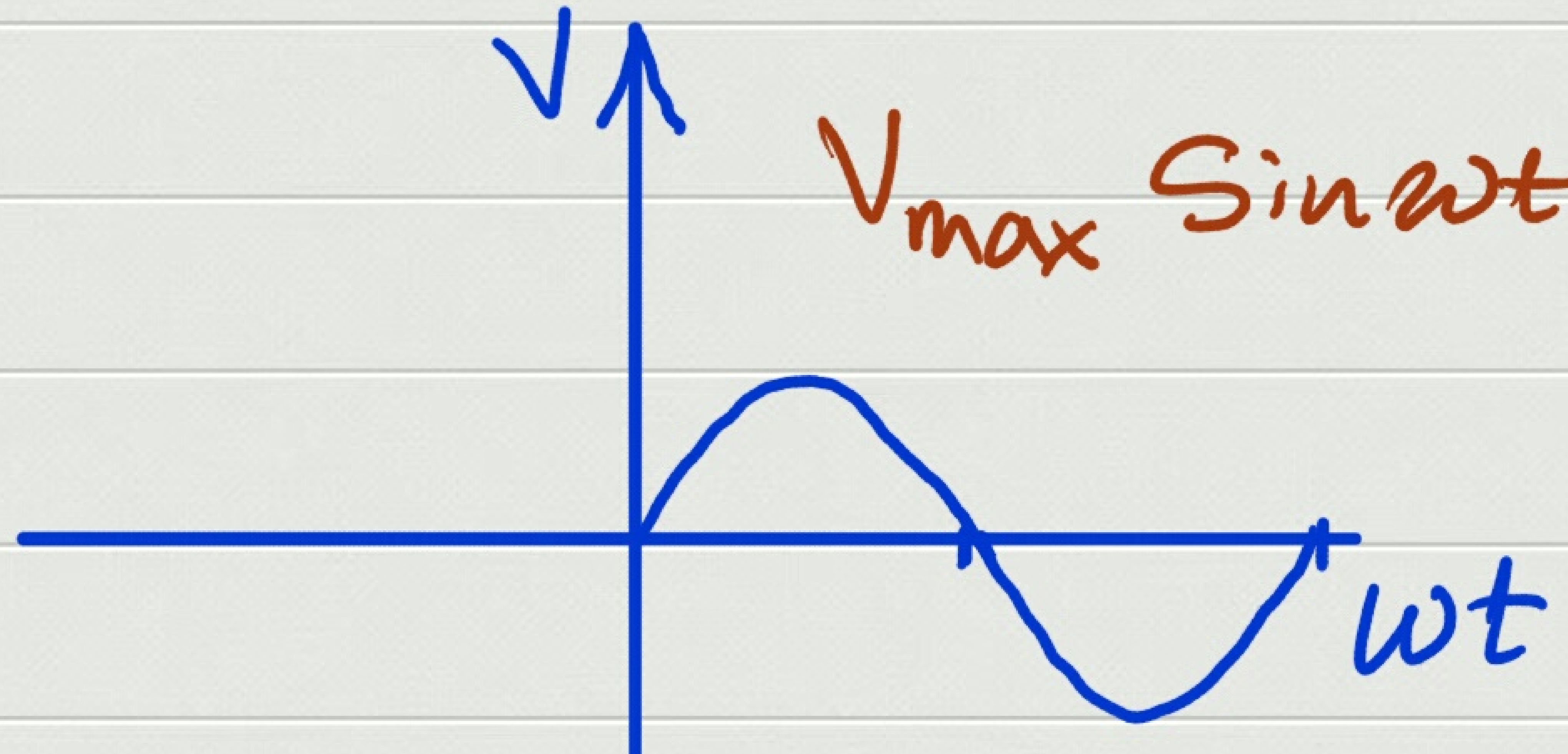
