EE 442 / EGG 642
Power Electronics
Sept. 12, 2022
Lecture 4

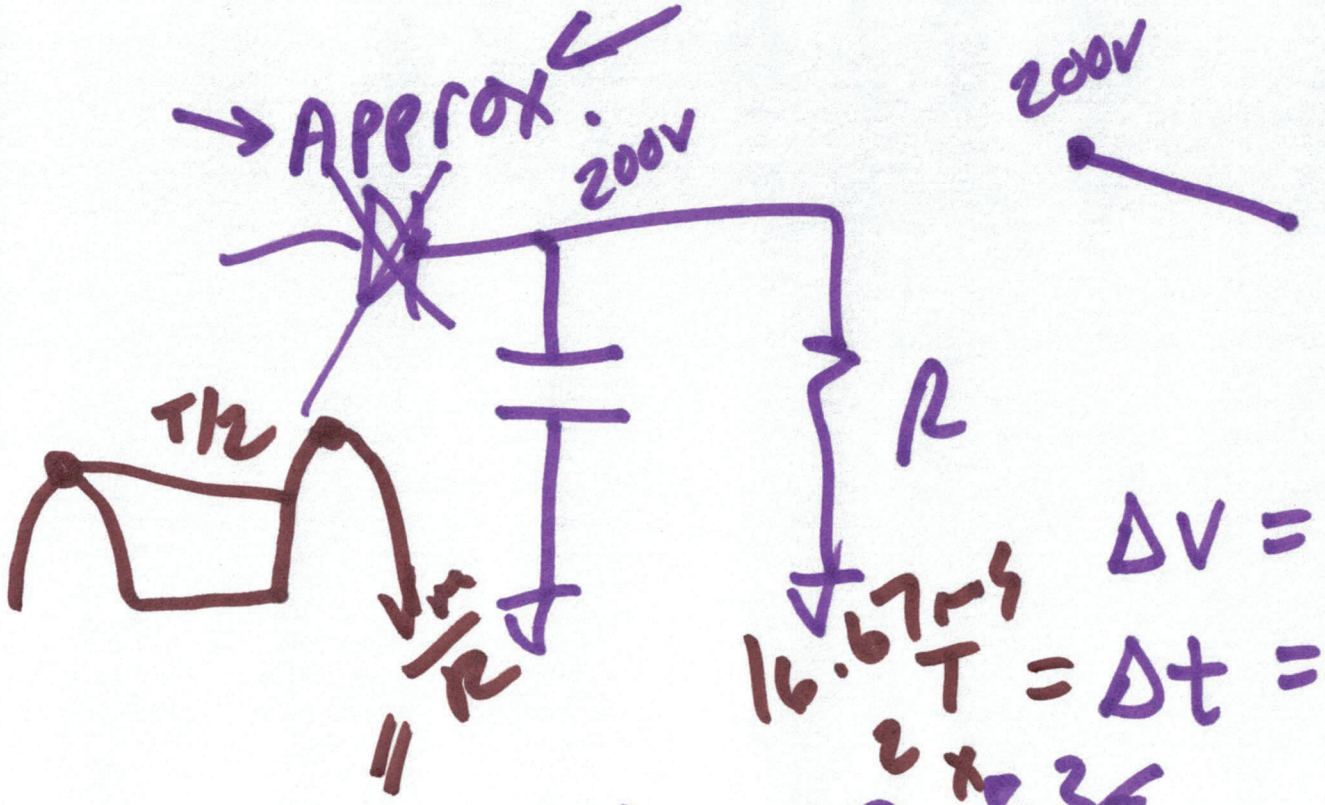
$V_m = 200V$, $R = 1K$, $C = 1mF$

$\omega = 377$

$RC = 1s$

$T = \frac{1}{60} = 16.67ms$

$RC >> \frac{1}{2}T$



$$I = C\frac{dV}{d\tau}$$

$$I = C\frac{\Delta V}{\Delta t}$$

$\Delta V = ripple$

$T = \Delta t = \frac{T}{2} \approx 8.3ms$

2×8.3

$\Delta V = \frac{I \cdot \Delta t}{C} = \frac{0.2 \cdot 8.3}{1m}$

$I = \frac{200}{1K} = 200mA$

$C = 1mF$

$\Delta V = 1.66V \times 2$

$3.2V$

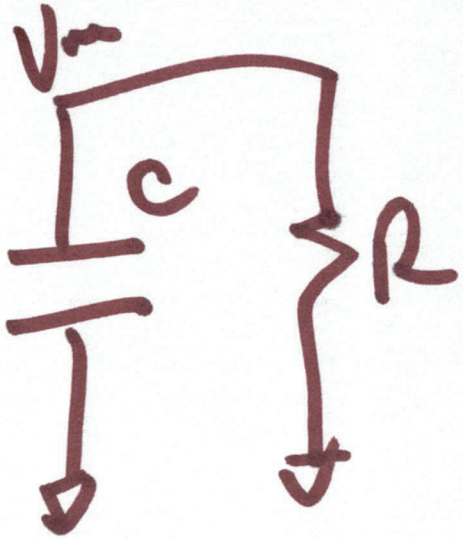
$\Delta V = \frac{V_m}{fRC} = \frac{I}{f \cdot C} = \frac{I}{C}$

$V_m \cdot e^{-t/RC} = \Delta V = 200\, e^{-\frac{16.6\text{ms}}{1\text{s}}}$

$\Delta V = 196.7$

$\Delta V = 200 - 196.7$

