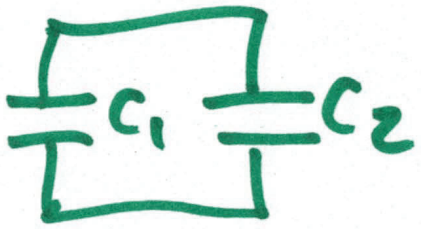
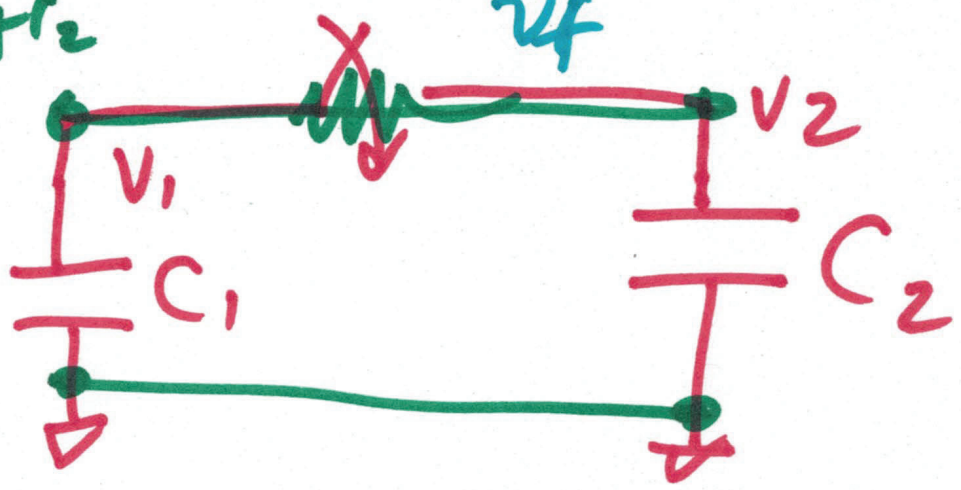
EE 220 circuits 1