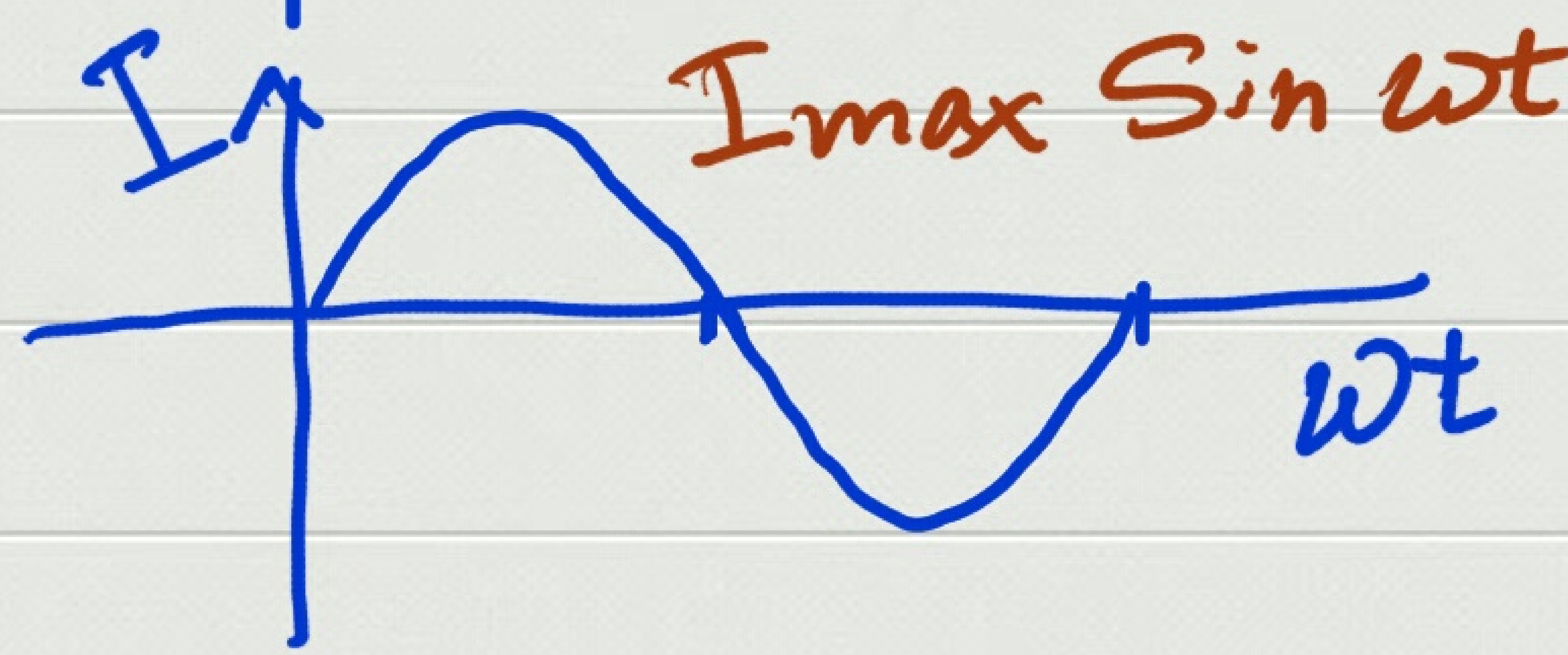
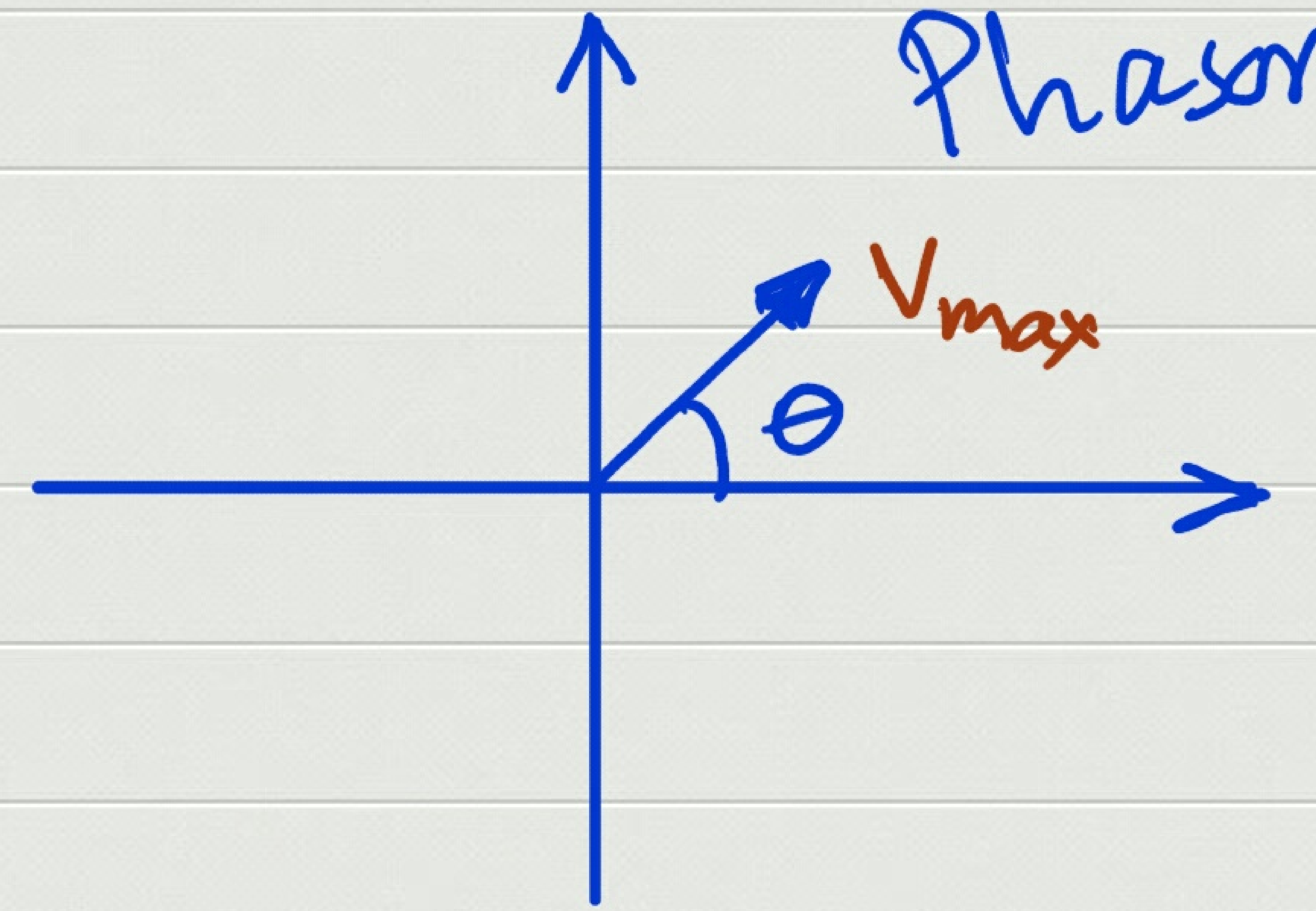
