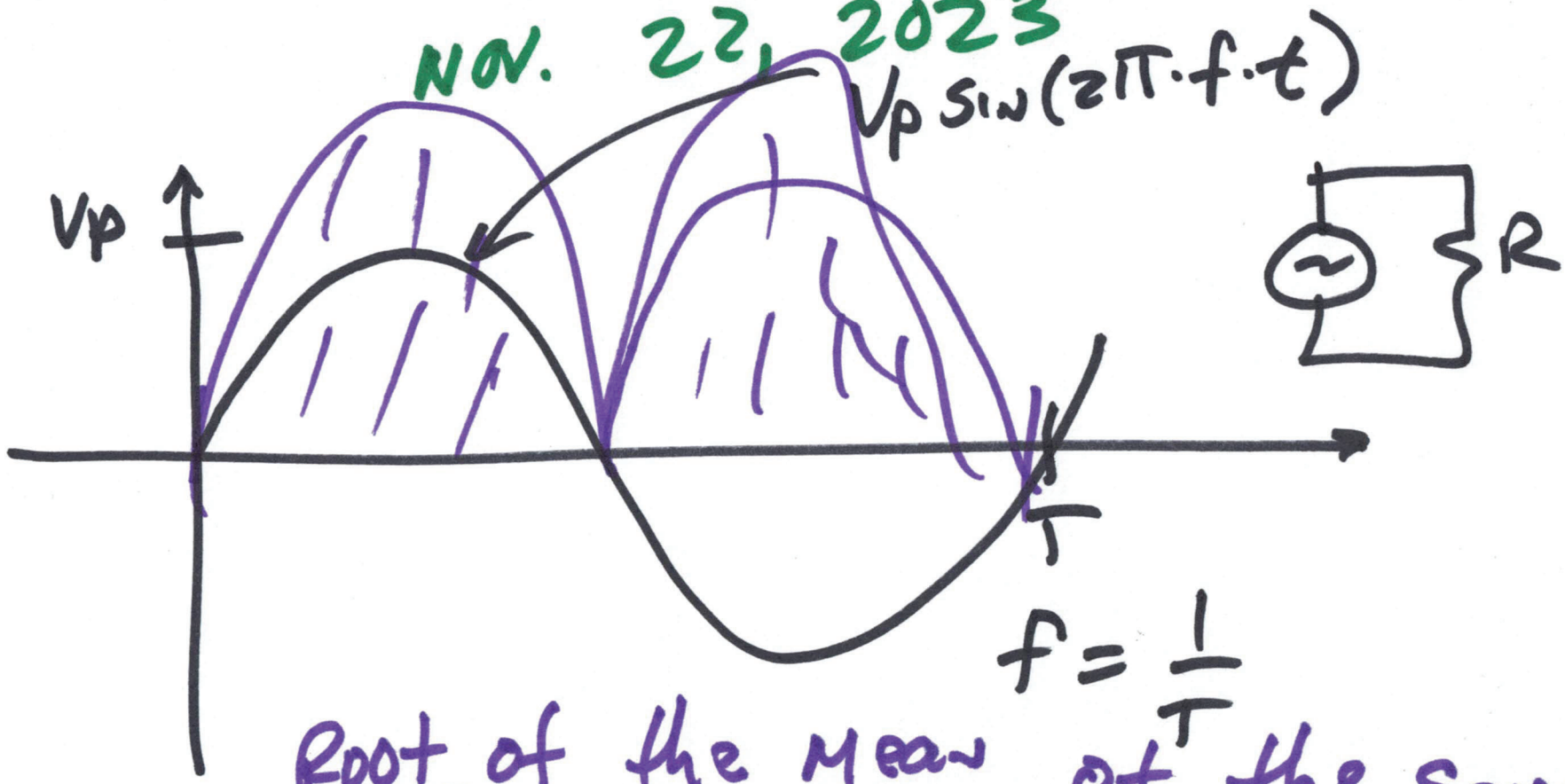
EE 221 Circuits I

Lecture 23

Nov. 22, 2023



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

Root of the Mean of the Square

RMS

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V_p^2 \sin^2(2\pi f t)\cdot dt}$$