3.3V

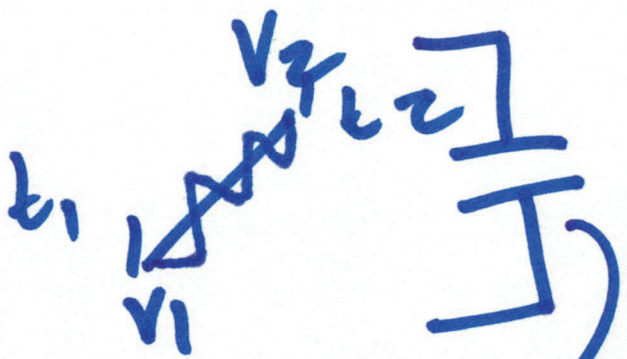


3)

Instantaneous power

$$p(t) = i(t) \cdot v(t)$$

$$\text{Energy} = \int_{t_1}^{t_2} p(t) \cdot dt$$

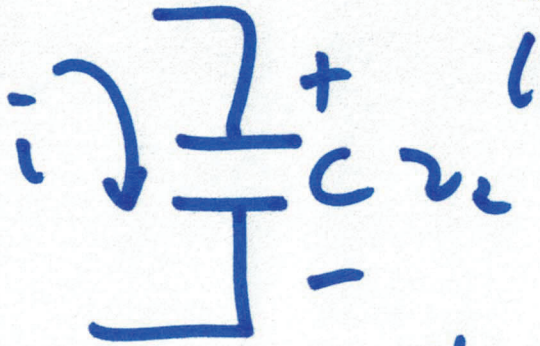


$$\mathcal{E} = \int_{t_1}^{t_2} \frac{Q}{t_2 - t_1} \cdot (V_2 - V_1) \cdot dt$$

$$CV = Q$$

$$C(V_2 - V_1) = Q$$

$$\mathcal{E} = \int_{t_1}^{t_2} \frac{C(V_2 - V_1)^2}{t_2 - t_1} dt$$



$$i = C\frac{dv_c}{dt}$$

$$p(t) = i(t) \cdot v_c(t)$$

$$\int_{v_1}^{v_2} p(t)\,dv = C\,v_c(t) \cdot \frac{dv_c(t)}{dt}$$

$$= C\int_{v_1}^{v_2} v \cdot dt$$

$$\mathcal{E} = \frac{1}{2}CV^2$$

$$\boxed{\mathcal{E} = \frac{1}{2}CV^2}$$

$$\mathcal{E}_f = \int_0^{\mathcal{E}_f} d\mathcal{E} = \int_0^{V_f} \underbrace{C \cdot v}_{Q}\, dv$$