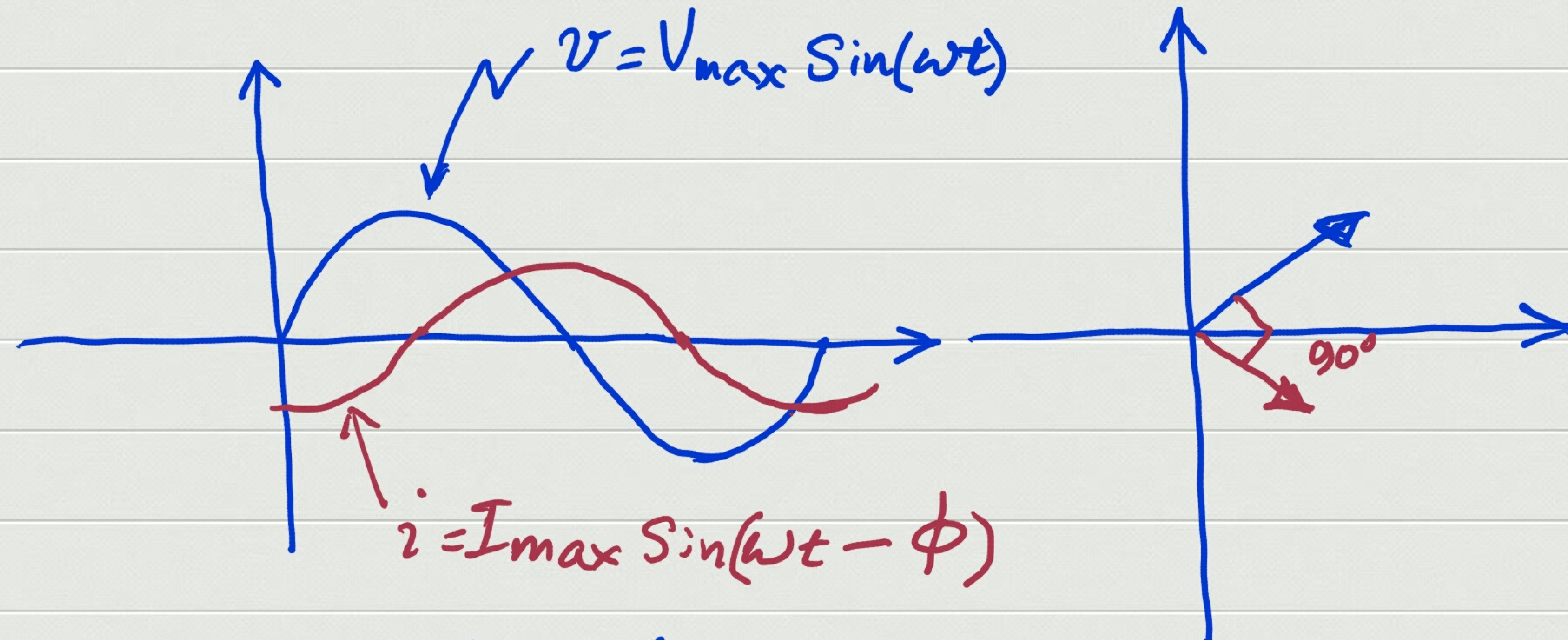