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T V_p^2 \cdot \sin^2(2\pi f t)\,dt}$$

$$\sin^2 X = \frac{1-\cos 2X}{2}$$

$$= \sqrt{\frac{V_p^2}{2T}\int_0^T (1-\cos 4\pi f t)\cdot dt}$$

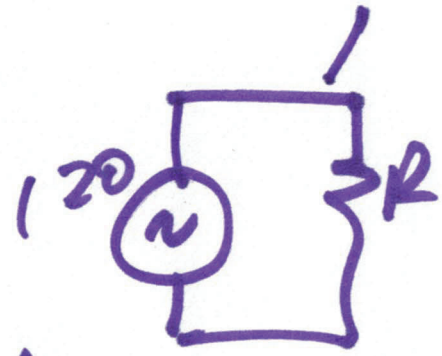
$$= \sqrt{\frac{V_p^2}{2T}\left(t - \frac{1}{4\pi f}\sin(4\pi f t)\right)_0^T}$$

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

$$V_{rms} = \frac{V_p}{\sqrt{2}} = \sqrt{\frac{V_p^2}{2T}(T-0) - \frac{1}{4\pi f}\left(\sin\left(4\pi\cdot\frac{1}{T}\cdot T\right) - \sin 0\right)}$$

$\sin 0 \rightarrow 0$

$$V_{p_{rms}} = \frac{V_p}{\sqrt{2}}$$

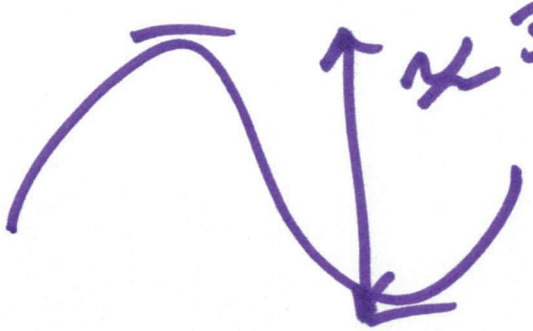


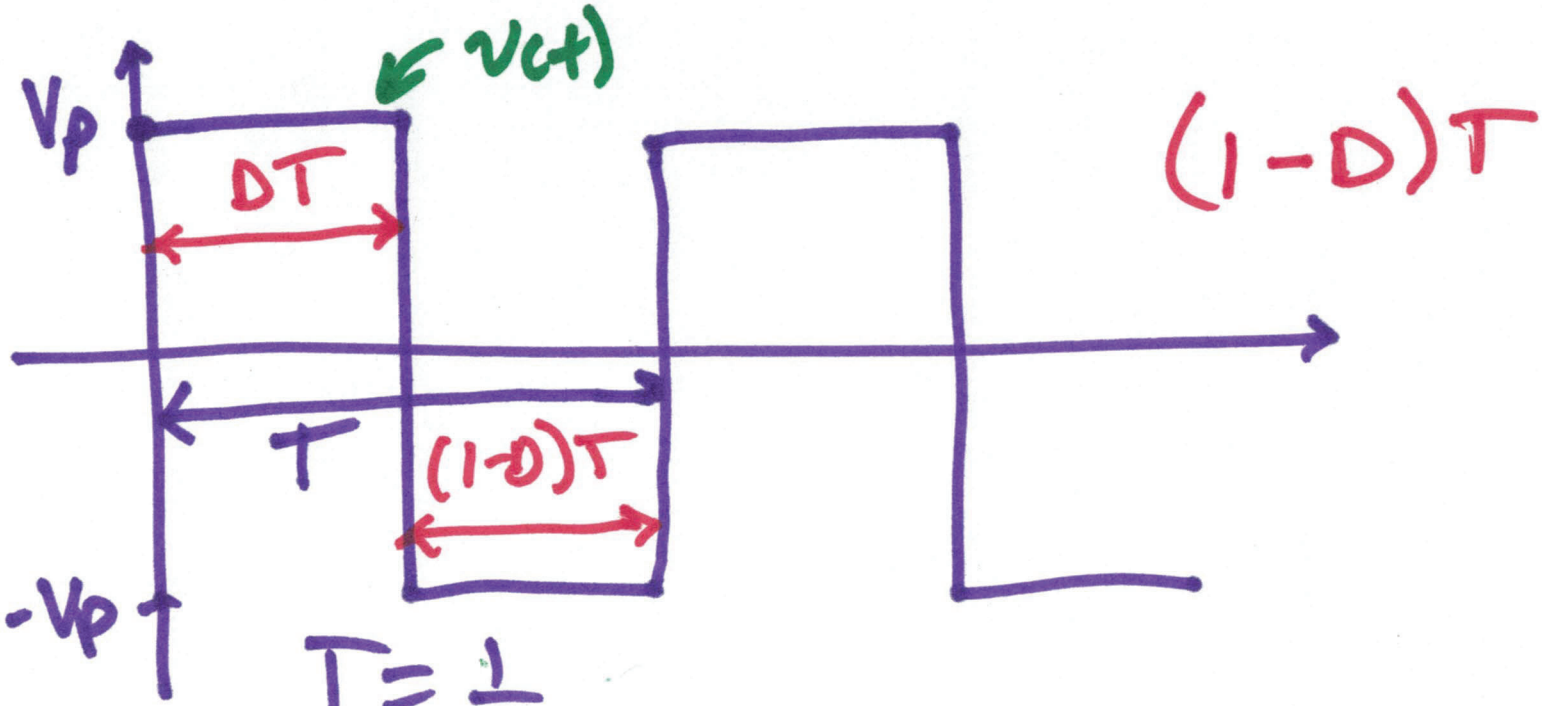
$$120 = V_{rms} = \frac{V_p}{\sqrt{2}}$$

