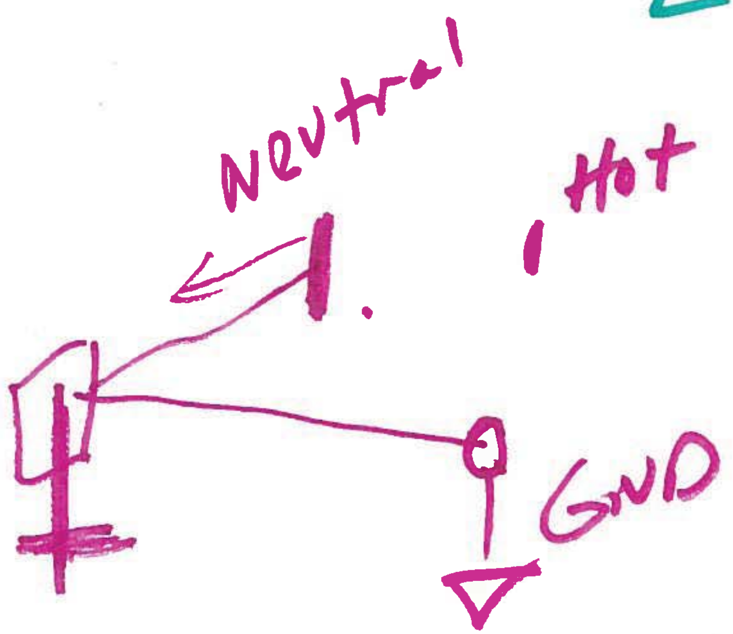
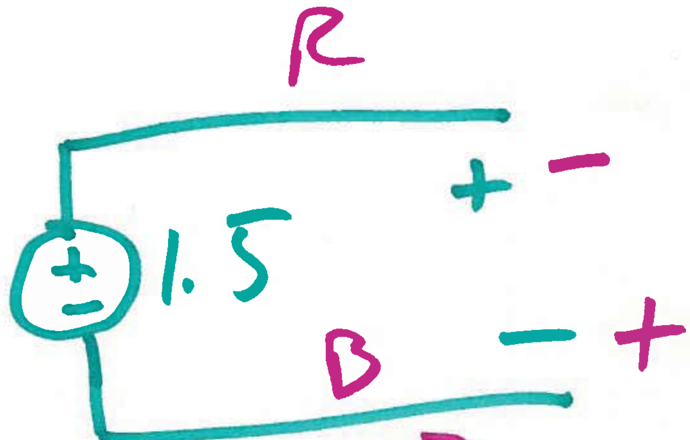
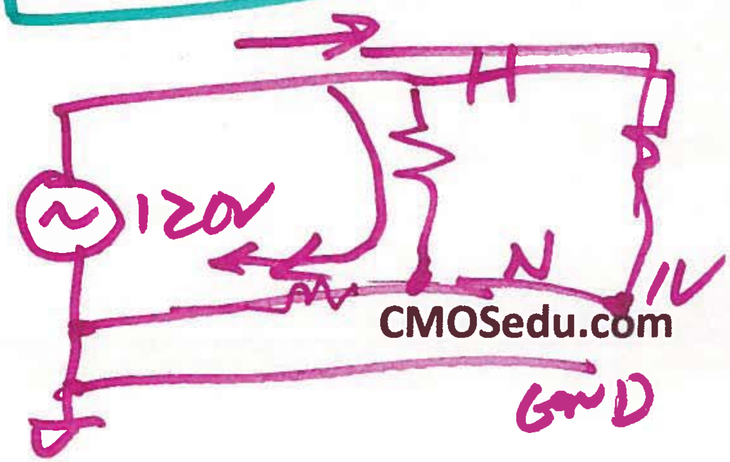
EE 220
Circuits 1