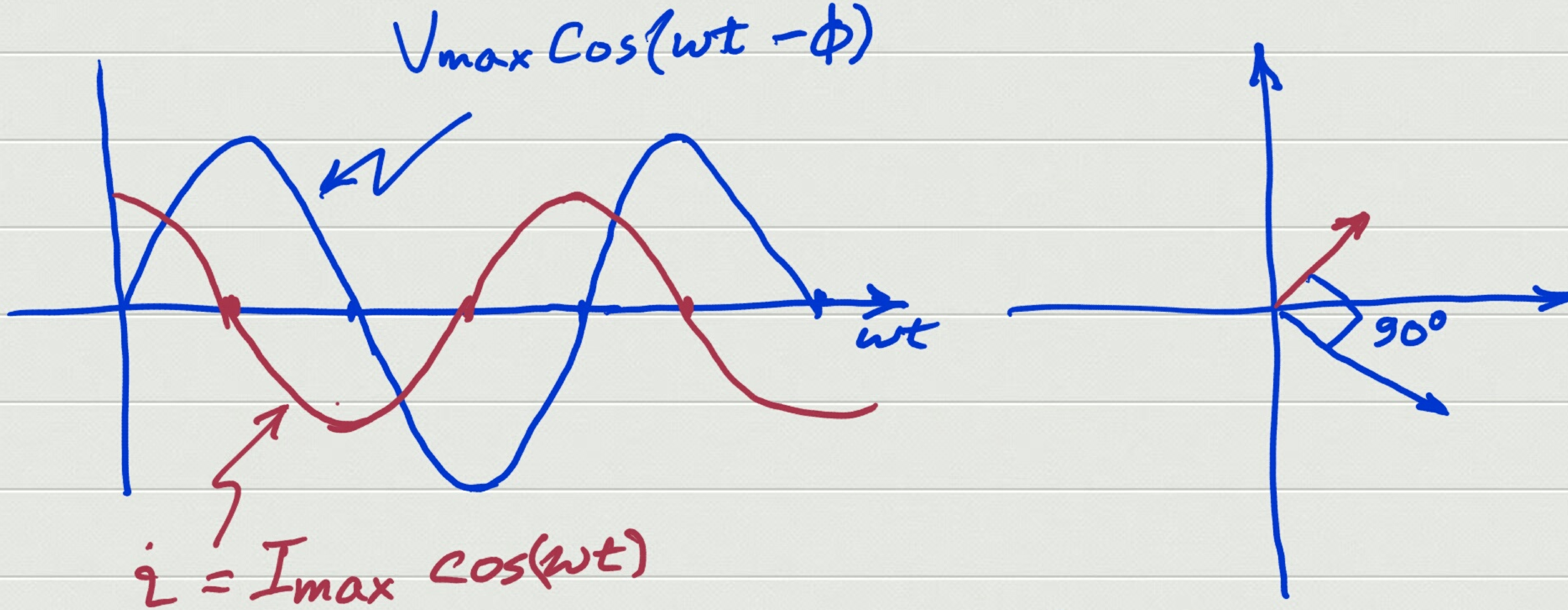
Resistive cct







Inductive load



Capacitive Load

Ref: Principles of Electrical Machines
and Power Electronics
P.C. Sen

Resistor $v = iR$

Inductor $v = L\frac{di}{dt}$, $i = \frac{1}{L}\int v\,dt$

Capacitor $i = C\frac{dv}{dt}$, $v = \frac{1}{C}\int i\,dt$

Euler Formula

$$\left.\begin{matrix} e^{x} \\ e^{-t} \end{matrix}\right\} \rightarrow$$ what is special about this?

When we take the derivative of this function we get a scaled function of the original

- $\frac{d}{dx}(e^{x}) = e^{x}$ ← same function
- $\frac{d}{dt}(e^{\tau t}) = \tau e^{t}$ ← scaled function

