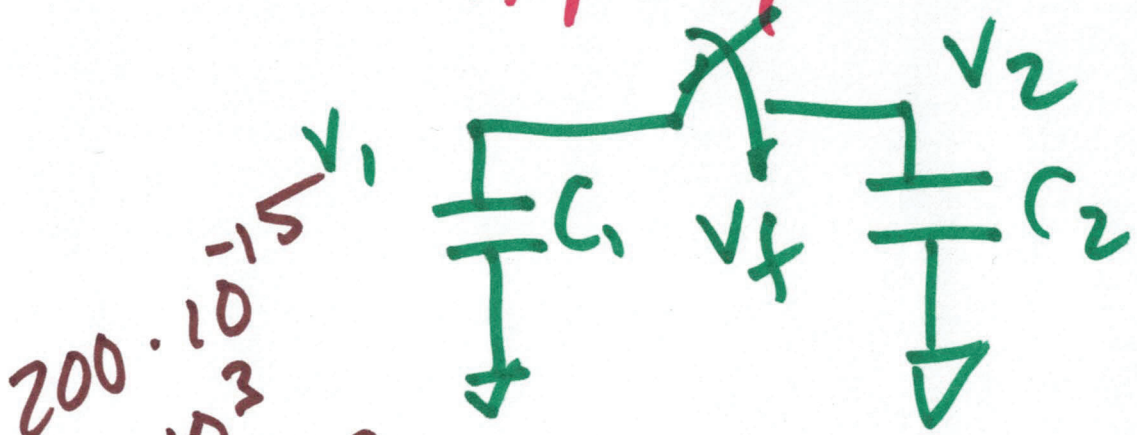
EE 220 Circuits I
Lecture 22
11/21/2022

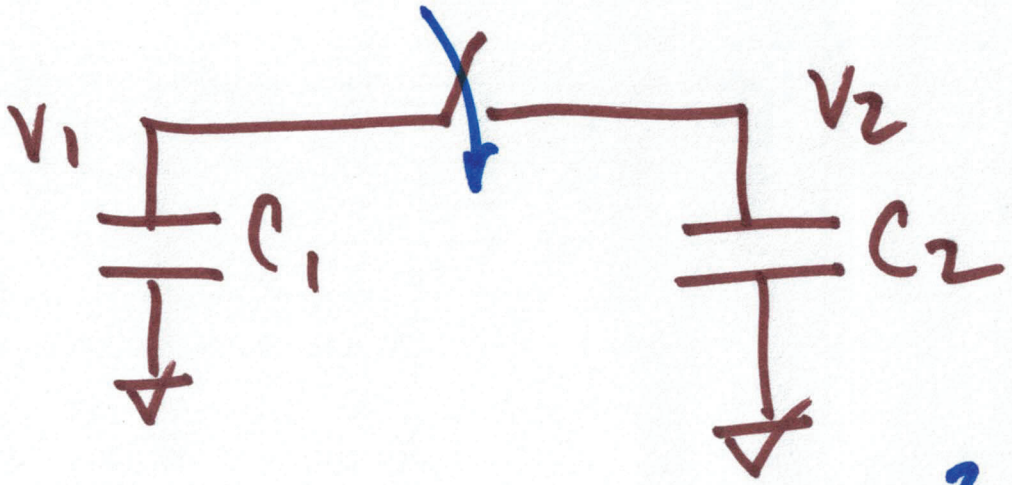


$CV = Q$

$200 \cdot 10^{-15}$
10^3
$200 \cdot 10^{-12}$
200PS
0.2NS

$$C_1V_1 + C_2V_2 = (C_1 + C_2)V_f$$

$$V_f = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$



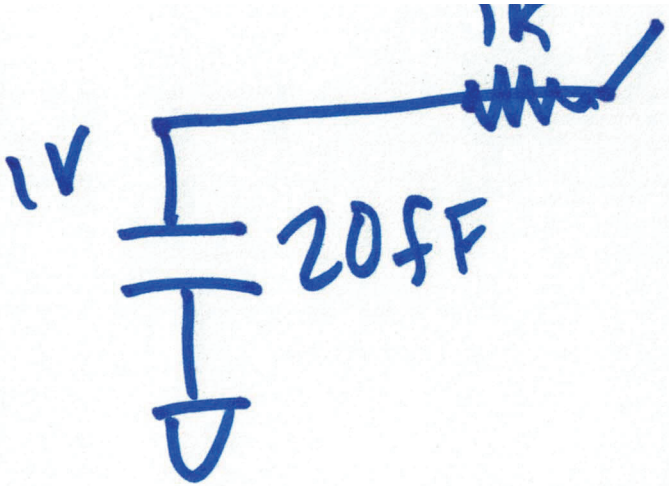
$$\frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 \stackrel{?}{=} \frac{1}{2}(C_1+C_2)V_f^2$$

$$V_f = \frac{C_1V_1 + C_2V_2}{C_1+C_2}$$