$$\boxed{\mathcal{E}_f = \frac{1}{2} C V_f^2}$$

$$\boxed{\mathcal{E}_L = \frac{1}{2} L I^2}$$

$$i \cdot v = \frac{L\, di}{dt} \cdot i = \frac{d\mathcal{E}}{dt} = p(t)$$

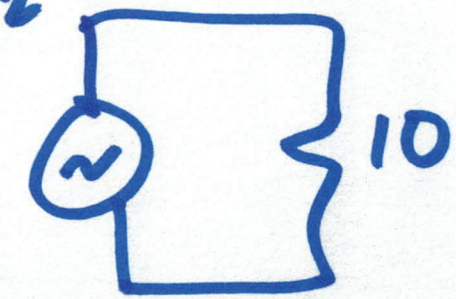
Power from a DC source

$$P_{DC} = \frac{1}{T}\int_{t_0}^{t_0+T} v_{DC}(t)\cdot i(t)\,dt$$

$$P = \frac{V^2}{R} = I^2R = VI = \frac{1V^2}{10} = \frac{1}{10}$$

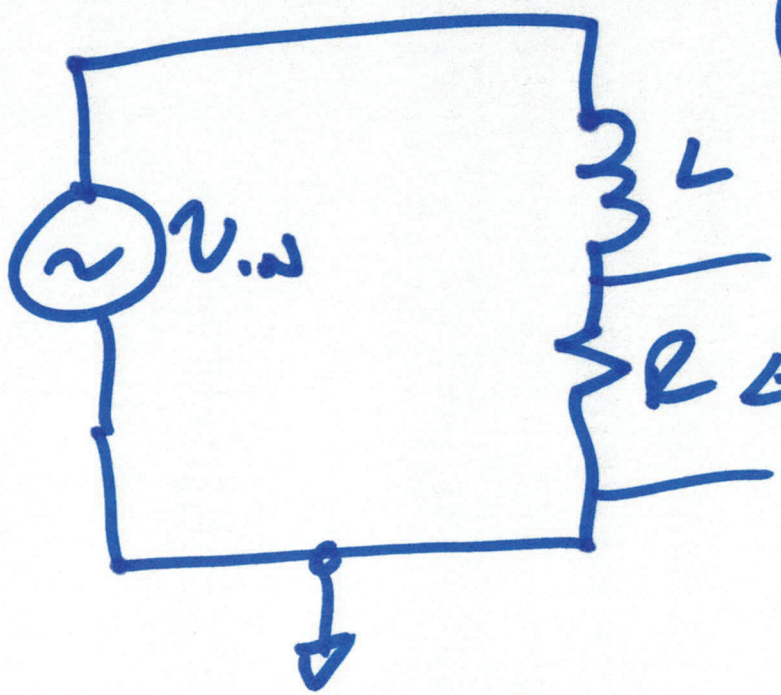
100mW

$1V\cdot\sqrt{2} = 1.414V$



TRUE (Real) Power

$P = \frac{V^2}{R}$

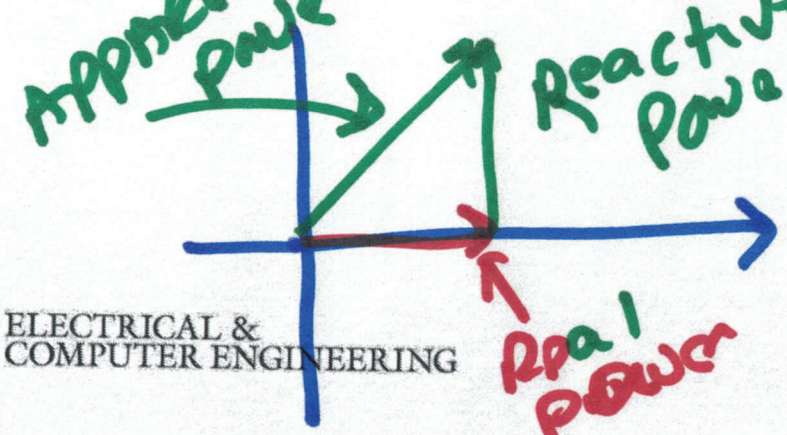


$$P = \frac{V_{in} \cdot R}{R + j\omega L} \cdot \frac{V_{in} \cdot R}{R + j\omega L} \cdot \frac{1}{R}$$