$$e^{jx} = \cos(x) + j\sin(x)$$

$$e^{-jx} = \cos(x) - j\sin(x)$$

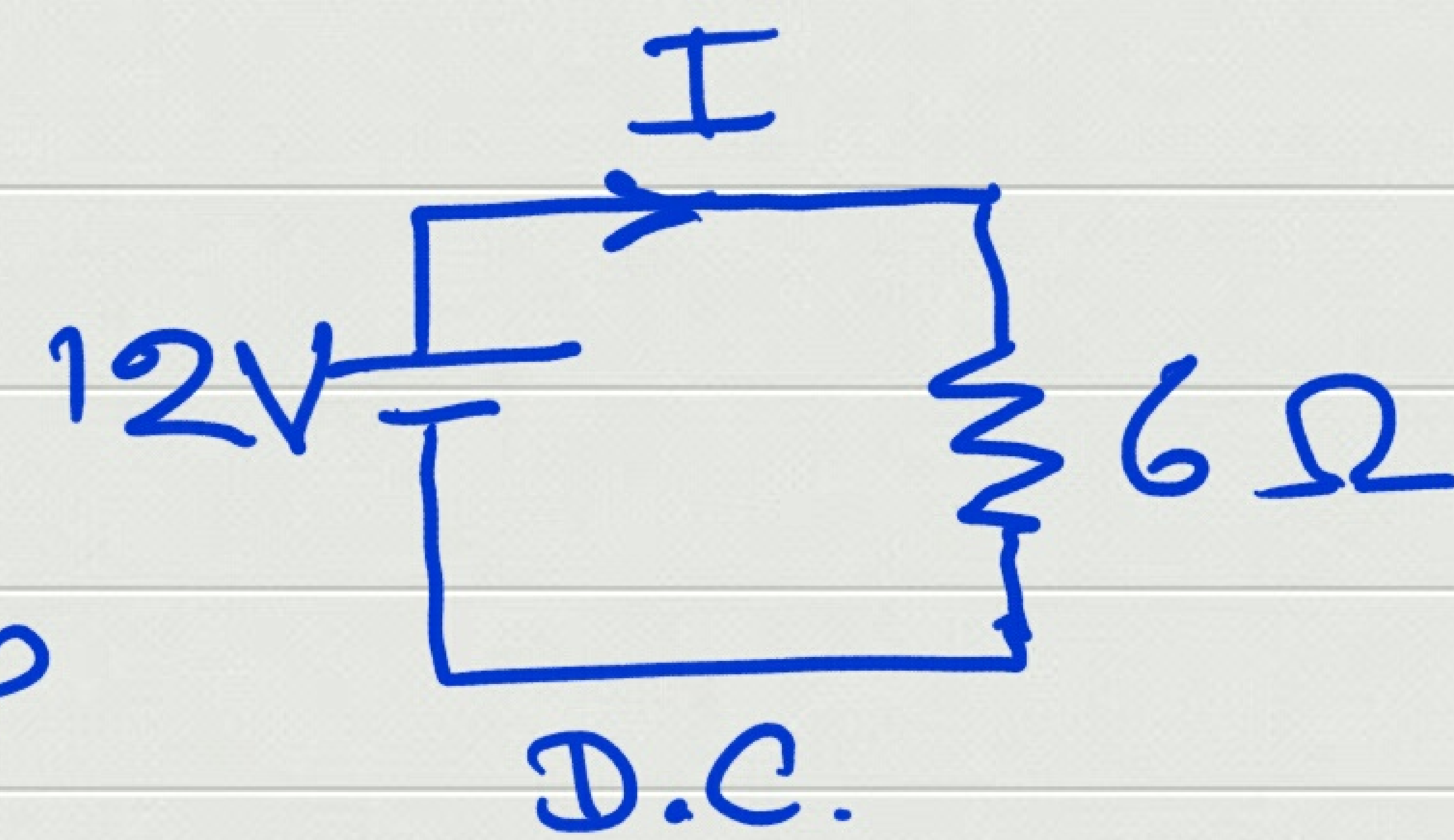
$$\cos(x) = \frac{e^{jx} + e^{-jx}}{2}$$

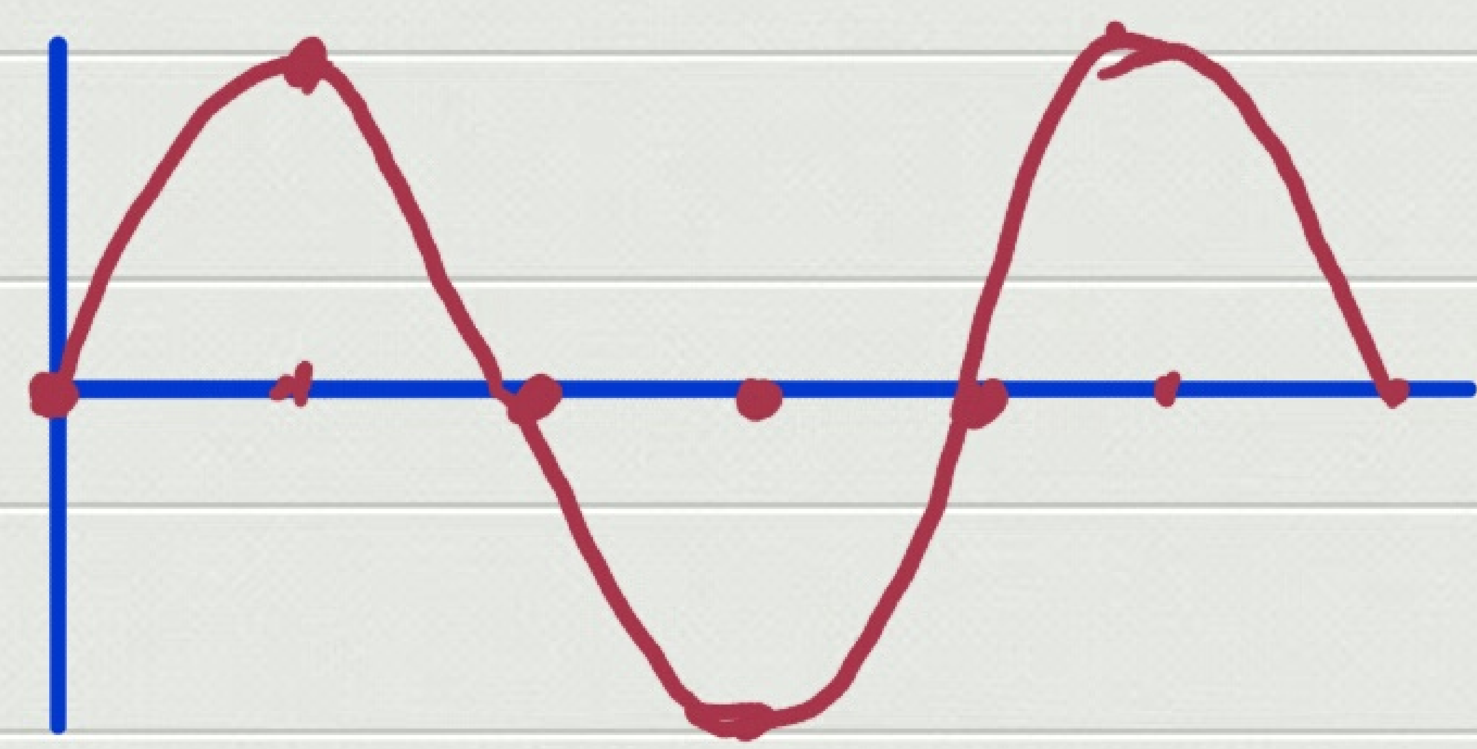
$$\sin(x) = \frac{e^{jx} - e^{-jx}}{2j}$$

