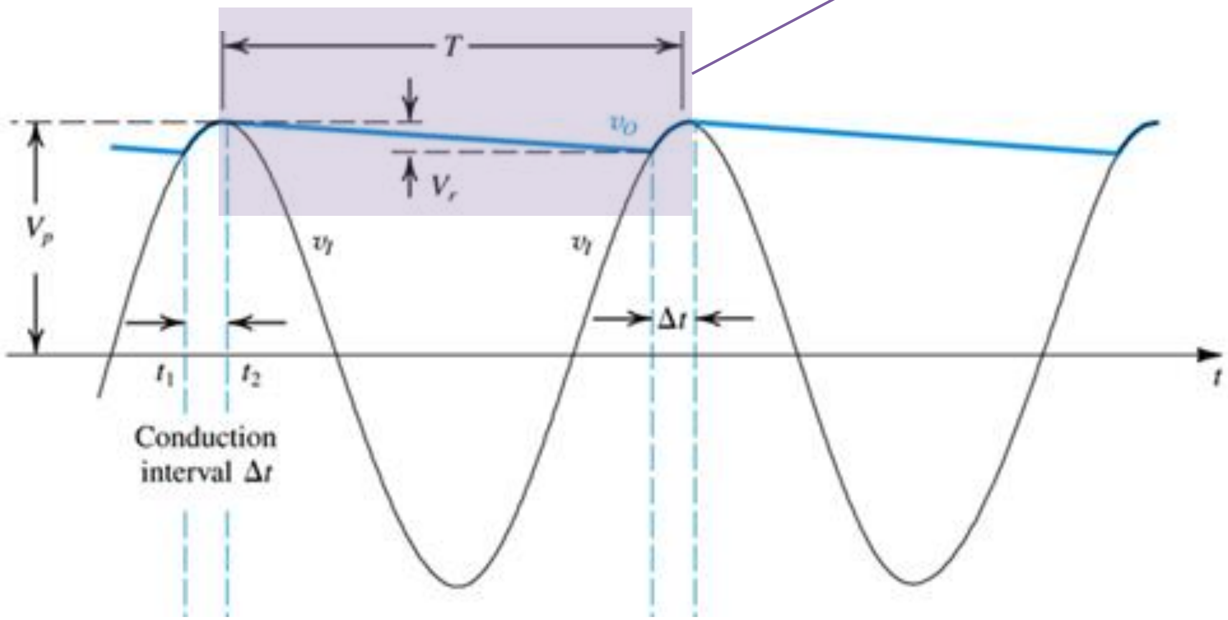
$$\Delta\theta = \pi - 2\theta$$

Last Lecture → Filter



$$v_0(t) = V_s e^{-t/CR}$$

assume CR>>T



- **Half-Wave**

$$\overline{V_0} = V_S - \frac{V_r}{2}$$

$$\overline{I_L} = \frac{\overline{V_0}}{R}$$

$$V_r = \frac{V_S}{fCR} \approx \frac{I_L}{fC}$$

$$\Delta\theta \approx \sqrt{2V_r/V_S}$$

$$i_{Davg} = I_L\left(1 + \pi\sqrt{2V_S/V_r}\right)$$

$$i_{Dmax} = I_L\left(1 + 2\pi\sqrt{2V_S/V_r}\right)$$

- **Full-Wave**

$$\overline{V_0} = V_S - \frac{V_r}{2}$$

$$\overline{I_L} = \frac{\overline{V_0}}{R}$$

$$V_r = \frac{V_S}{2fCR} \approx \frac{I_L}{2fC}$$

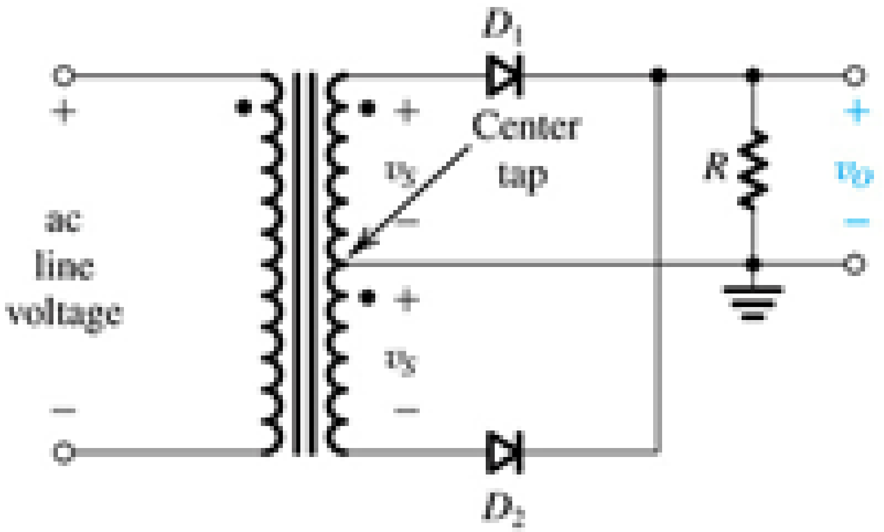
$$\Delta\theta \approx \sqrt{2V_r/V_S}$$