Lecture 22

NOV. 16, 2020



$\frac{1}{T}$ $C_1 + C_2$



Micron = 10^{-6} meters

ITIC

Drain

$CV = Q$

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

$a = 10^{-18}$

$f = 10^{-15}$

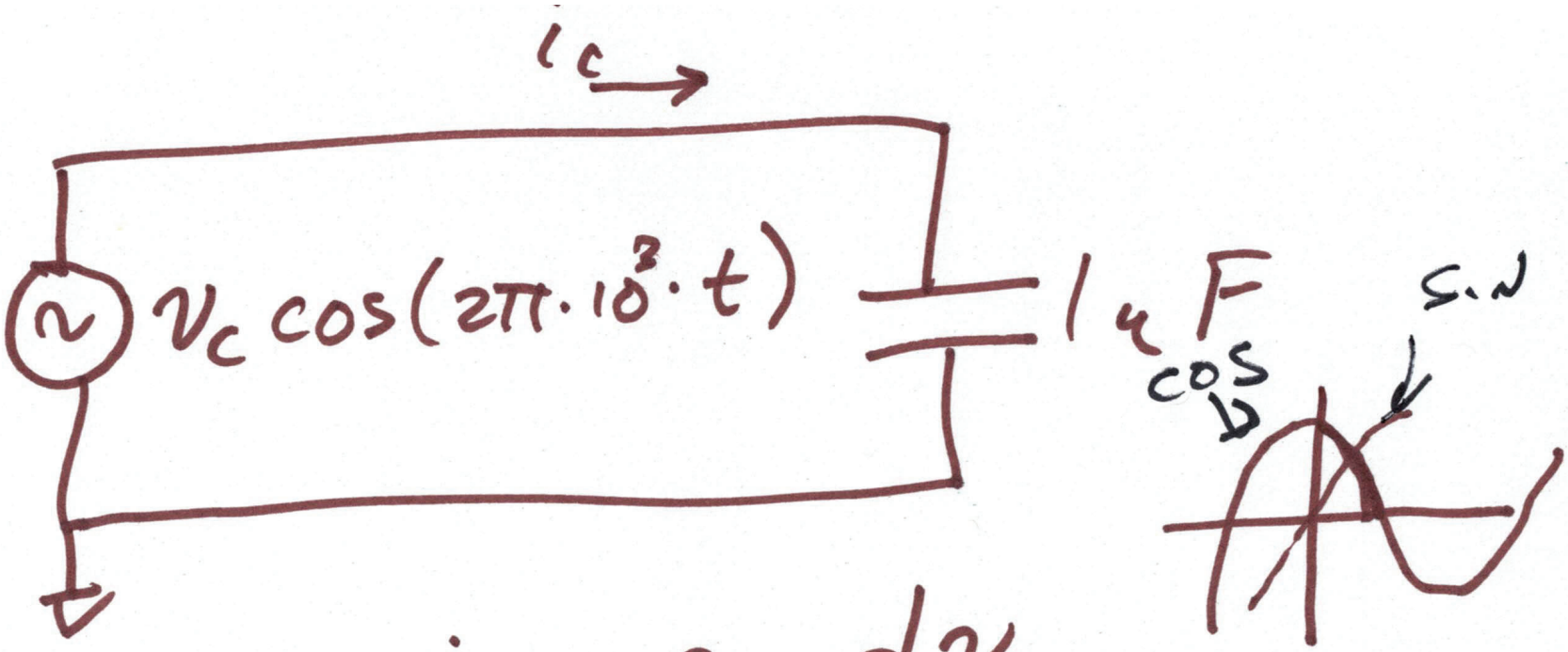
$p = 10^{-12}$

$n = 10^{-9}$

$\mu = 10^{-6}$

$Q_1 = C_1V_1$ $\quad Q_2 = C_2V_2$

$Q_1 + Q_2 = Q_f = (C_1 + C_2) \cdot V_f = C_1V_1 + C_2V_2$



$$i_c = C \cdot \frac{dv_c}{dt}$$

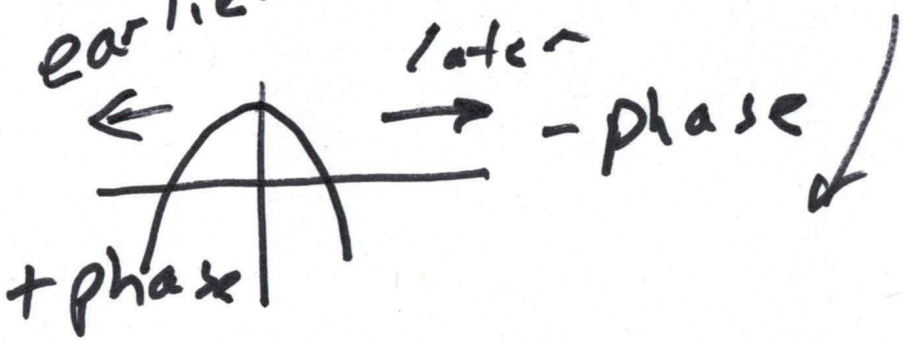
$$= 10^{-6} \cdot \frac{d}{dt}(\cos 2\pi \cdot 10^3 \cdot t)$$

$$-10^{-6} \cdot 2\pi \cdot 10^3 \cdot \sin(2\pi 10^3 \cdot t) \quad = -10^{-6} \cdot (\sin 2\pi \cdot 10^3 t) \cdot \frac{d\, 2\pi \cdot 10^3 \cdot t}{dt}$$