$$\frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 \stackrel{?}{=} \frac{1}{2}\cancel{(C_1+C_2)}\cdot\frac{(C_1V_1+C_2V_2)^2}{(C_1+C_2)^{\cancel{2}}}$$

$$\stackrel{?}{=} \frac{1}{2}\frac{C_1^2}{C_1+C_2}V_1^2 + \frac{1}{2}\frac{C_2^2}{C_1+C_2}V_2^2$$

NO



$$\mathcal{E}_{before} = \frac{1}{2}\cdot 20fF \cdot 1^2 + \frac{1}{2}\cdot 180fF\,(0.5)^2$$

$$= 10fJ + 22.5fJ = 32.5fJ$$

$$\mathcal{E}_{drift} = 32.5 - 30.25 = 2.25fJ$$

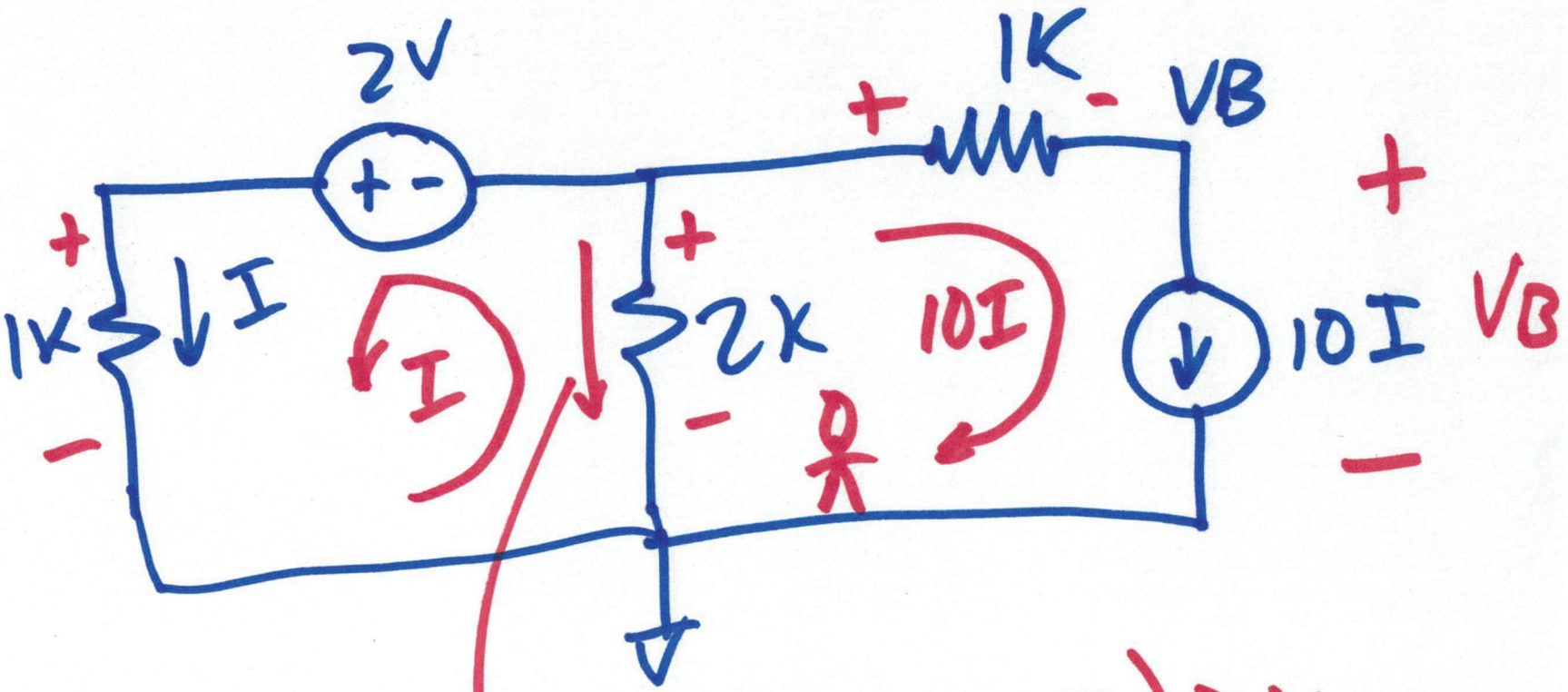
$$V_f = \frac{20fF\cdot 1 + 180fF\cdot\frac{1}{2}}{20f + 180f}$$