120VDC

$$V_p = \sqrt{2} \cdot 120 = 169.7$$

$$120V_{rms} \rightarrow 169.7\,Sin(2\pi \cdot 60 \cdot t)$$





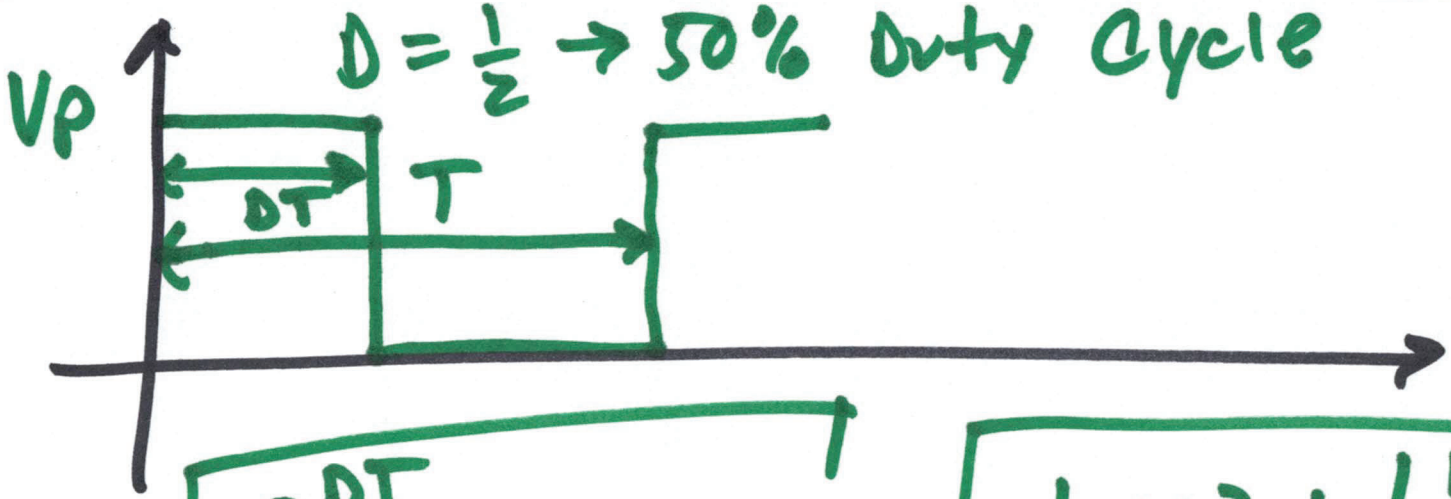
$$T = \frac{1}{f}$$

$$\sqrt{\frac{1}{T}\int_0^T V_p^2 \cdot dt} = \sqrt{\frac{1}{T}\left(V_p^2 t\Big|_0^T\right)}$$