$$v_i(t) = V_c \cos(2\pi \cdot 1kHz \cdot t)$$

$$i_c(t) = -2\pi \cdot 10^{-3} \sin(2\pi \cdot 10^3 \cdot t)$$

$$i_c = -2\pi \cdot 10^{-3} \cdot \cos(2\pi \cdot 10^3 \cdot t + 90)$$

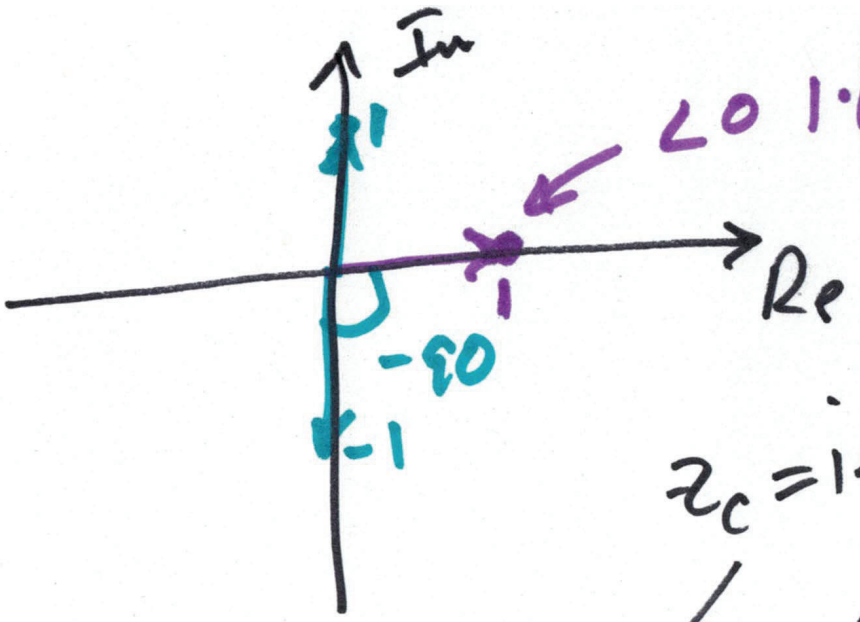


$$i_c(t) = \frac{2\pi \cdot 10^{-3}}{2\pi f \cdot C} \cos(2\pi 10^3 \cdot t + 270^\circ)$$

$$= 2\pi \cdot 10^{-3} \cos(2\pi 10^3 \cdot t - 90)$$

$$\frac{i_c(t)}{2\pi f \cdot C} = \frac{i_c}{\omega C}$$

$$\omega = 2\pi f$$



$1 + j0 \rightarrow \sqrt{1^2+0^2} = 1$

$\angle = \tan^{-1}\frac{0}{1} = 0$

Z_C = impedance of capacitor

$0 + j\cdot 1 \rightarrow \sqrt{0^2+1^2} = 1$

$\angle = \tan^{-1}\frac{1}{0} = 90^\circ$

$$v_c = i_c \cdot \frac{1}{j\omega C}$$

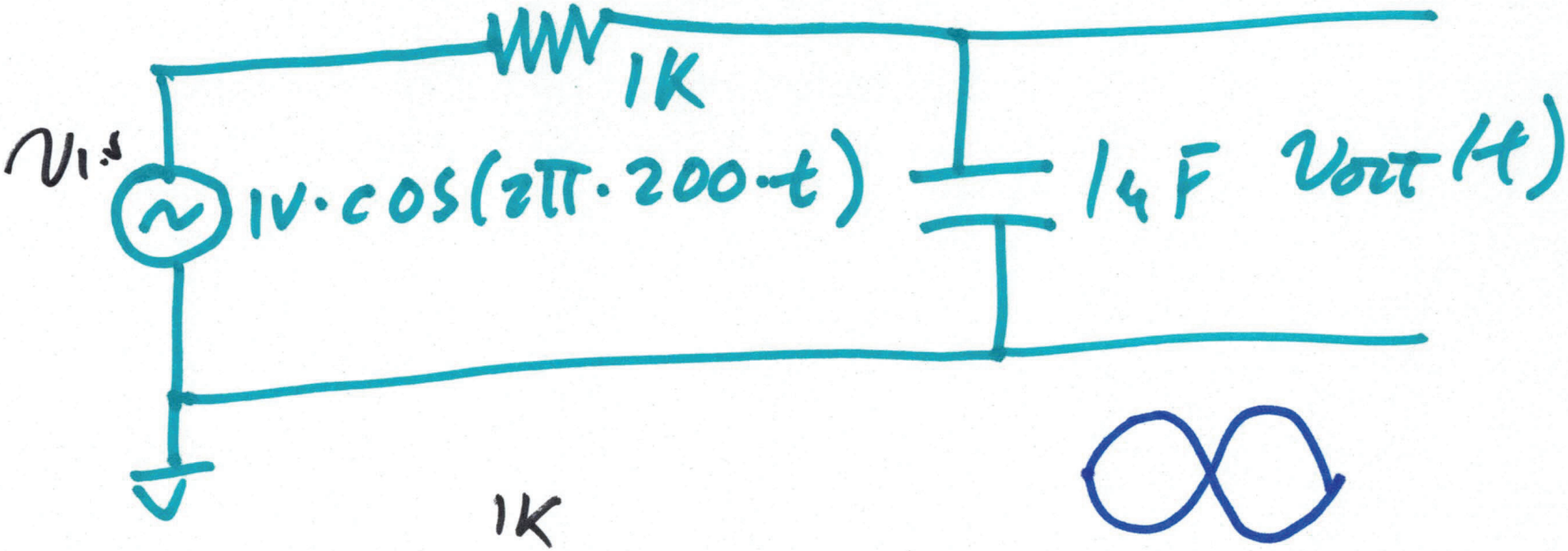
$$\frac{1}{j}\cdot\frac{j}{j} = \frac{j}{-1}$$