$$V_f = \frac{110}{200} = .55V$$

$$\mathcal{E}_{final} = \frac{1}{2}(200ff)\cdot .55^2$$

$$= 30.25fJ$$

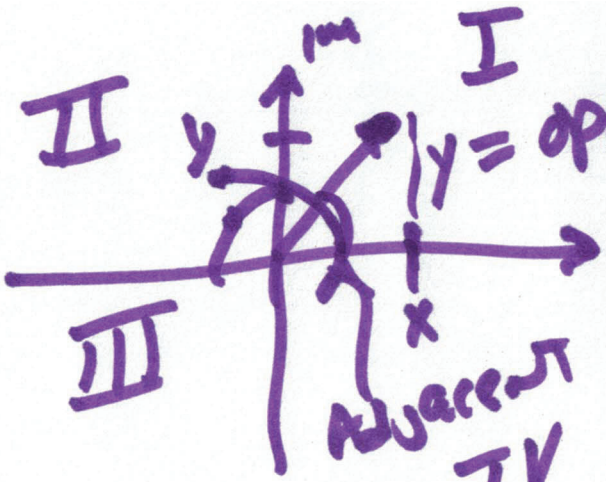
b)



$$(-I-10I)2K$$

$$V_B + 10I \cdot 1K - 2k(-I-10I) = 0$$

$$2k(-I-10I) + 2 - 1KI = 0$$



Re . Im

$x + jy = A\angle\theta$ rect. polar

$A = |x+jy| = \sqrt{x^2+y^2}$

$\angle\theta = \angle x+jy = \tan^{-1}\frac{y}{x}$

$a_1 + jb_1 + a_2 + jb_2$

$= (a_1+a_2) + j(b_1+b_2)$

$A_1 \cdot A_2 \angle\theta_1+\theta_2 = A_1\angle\theta_1 + A_2\angle\theta_2$

$A_1\cos\theta_1 + jA_1\sin\theta_1 + A_2\cos\theta_2 + jA_2\sin\theta_2$

$$\frac{x_1 + jy_1}{x_2 + jy_2} = \frac{\sqrt{x_1^2 + y_1^2}\ \angle \tan^{-1}\frac{y_1}{x_1}}{\sqrt{x_2^2 + y_2^2}\ \angle \tan^{-1}\frac{y_2}{x_2}}$$

$$= \frac{\sqrt{x_1^2 + y_1^2}}{\sqrt{x_2^2 + y_2^2}}\ \angle \tan^{-1}\frac{y_1}{x_1} - \tan^{-1}\frac{y_2}{x_2}$$

$$\frac{1}{x+jy} \cdot \underbrace{\frac{x-jy}{x-jy}}_{=1} = \frac{x+j(-y)}{x^2+y^2}$$