$\frac{V^2}{R}$

WATTS

Reactive Power



$$Q = \frac{V_{in} \cdot j\omega L}{R + j\omega L} \cdot \frac{V_{in} \cdot j\omega L}{R + j\omega L} \cdot \frac{1}{j\omega L}$$

$\frac{V^2}{X}$ ← reactance

VAR

Apparent power

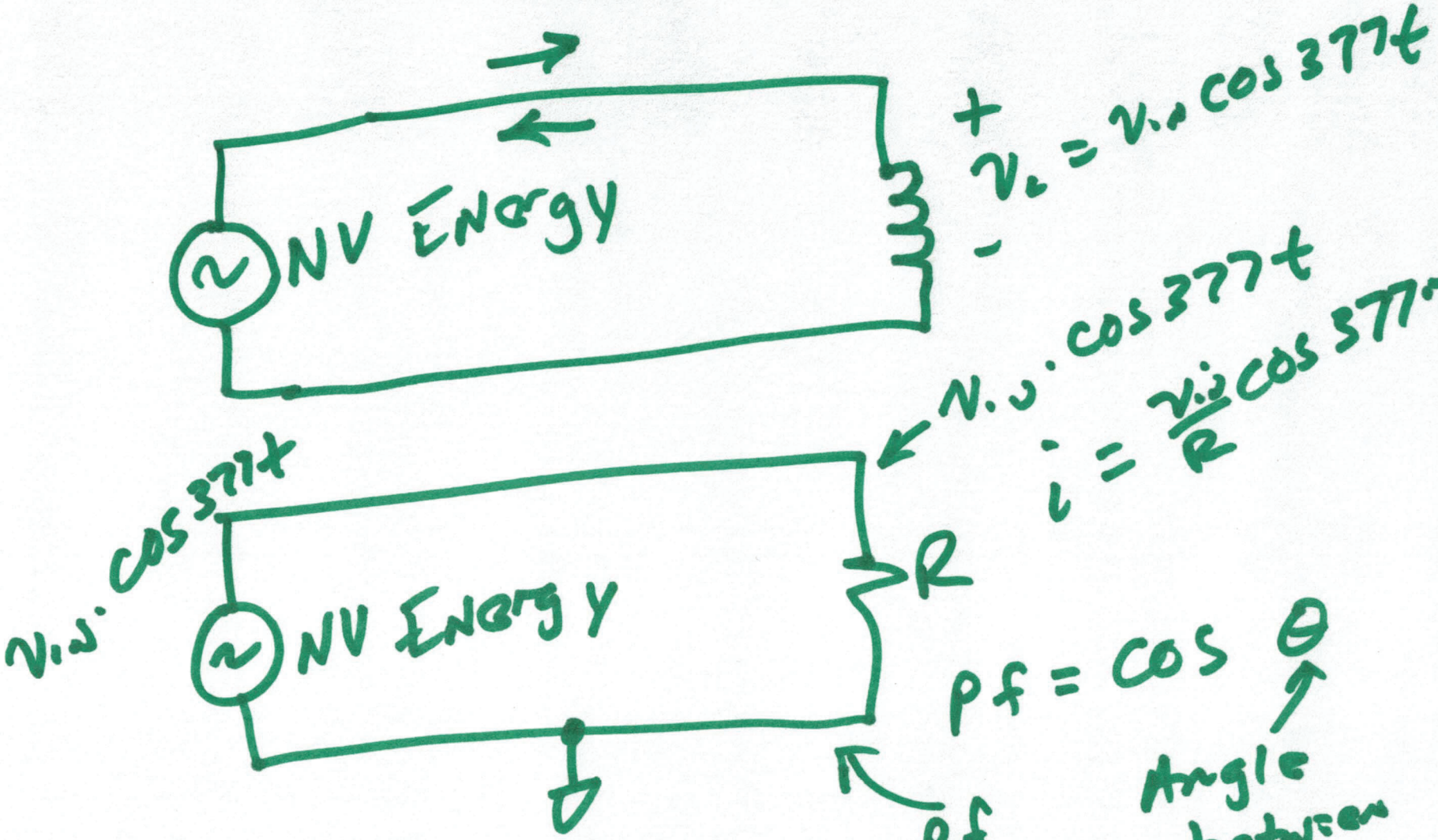
$$S = \frac{V_{in}^2}{jWL + R} = P + Q$$