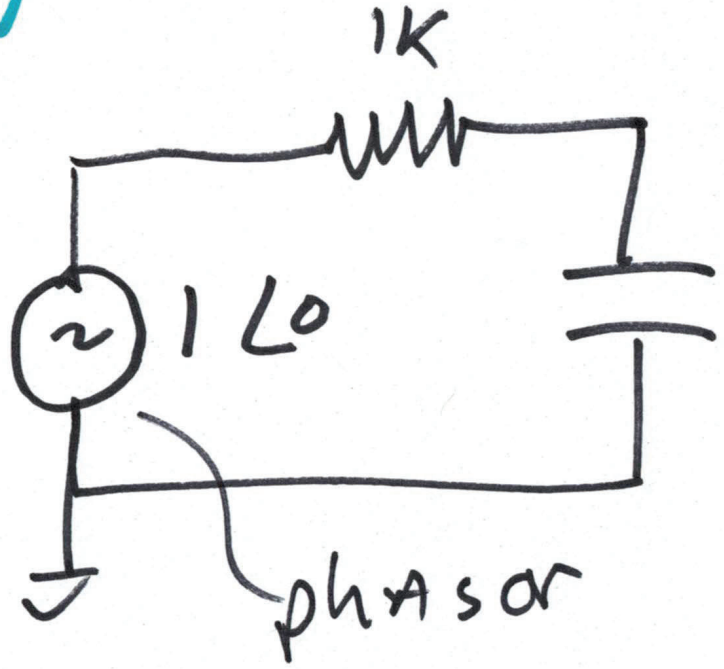
$$= -j \rightarrow$$

$0 - j = 0 + j(-1)$

$|1| = 1$

$-90^\circ \quad \angle = \tan\frac{-1}{0} = -90$

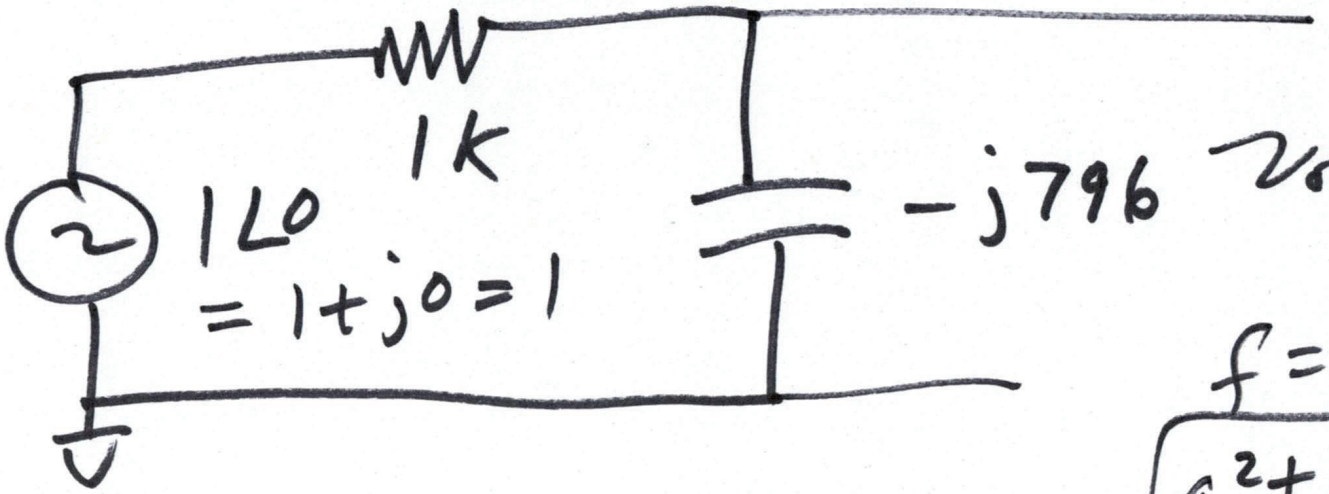




$$\frac{1}{j \cdot 2\pi \cdot 200 \cdot 10^{-6}}$$

$$= \frac{-j}{1256 \cdot 10^{-3}}$$

$$= -j796$$



$$V_{out} = 1\angle 0 \cdot \frac{-j796}{1000 - j796}$$

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

$$a + jb + c + jd = a + c + j(b+d)$$

$$\frac{a+jb}{c+jd} = \frac{\sqrt{a^2+b^2}\,\angle \tan^{-1}\frac{b}{a}}{\sqrt{c^2+d^2}\,\angle \tan^{-1}\frac{d}{c}}$$