Nov. 6, 2017

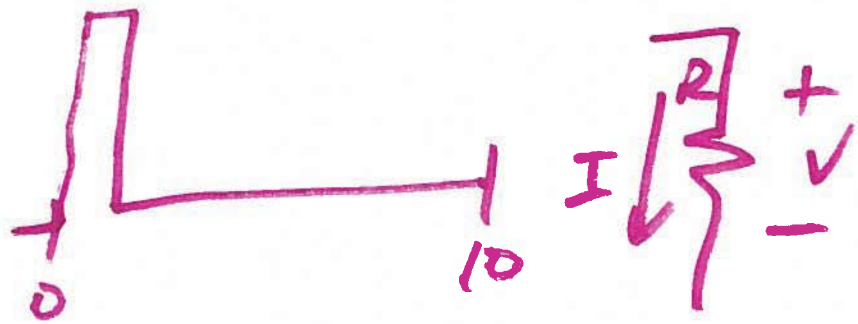
Lecture 19



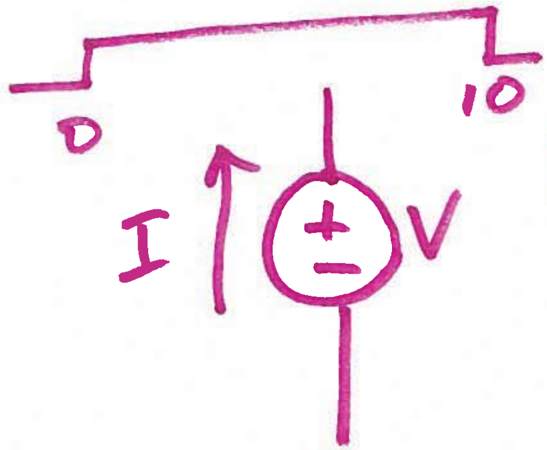




Energy & Power



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



$P = -I \cdot V$ neg. power indicates supplying power

$\text{power, WATTS} = \frac{\text{Energy, Joules}}{\text{time, seconds}}$

1.5V 1.5mA·H → $E|_{\text{stored}} = 2.25 \cdot 3600$ Joule

2.25 mW H

Ideal CAPACITOR & inductor don't dissipate power

$\mathcal{E} = 200 \cdot 12 \cdot 5$ Joules

they store energy!