$$i_{Davg} = I_L\left(1 + \pi\sqrt{V_S/2V_r}\right)$$

$$i_{Dmax} = I_L\left(1 + 2\pi\sqrt{V_S/2V_r}\right)$$

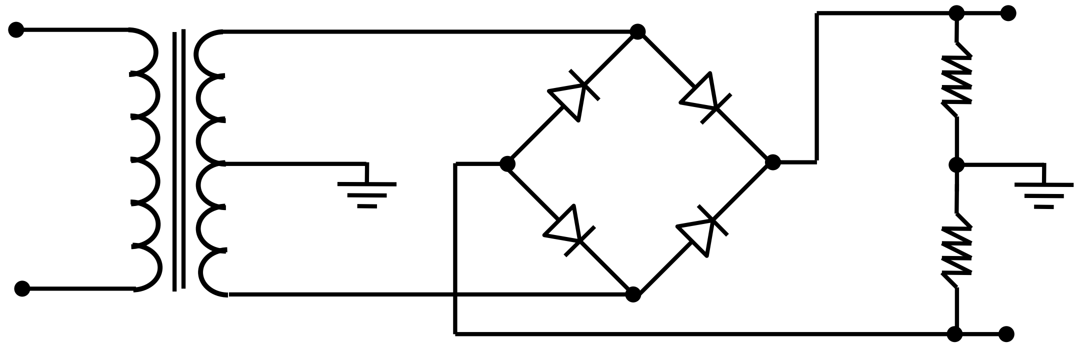
Problem 4.71

It is required to design a full-wave rectifier circuit using a center-tap transformer to provide an average output voltage of a) 10V and b) 100V. In each case find the required runs ratio of the transformer. Assume that a conducting diode has a voltage drop of 0.7V. The ac line is 120 V_{rms}.



Problem 4.74

The circuit provided below implements a complementary-output rectifier. Sketch and clearly label the waveforms of V_0^+ and V_0^-. Assume a 0.7-V drop across each conducting diode. If the magnitude of the average of each output is to be 15V, find the required amplitude of the sine wave across the entire secondary winding. What is the PIV of each diode?



Problem D 4.78

It is required to use a peak rectifier to design a dc power supply that provides an average dc output voltage of 15V on which a maximum of ±1-V ripple is allowed. The rectifier feeds a load of 150Ω. The rectifier is fed from the line voltage (120V_{rms}, 60Hz) through a transformer. The diodes available have a 0.7-V drop when conducting. If the designer opts for the half-wave rectifier circuit:

a) **Specify the rms voltage that must appear across the transformer secondary.**
b) **Find the required value of the filter capacitor.**
c) **Find the maximum reverse voltage that will appear across the diode, and specify the PIV rating of the diode.**
d) **Calculate the average current through the diode during conduction.**
e) **Calculate the peak diode current.**

Problem

A voltage regulator consisting of two diodes in series fed with a constant-current source is used as a replacement for a single carbon-zinc cell (battery) of nominal voltage 1.5V. The regulator load current varies from 2mA to 7mA. Constant-current supplies of 5mA, 10mA, and 15mA are available. Which would you choose, and why?

Example 4.7

The 6.8-V zener diode in the circuit below is specified to have V_z=6.8V at I_z=5mA, r_z=20Ω, and I_{ZK}=0.2mA. The supply voltage V^+ is nominally 10V but can vary by ±1V.

a) **Find V_0 with no load and with V^+ at its nominal value.**
b) **Find the change in V_0 resulting from the change in V^+ (also known as supply regulation).**
c) **Find the change in V_0 resulting from connecting a load resistance R_L that draws a current I_L=1mA, and hence find the load regulation ($\Delta V_0 / \Delta I_L$) in mV/mA.**
d) **Find the change in when R_L=2kΩ.**
e) **Find the change in when R_L=0.5kΩ.**
f) **What is the minimum value of R_L for which the diode still operates in the breakdown region?**