$$f = 200$$

$$V_{oT} = (1 + j0) \cdot \frac{0 + j(-796)}{1000 + j(-796)}$$

$-90°$

$$= \sqrt{1^2 + 0^2} \cdot \frac{\sqrt{0^2 + (-796)^2}\ \angle \tan^{-1}\frac{-796}{0}}{\sqrt{1000^2 + (-796)^2} \cdot \tan^{-1}\frac{-796}{1000}}$$

$$V_{oT} = \frac{796\ \angle -90°}{1{,}278\ \angle -38.5°}$$

$$= \frac{796}{1278}\ \angle -90 - (-38.5°)$$

$$V_{oT} = .623\ \angle -51.5°$$

$$v_{OUT}(t) = 0.623 \cos(2\pi \cdot 200 \cdot t - 51.5^\circ)$$

$$v_{IN} = 1 \cdot \cos(2\pi \cdot 200 \cdot t)$$

$\times t_d$

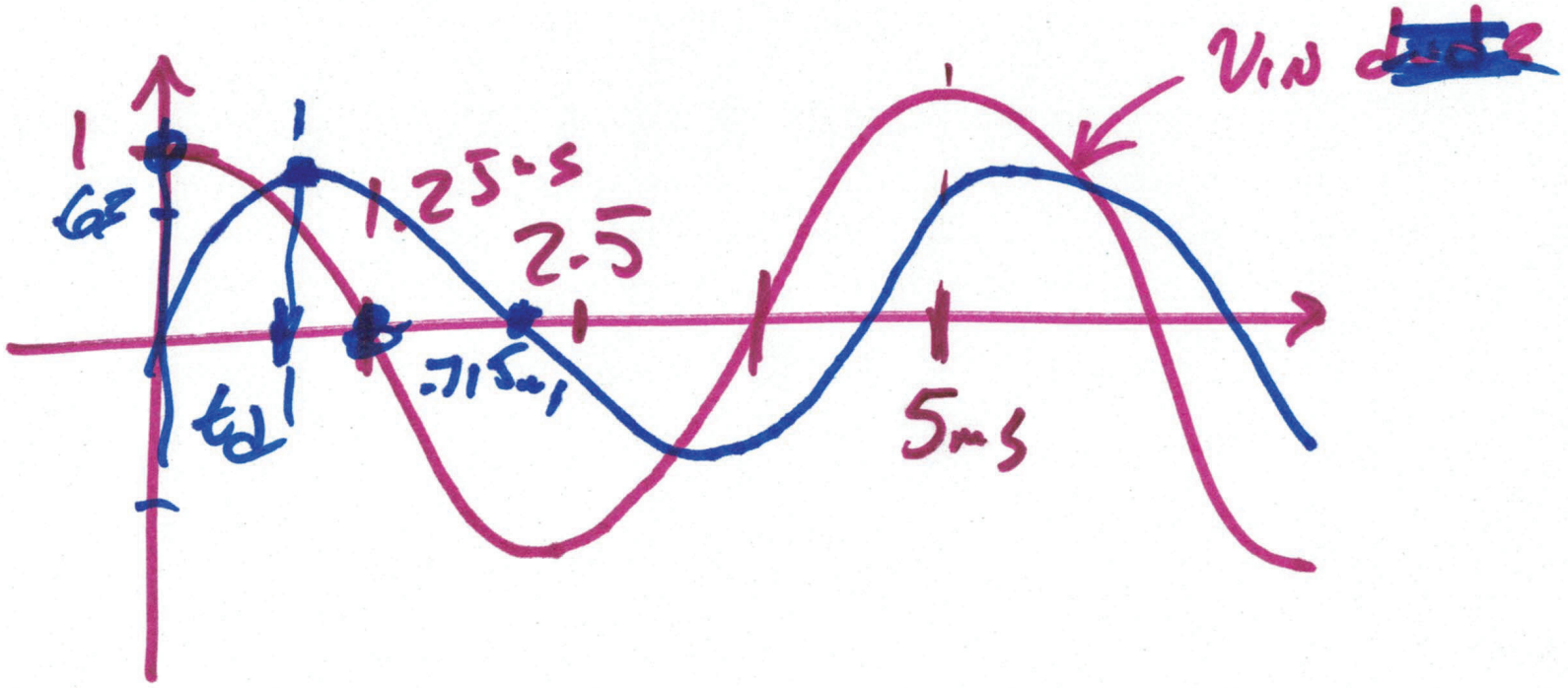
$$\theta = \frac{t_d}{T} \cdot 360 \quad , \quad T = \frac{1}{f}$$