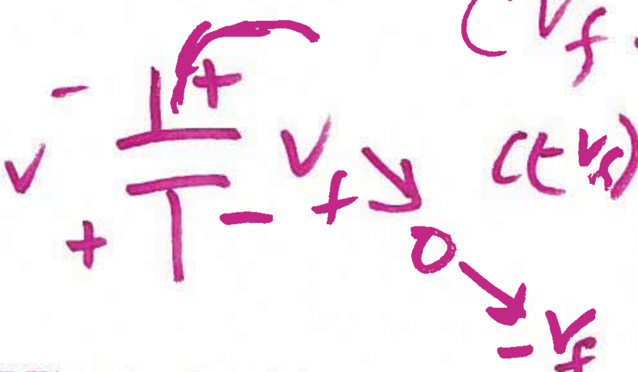
IF

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

$$\mathcal{E} = \int p(t) \cdot dt = \text{Energy}$$

$$i(t) = C \frac{dv(t)}{dt}$$

$$CV_f = Q$$

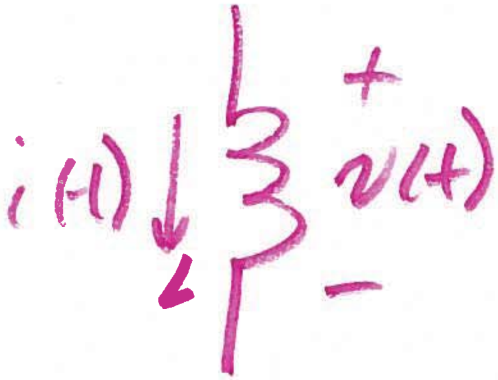


$$= \int_0^{V_f} v(t) \cdot C \cdot \frac{dv(t)}{dt} \cdot dt$$

$$= C \cdot \frac{1}{2} v^2 \Big|_0^{V_f} = \frac{1}{2} C V_f^2 = \mathcal{E}$$

Inductor Energy storage

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



$$\mathcal{E} = \int p(t) \cdot dt$$

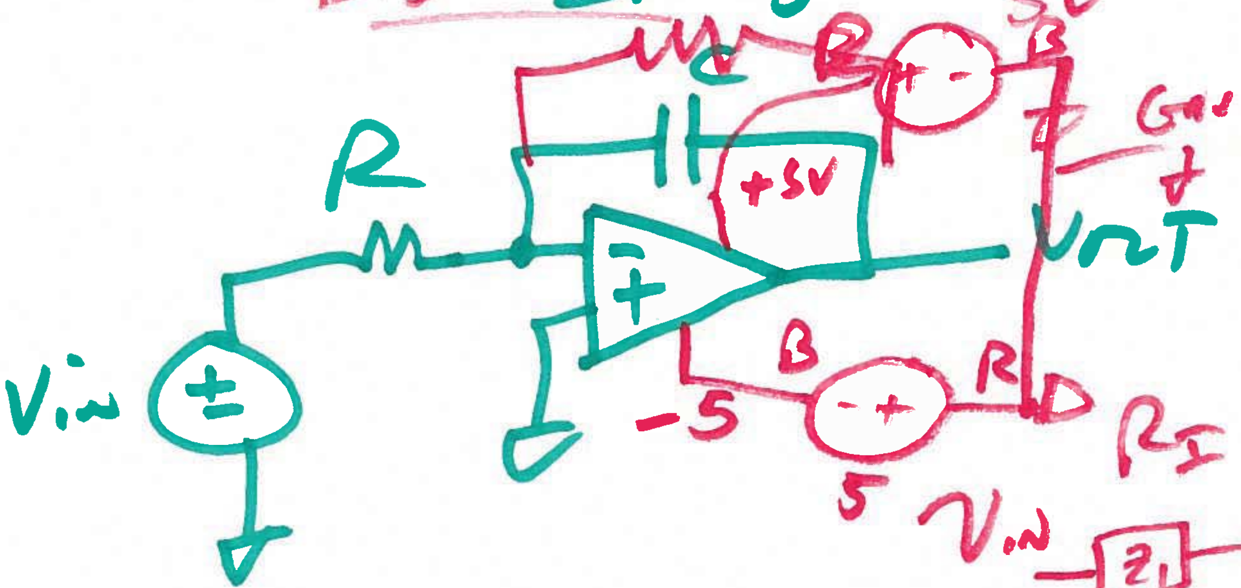
$$v(t) = L \cdot \frac{di(t)}{dt}$$

$$\mathcal{E} = L\int_0^I i(t) \cdot \frac{di(t)}{\cancel{dt}} \cdot \cancel{dt}$$

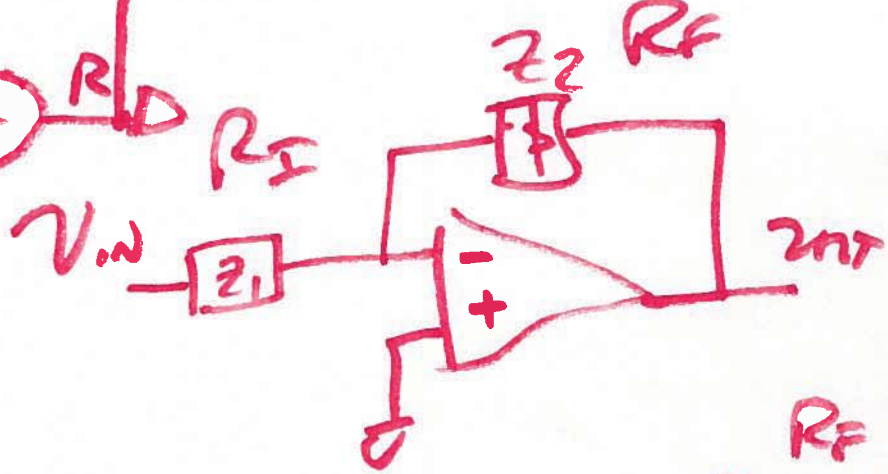
$$\boxed{\mathcal{E} = \frac{1}{2} L I^2}$$