$$V_{Rms} = V_p$$

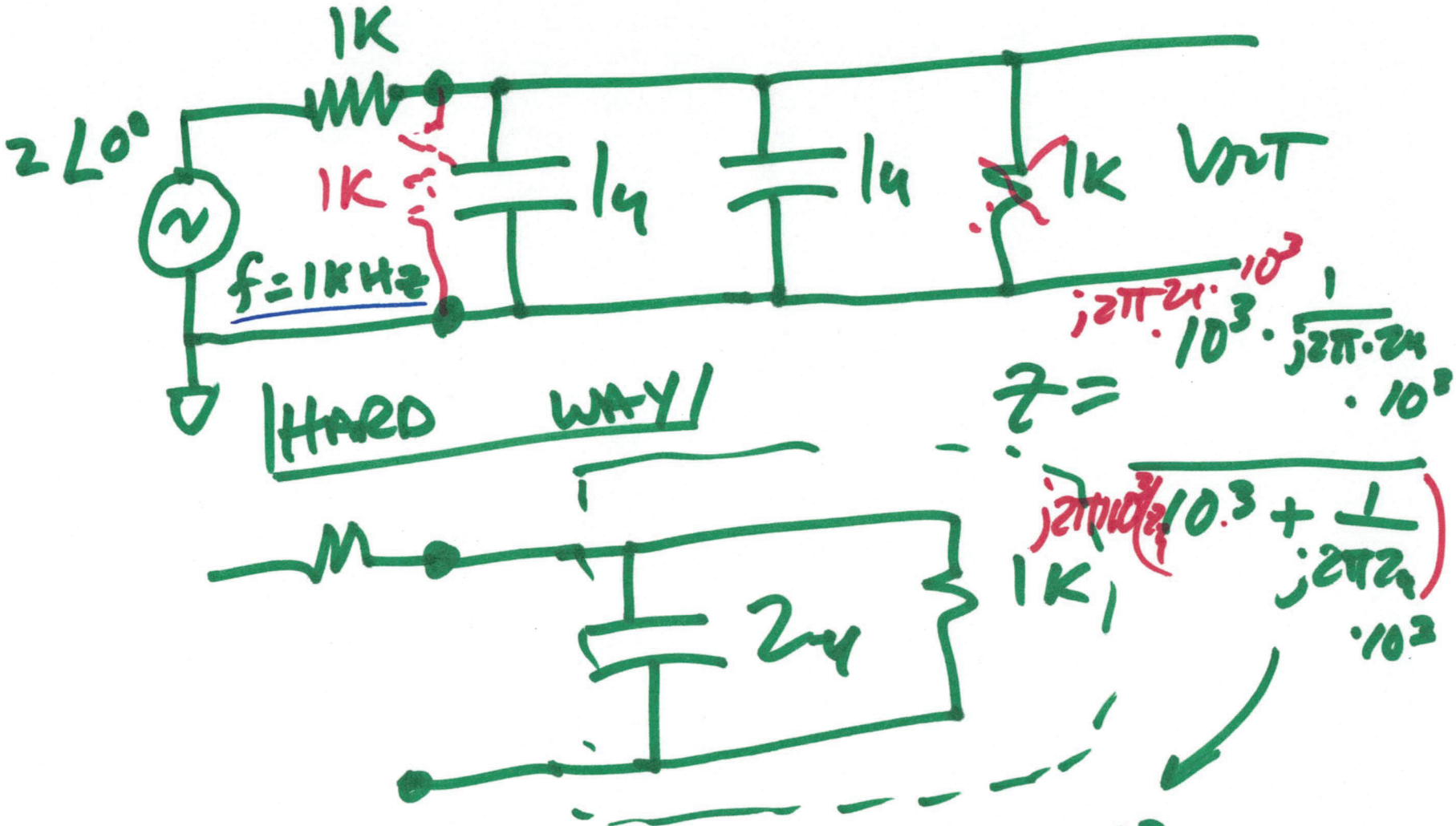
$$V_{RMS} = \sqrt{\int_0^T v^2(t) \cdot dt}$$