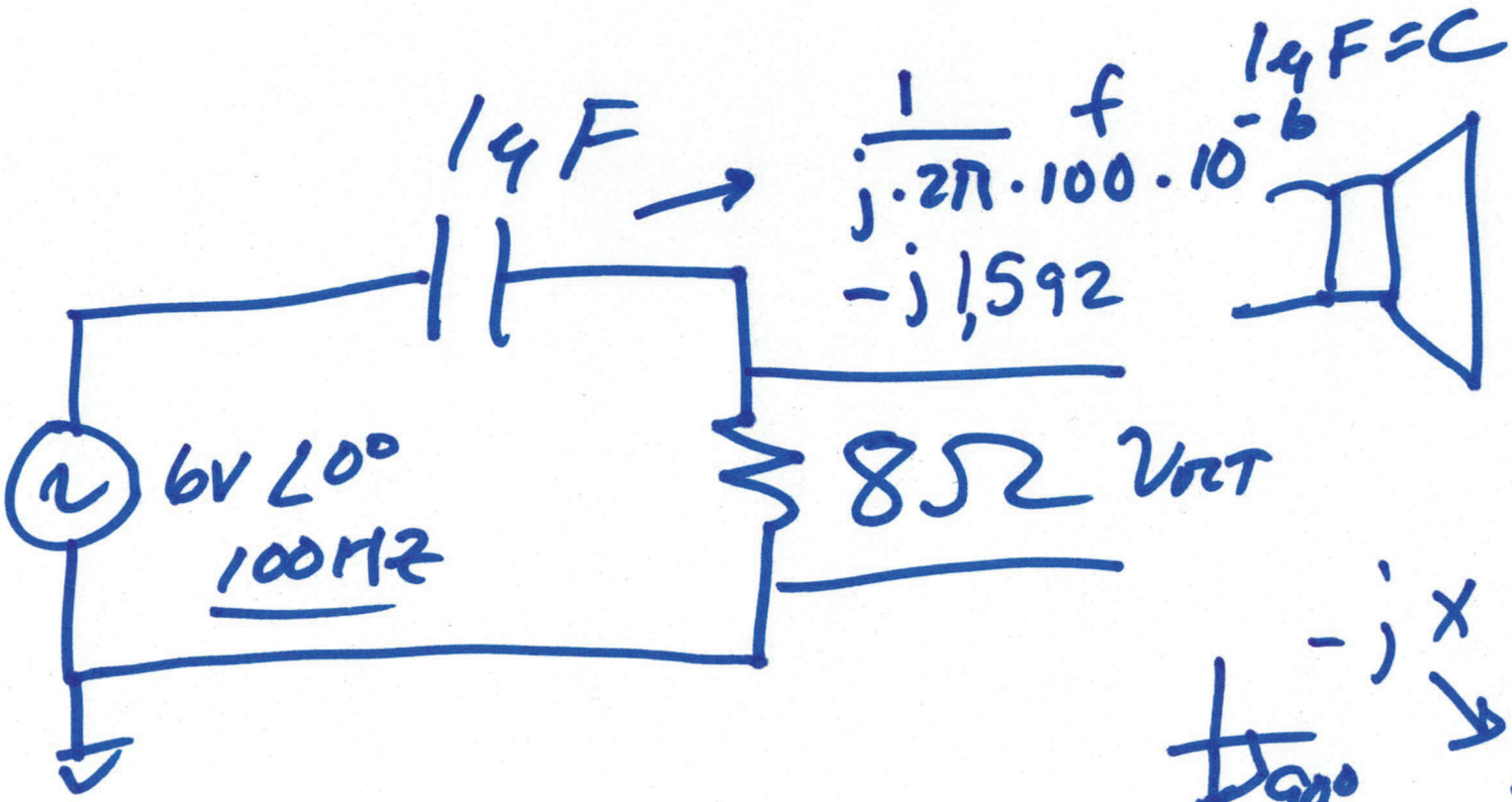
$$T = 5\,ms$$

$$51.5 = 200 \cdot t_d \cdot 360$$

$$t_d = 0.715\,ms$$

b)