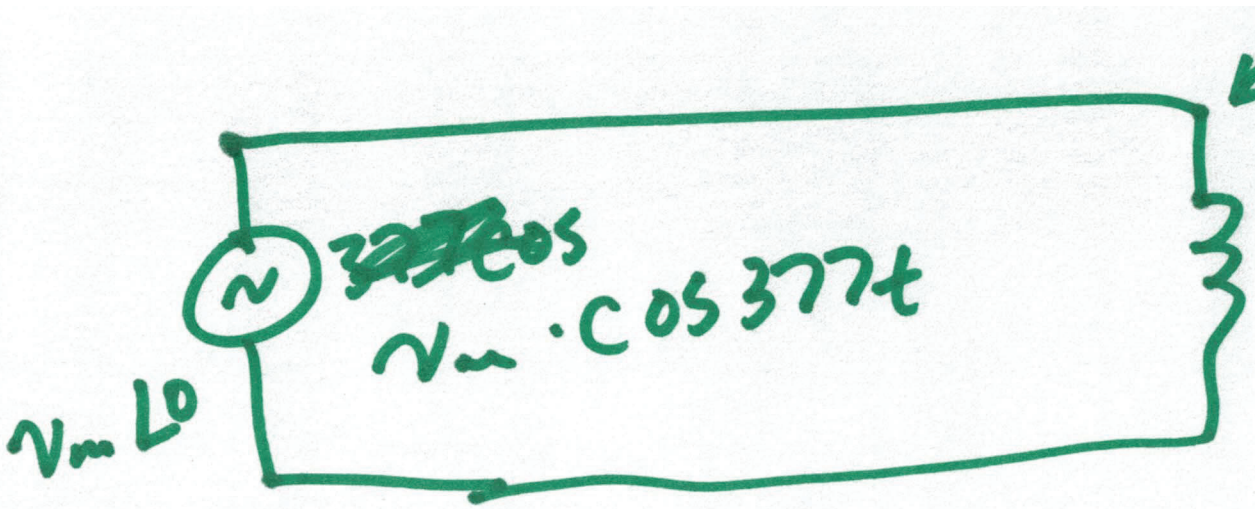
WATTS, VAR

$$= \frac{V_{in}^2 R + jWL \cdot V_{in}^2}{(jWL + R)^2} = P + Q$$

$$= \frac{V_{in}^2 \cdot (jWL + R)}{(jWL + R)^2}$$

VA


NV Energy
NV Energy
R
p.f. = 1
pf = cos θ
Angle between voltage AND current



$$\dot{i} = \frac{v_m \angle 0}{j\omega L}$$

$$i(t) = \frac{v_m}{2\pi f \cdot L} \cos(377t - 90)$$

$$= \frac{v_m \angle 0}{2\pi f \cdot L \angle 90}$$

$$= \frac{v_m}{2\pi f \cdot L} \angle -90$$

$$p.f. = \cos(\pm 90)$$

$$= 0$$

bad

$$\omega_0 = \frac{1}{2\pi\sqrt{L \cdot C}}$$