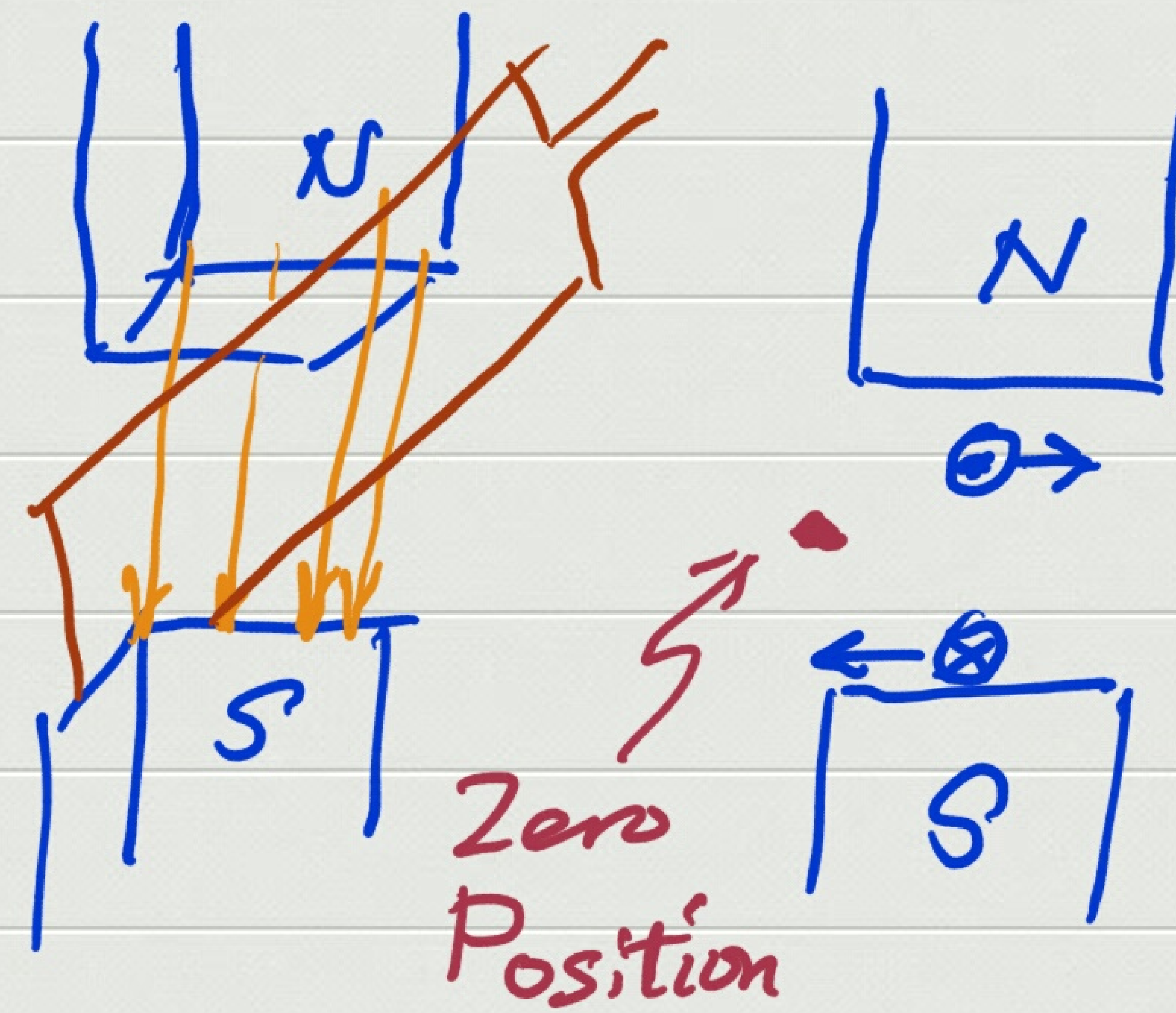
A.C. Circuits

Ohm's law

$$I = \frac{V}{R} = \frac{12}{6} = 2 \text{ Amp}$$







$$emf = -\frac{d\phi}{dt}$$

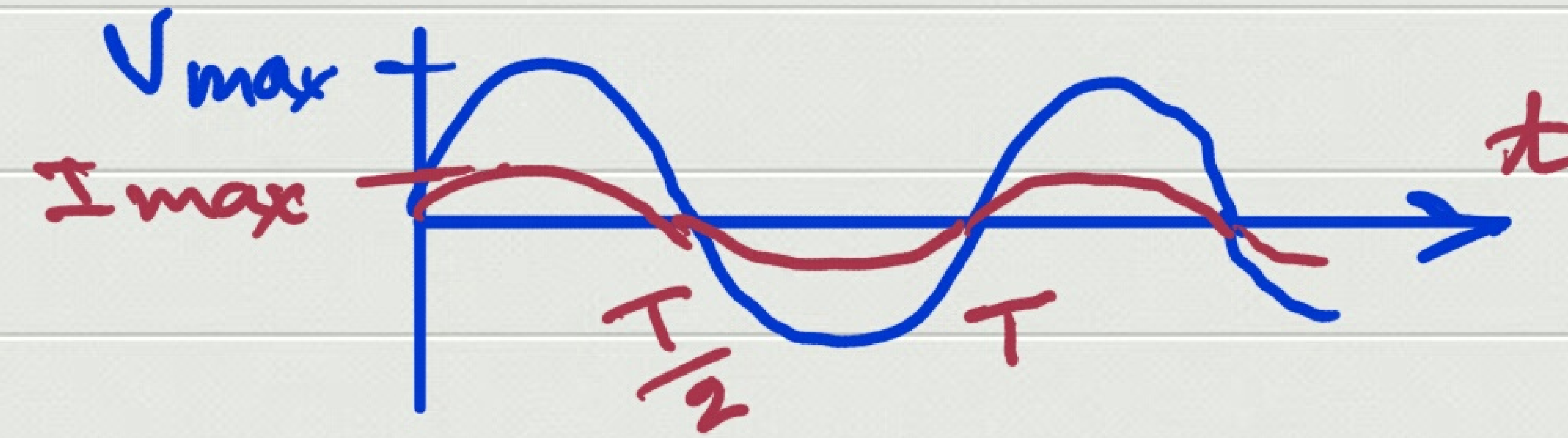
Power

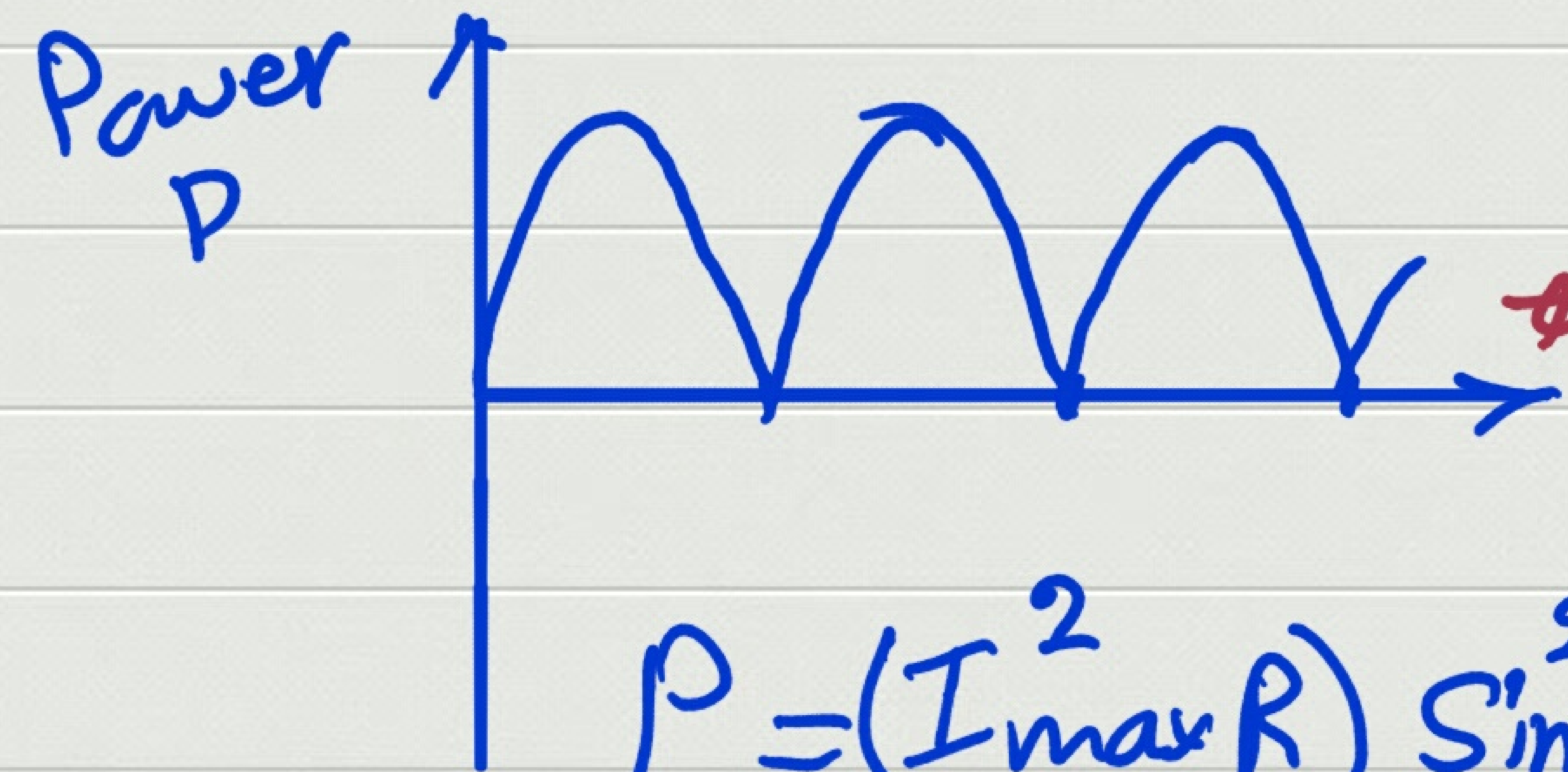
$$v = V_{max}\sin(\omega t)$$
$$i = I_{max}\sin(\omega t)$$
$$P = v \times i$$

for a resistive circuit:

$$v = iR \quad \& \quad i = \frac{v}{R}$$
$$P = i^2 R \quad \text{or} \quad \frac{v^2}{R}$$
$$P = \frac{(V_{max}\sin(\omega t))^2}{R}$$

or $$P = (I_{max}\sin(\omega t))^2 R$$





$$P = (I_{max}^2 R)\sin^2(\omega t)$$

Scaler value

$$\omega = 2\pi f = \frac{2\pi}{T}$$

@ $t = 0$, $\omega t = \frac{2\pi}{T} \times 0$, $\sin^2(0) = 0$