1
1
1.25ms
2.5
.715ms
5ms
VIN



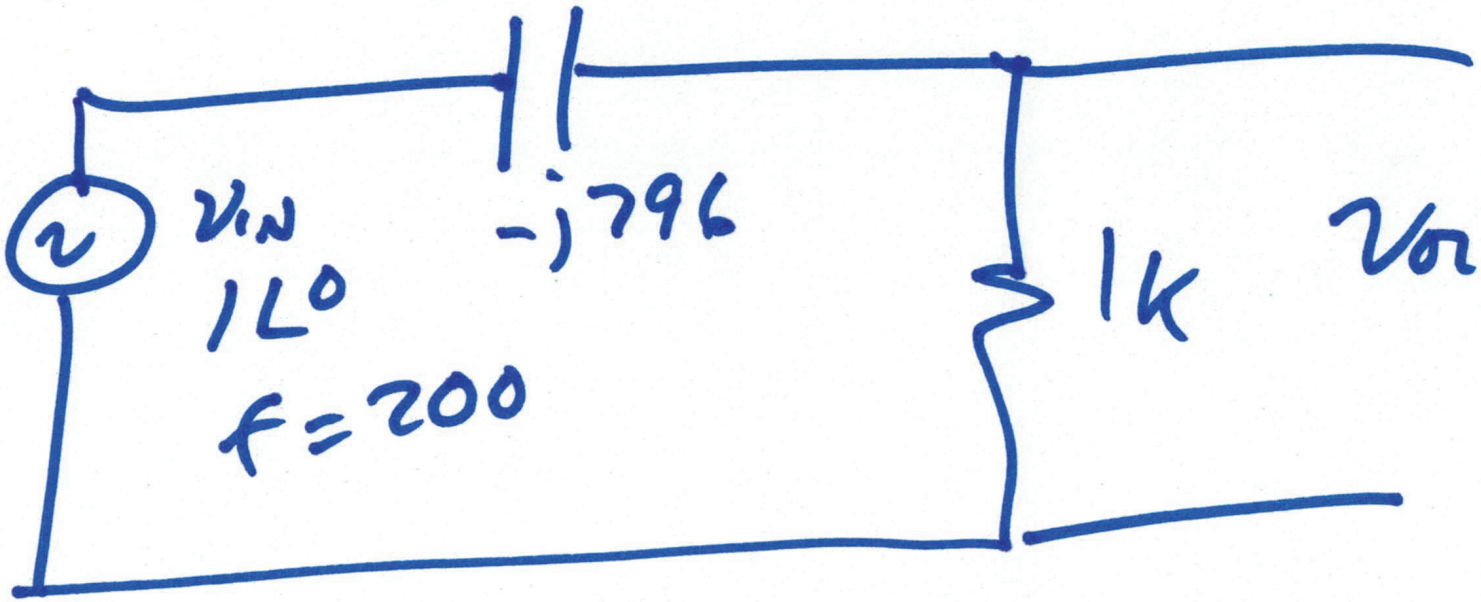
$-j\,X \rightarrow \angle -90°$

$$V_{OUT} = \frac{6\angle 0}{6 + j0} \cdot \frac{8}{8 + j(-1{,}592)}$$

$$\cong 6 \cdot \frac{8\angle 0°}{1{,}592\angle -90°}$$

$$= 0.03V \angle 90$$

10)



$$v_{out} = 1 \cdot \frac{1k}{1k + j(-796)}$$

$$v_{out} = .782 \cos(2\pi \cdot 200 \cdot t + 38.5^\circ) = \frac{1k}{1{,}278\ \angle -38.5^\circ}$$

$$38.5 = \frac{t_d}{5ms} \cdot 360$$

$$t_d = .53ms$$

$$= .782\ \angle 38.5^\circ$$

11)