Bias = 10k

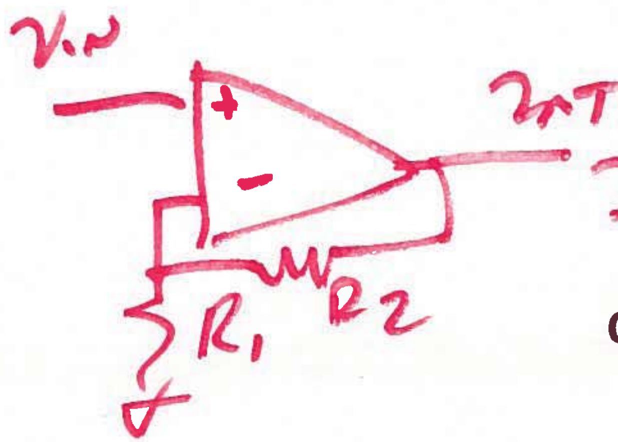
Integrator



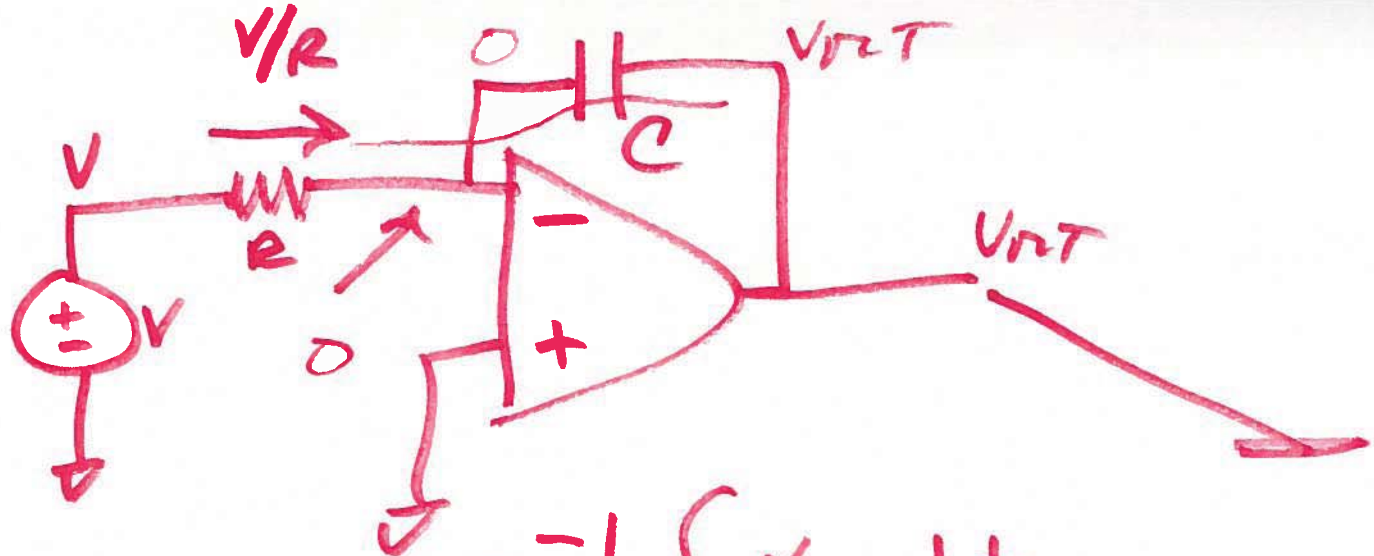
Inverting

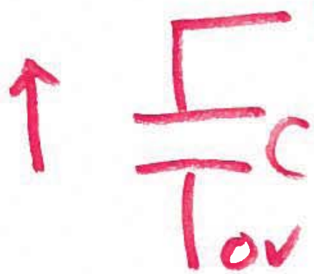


$$\frac{v_{out}}{v_{in}} = -\frac{Z_2}{Z_1} \quad \left(\frac{R_F}{R_I}\right)$$



$$\frac{v_{out}}{v_{in}} = 1 + \frac{R_2}{R_1} = \frac{R_1 + R_2}{R_1}$$

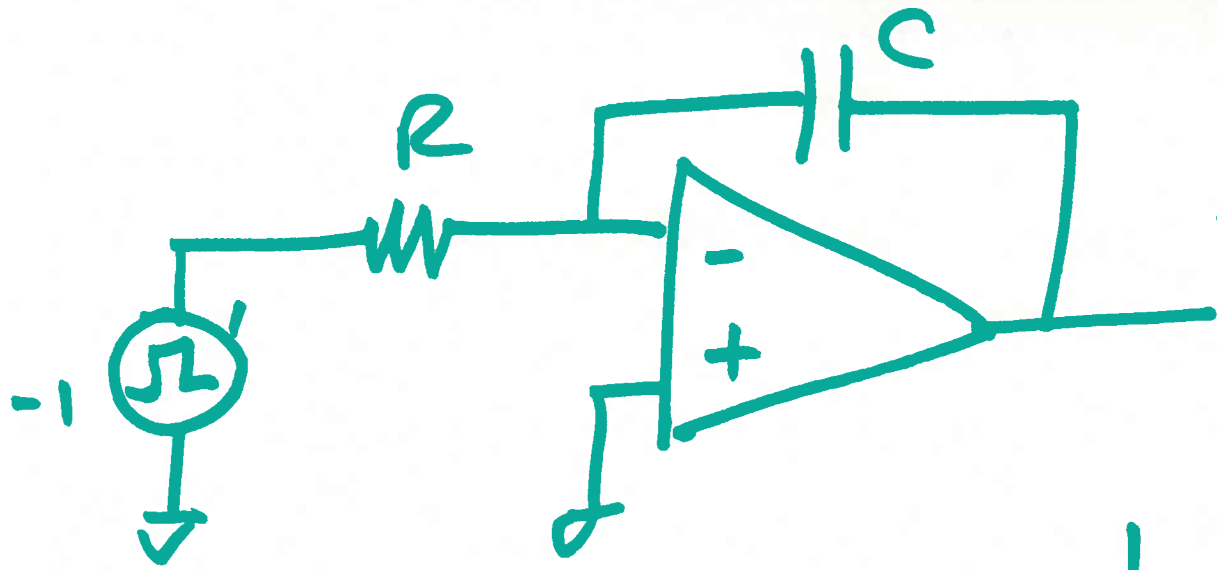


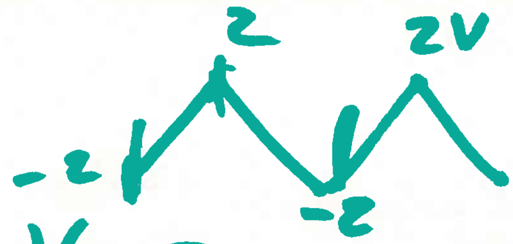


$$V_{OUT} = \frac{-1}{C}\int \frac{V}{R}\cdot dt$$

$$= -\frac{1}{RC}\cdot\int_0^t v\cdot dt$$

$$V_{OUT} = -\frac{1}{RC}\cdot V\cdot t$$





V_{OUT}

1 KHz

$$V_{OUT} = \frac{1}{RC} \cdot \int_0^{\frac{1}{2} ms\ T=} \pm 1 \cdot dt$$

10^3 Hz

$$T = \frac{1}{f} = 1ms$$

$$\frac{1}{R \cdot 10^{-6}} \cdot \frac{1}{2} ms = 4 = \frac{1}{RC} \cdot \int_0^{\frac{1}{2} ms} 1 \cdot dt$$

$$\frac{0.5 \cdot 10^3}{R} = 4$$

C = 1μF

$$R = \frac{0.5 \cdot 10^3}{4} = 125$$