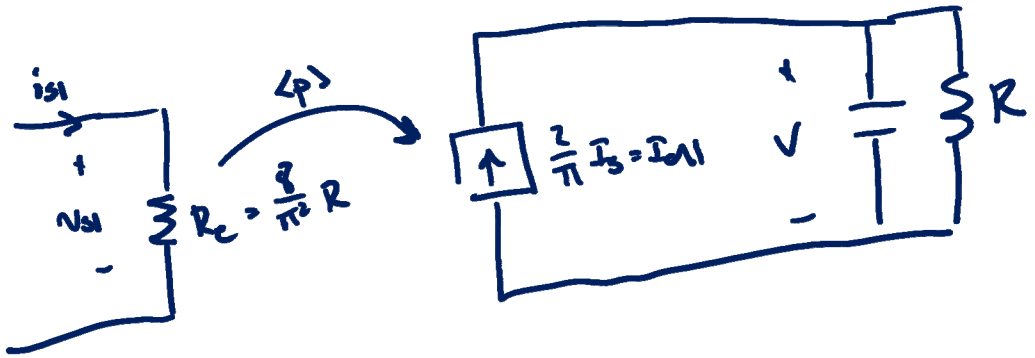
Diode Rectifier Equivalent Circuit



$$v_{s1}(t) = \frac{4}{\pi} V_{out} \sin(2\pi f_s t - \varphi_{ps})$$

$$i_{s1}(t) = I_s \sin(2\pi f_s t - \varphi_{ps})$$

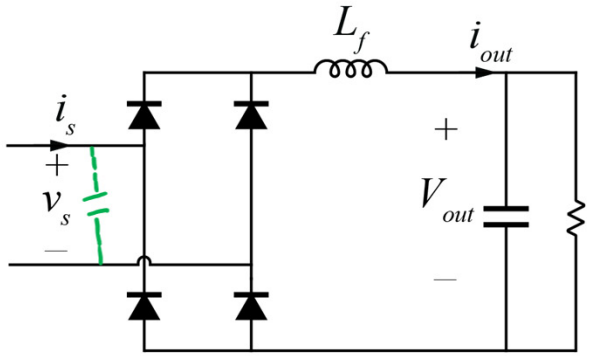
$$I_{out} = \frac{2}{\pi} I_s$$

$$V_{out} = I_{out} R = \frac{2}{\pi} I_s R$$

for ideal diode rectifier w/ voltage-source output & high-z input

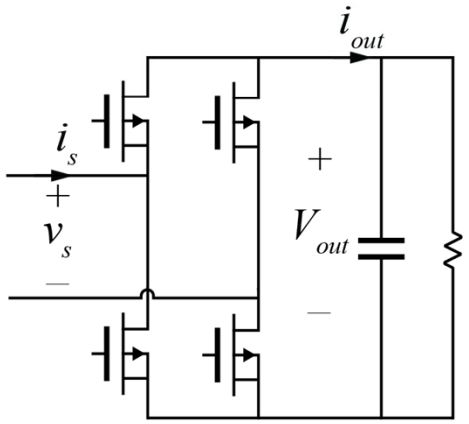
$$R_{rec} = \frac{v_{s1}(t)}{i_{s1}(t)} = \frac{\frac{4}{\pi} V_{out} \sin(2\pi f_s t - \varphi_{ps})}{I_s \sin(2\pi f_s t - \varphi_{ps})} = \frac{\frac{4}{\pi} \cdot \left(\frac{2}{\pi} I_s R\right)}{I_s} = \boxed{\frac{8}{\pi^2} R = R_e}$$

Other Implementations



Current-loaded rectifier

current, instead is a square wave
find fundamental & assume $V_{s1}(t)$ is sinusoid