$D = \frac{1}{2} \rightarrow 50\%$ Duty Cycle

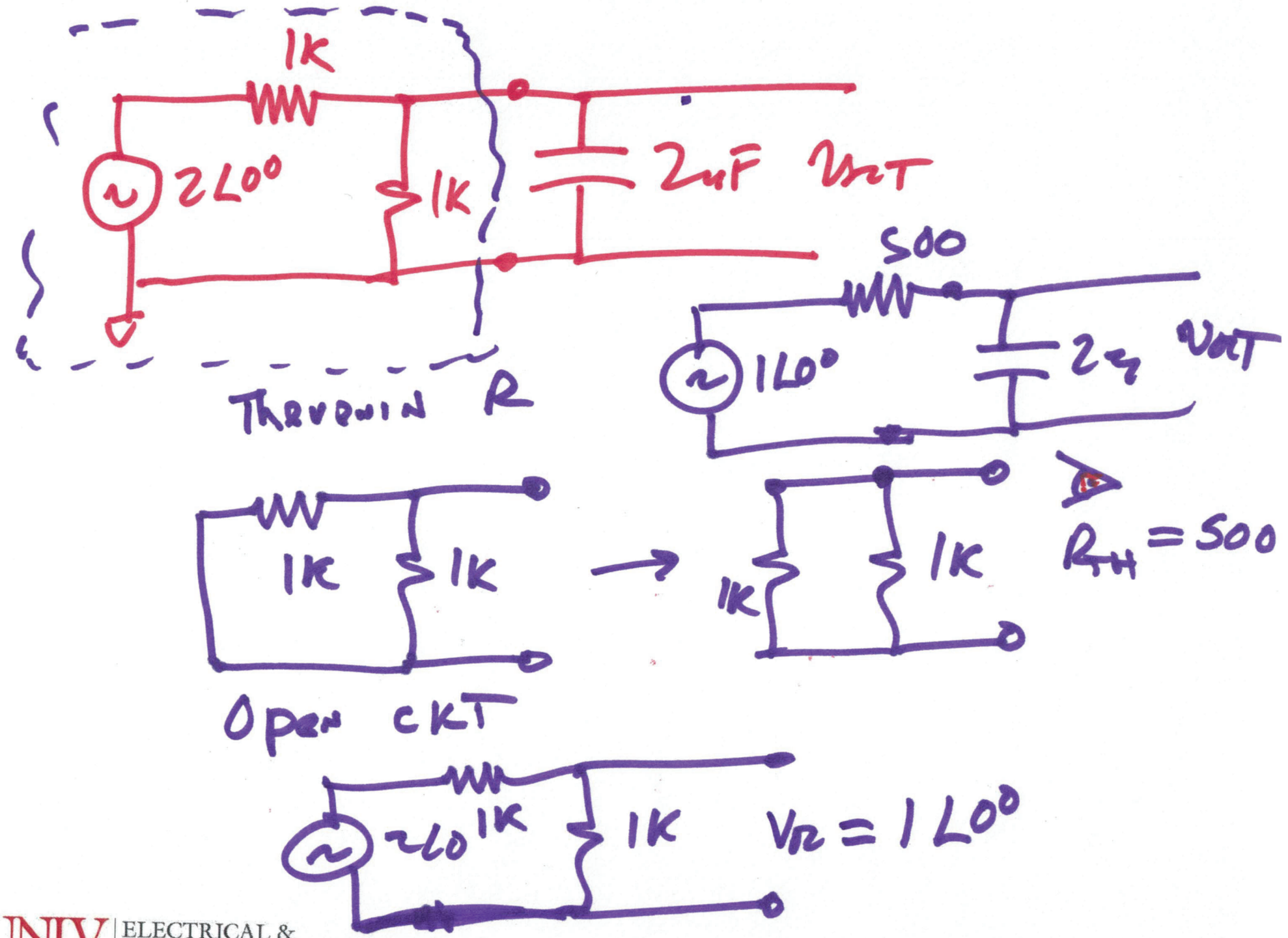


$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^{DT} V_p^2 \cdot dt} = \sqrt{\frac{1}{T} V_p^2 \cdot t \Big|_0^{DT}}$$

$$\boxed{V_{RMS} = \sqrt{D} \cdot V_p}$$



$$V_{out} = 2\angle 0^\circ \cdot \frac{Z}{Z + 10^3} \qquad Z = \frac{10^3}{1 + j\omega C 10^6}$$