$$= \frac{x}{x^2+y^2} + j\,\frac{-y}{x^2+y^2}$$

$$\left|\frac{1}{x+jy}\right| = \sqrt{\frac{x^2}{(x^2+y^2)^2} + \frac{(-y)^2}{(x^2+y^2)^2}}$$

$$\frac{1}{\sqrt{x^2+y^2}} = \sqrt{\frac{x^2+y^2}{(x^2+y^2)^2}}$$

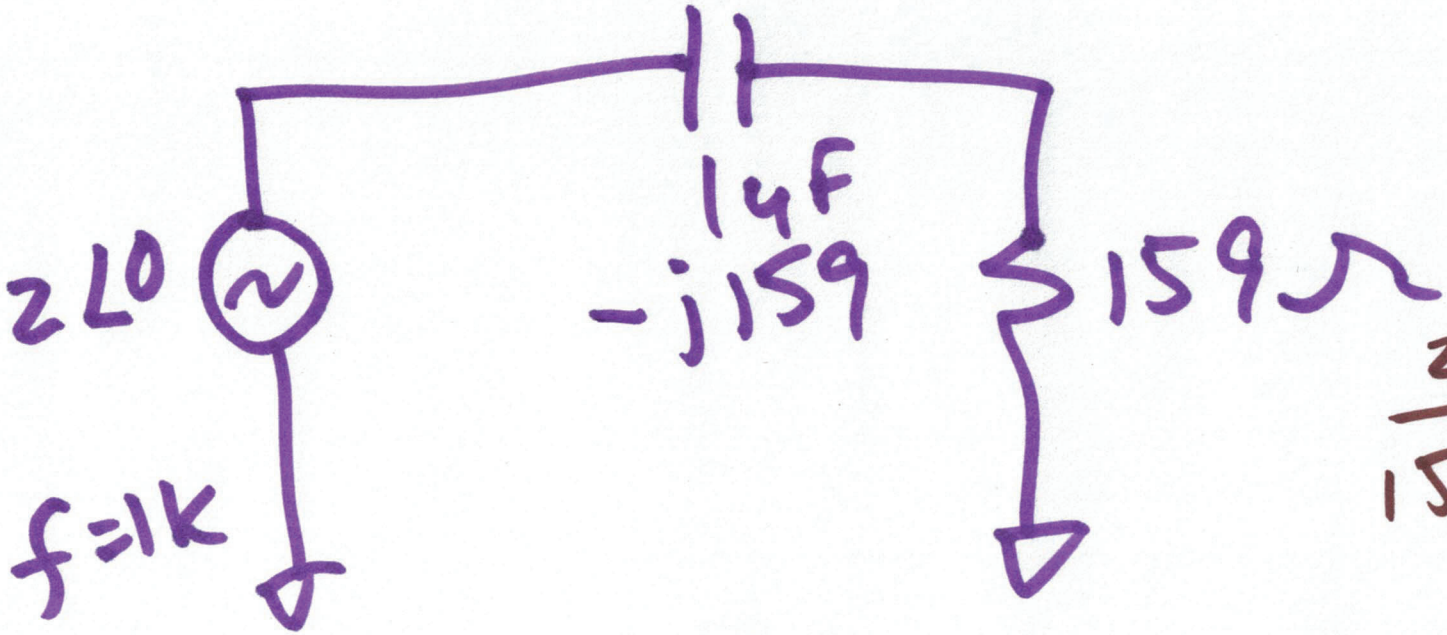
$$\angle = \tan^{-1} \frac{\frac{-y}{x^2+y^2}}{\frac{x}{x^2+y^2}}$$

$$= \tan^{-1} -\frac{y}{x} = -\tan^{-1}\frac{y}{x}$$

$$\left|\frac{1}{x+jy}\right| = \frac{1}{\sqrt{x^2+y^2}}$$

$$\angle \frac{1}{x+jy} = -\tan^{-1}\frac{y}{x}$$

b)