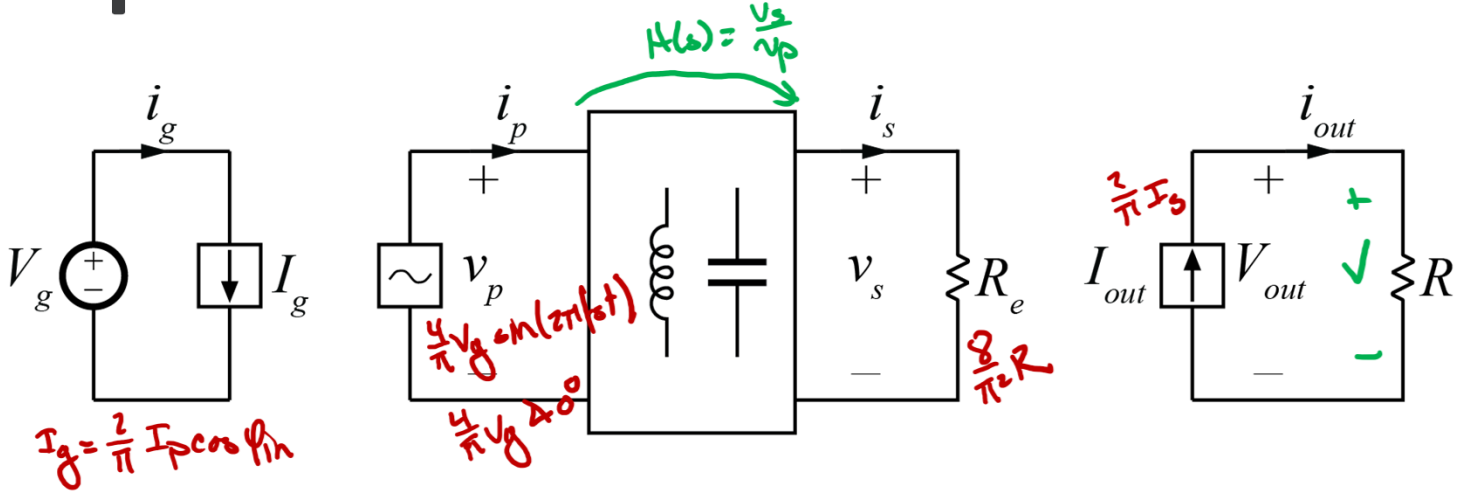


Active Rectifier

Can control phase & duty cycle of switching

$Z_{ac} = R_e + jX_e$

Complete Equivalent Circuit

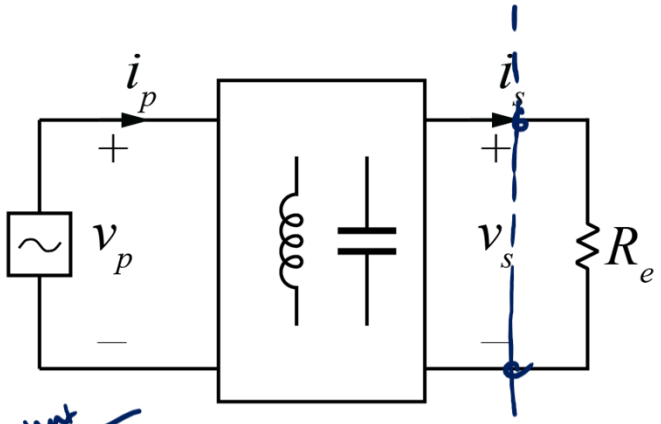


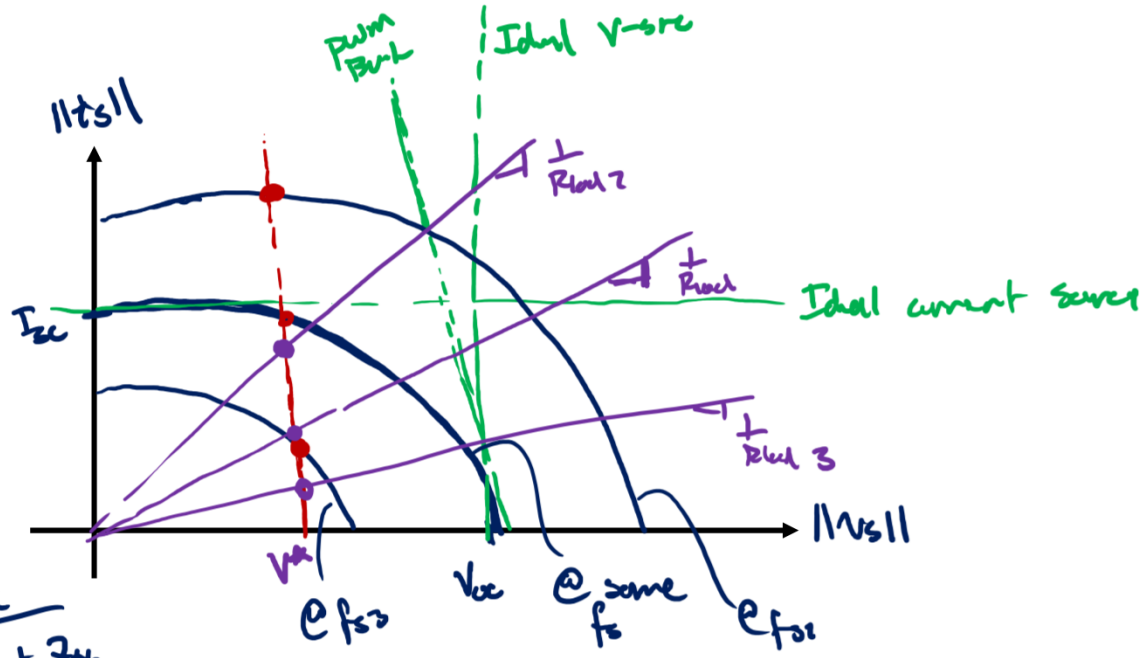
$$M = \frac{V}{V_g} = \frac{V}{I_{out}} \cdot \frac{I_{out}}{I_s} \cdot \frac{I_s}{V_s} \cdot \frac{V_s}{V_p} \cdot \frac{V_p}{V_g}$$

$$M = R \cdot \left(\frac{2}{\pi}\right) \frac{\pi^2}{8} \frac{1}{R} \left(|H(s)|_{s \to j\omega_s}\right) \cdot \frac{4}{\pi}$$

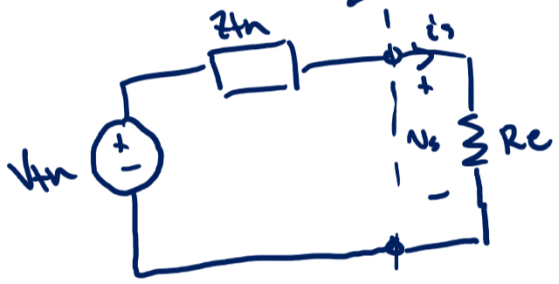
$$M = |H(s)|_{s \to j\omega_s}$$

Output Characteristic





Thevenin equivalent



$V_{oc} = V_{th}$ = open-circuit voltage

$$v_s = V_{th}\frac{R_e}{R_e + Z_{th}}$$

Assume Z_{th} is dominantly reactive $Z_{th} \simeq \emptyset + jX_{th}$

$$\|v_s\|^2 = \|V_{th}\|^2 \cdot \frac{R_e^2}{R_e^2 + X_{th}^2}$$

$$\frac{\|v_s\|^2 (R_e^2 + X_{th}^2)}{R_e^2 \|V_{th}\|^2} = 1$$

$$\frac{\|v_s\|^2 \cancel{R_e^2}}{\cancel{R_e^2}\|V_{th}\|^2} + \frac{\|v_s\|^2 X_{th}^2}{R_e^2 \|V_{th}\|^2} = 1 = \boxed{\frac{\|v_s\|^2}{\|V_{oc}\|^2} + \frac{\|i_s\|^2}{\|I_{sc}\|^2} = 1}$$