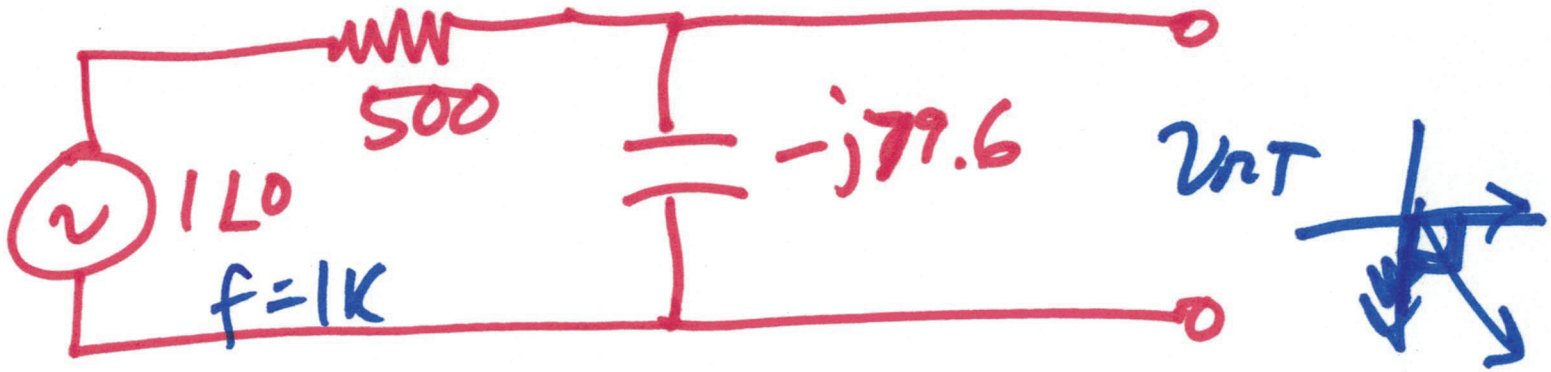

1K
2∠0°
1K
2μF
V_{OUT}
Thevenin R
500
1∠0°
2μ
V_{OUT}
1K
1K
1K
1K
R_{TH} = 500
Open CKT
2∠0°
1K
1K
V_{R2} = 1∠0°

$$Z_C = \frac{1}{j \cdot 2\pi \cdot 10^3 \cdot 2_4} = -j79.6$$

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

$$\frac{j}{j}\frac{1}{j} = \frac{j}{j^2}$$

$$-j = \frac{j}{(\sqrt{-1})^2}$$



$$v_{nT} = 1\angle 0 \cdot \frac{0 - j79.6}{500 + (-j79.6)}$$

$$= \frac{1\angle 00 \; 79.6\angle -90^\circ}{506.3\angle -9^\circ}$$

$$|1| = \sqrt{(500)^2 + (-79.6)^2}$$

$$\angle \tan^{-1}\left(\frac{-79.6}{500}\right)$$

b)

$$V_{nT} = \frac{1L0^{\circ} \cdot 79.6\,L-90^{\circ}}{506.3\,L-90^{\circ}} \qquad -90-(-9)$$

$$V_{nT} = 157mV\,L-81^{\circ}$$

$$360 \cdot \frac{t_d}{T} = \frac{t_d}{10^{-3}} \cdot 360 = -81^{\circ}$$

$$t_d = 225\mu s$$

$$\text{Period} = \frac{1}{f} = \frac{1}{10^3} = \frac{1}{1kHz}$$

$$v_{nT} = 157mV \sin(2\pi \cdot 10^3 \cdot t - 81^{\circ})$$

$$Z_C = \frac{1}{j \cdot 2\pi f \cdot 250\,nF}$$

$f = 0$

$Z_C = \text{Open} = \infty$

$f = 10^6$

$$Z_C = \frac{1}{j \cdot 2\pi \cdot 10^6 \cdot 250 \cdot 10^{-9}}$$

$$= \frac{1}{j\,2\pi \cdot (0.25)} = -j\,0.64$$