$$Z = \frac{1}{j2\pi f \cdot C} = \frac{1}{j\omega C}$$

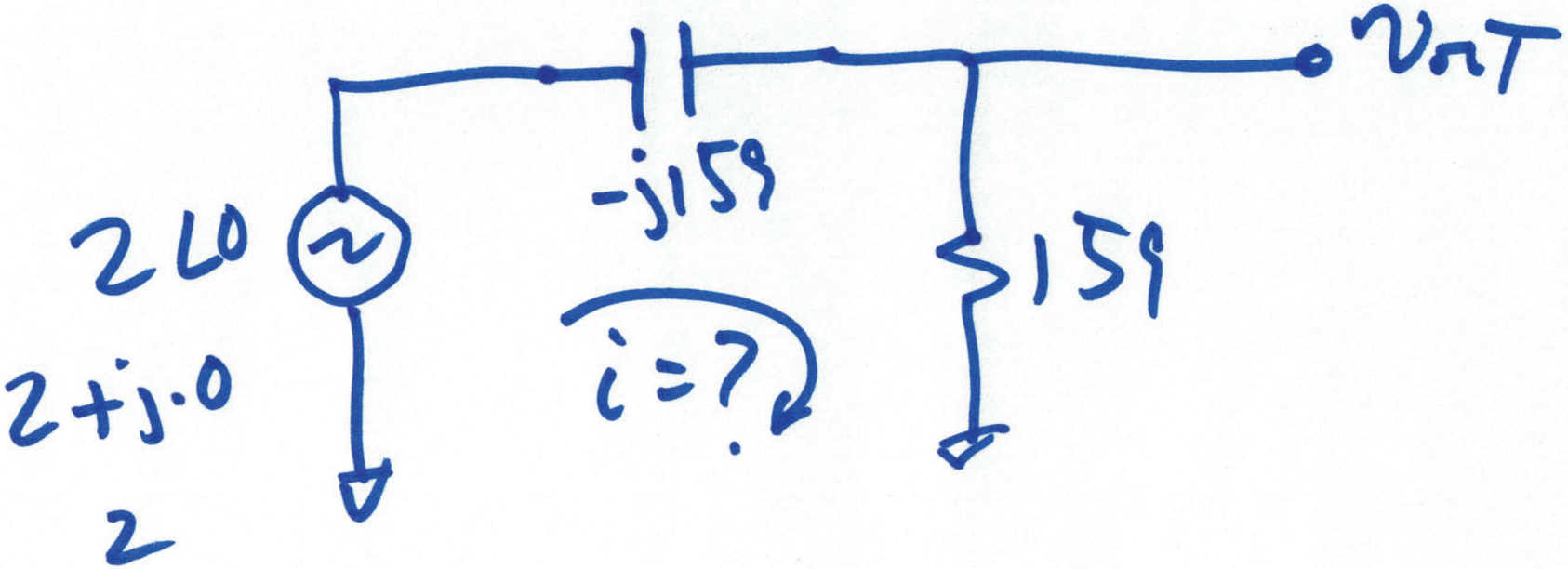
$$= \frac{1}{j \cdot 2\pi \cdot 10^3 \cdot 10^{-6}} = \frac{j}{j}\frac{1}{j} = -j159$$

$$\frac{2\angle 0}{159 + j(-159)}$$

$$= \frac{2\angle 0}{159 \cdot \sqrt{2}\angle -45^\circ}$$

$$\frac{2}{159 \cdot \sqrt{2}}\angle 45^\circ$$

$$8.9\,mA\angle 45^\circ$$



$$V_{OUT} = \frac{159}{159 + j(-159)} \cdot 2\angle 0$$

$$= \frac{1}{1-j} 2\angle 0$$

-45^0

$$V_{RT} = \frac{1\angle 0 \cdot 2\angle 0}{\sqrt{(1)^2+(-1)^2}\ \tan^{-1}\frac{-1}{1}} = -45$$

$$= \frac{2\angle 0}{\sqrt{2}\angle -45^\circ} = \frac{2}{\sqrt{2}}\angle +45^\circ$$

$$= 1.41V \angle 45^\circ$$

$$\frac{t_d}{T} \cdot 360 = \theta$$

$$T = \frac{1}{1k} = 1ms \qquad \frac{45}{360} = \frac{t_d}{1ms}$$

$$t_d = 0.125ms = 125\mu s$$