@ $t = \frac{T}{4}$, $\omega t = \underbrace{\frac{2\pi}{T} \cdot \frac{T}{4}}_{\pi/2}$, $\sin^2(\frac{\pi}{2}) = (1)^2 = 1$

@ $t = \frac{T}{2}$, $\omega t = \frac{2\pi}{T} \cdot \frac{T}{2} = \pi$, $\sin^2(\pi) = 0$

@ $t = \frac{3T}{4}$, $\omega t = \frac{2\pi}{T} \cdot \frac{3T}{4} = \frac{3}{2}\pi$, $\sin^2(\frac{3}{2}\pi) = 1$

@ $t = T$, $\omega t = \frac{2\pi}{T} \cdot T = 2\pi$, $\sin^2(2\pi) = 0$

so this $P(t)$ instantaneous value! Average Power?

$$P_{ave} = \frac{1}{T}\int_0^T p(t)\,dt$$

$$= \frac{2}{T}\int_0^{T/2} p(t)\,dt$$

$$P(t) = P_{max}\sin^2(\omega t)$$

$$P_{max} = I_{max}^2 R$$

$$\underbrace{= \frac{2}{T}\cdot P_{max}\cdot\int_0^{T/2}\sin^2(\omega t)\,dt}_{\frac{P_{max}}{2}}$$

The average of $\sin^2(\omega t)$ over a whole cycle is <u>0.5</u>

$$P_{ave} = \frac{I_{max}^2 R}{2}$$

<u>or</u>

$$= \frac{V_{max}^2}{2R}$$

This is valid for any alternating current supply

Root Mean Square (RMS)

$$P_{ave} = \frac{V_{rms}^2}{R} = \frac{V_{max}^2}{2R}$$

$$V_{rms}^2 = \frac{V_{max}^2}{2}$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_{rms} = 0.707\, V_{max}$$

$I_{rms} = ?$

$$P_{ave} = I_{rms}^2 \cdot R = \frac{I_{max}^2 \cdot R}{2}$$

or $I_{rms} = \dfrac{I_{max}}{\sqrt{2}}$

$$I_{rms} = 0.707\, I_{max}$$

for the 220 Volt RMS
the $V_{max} = 310$ Volt

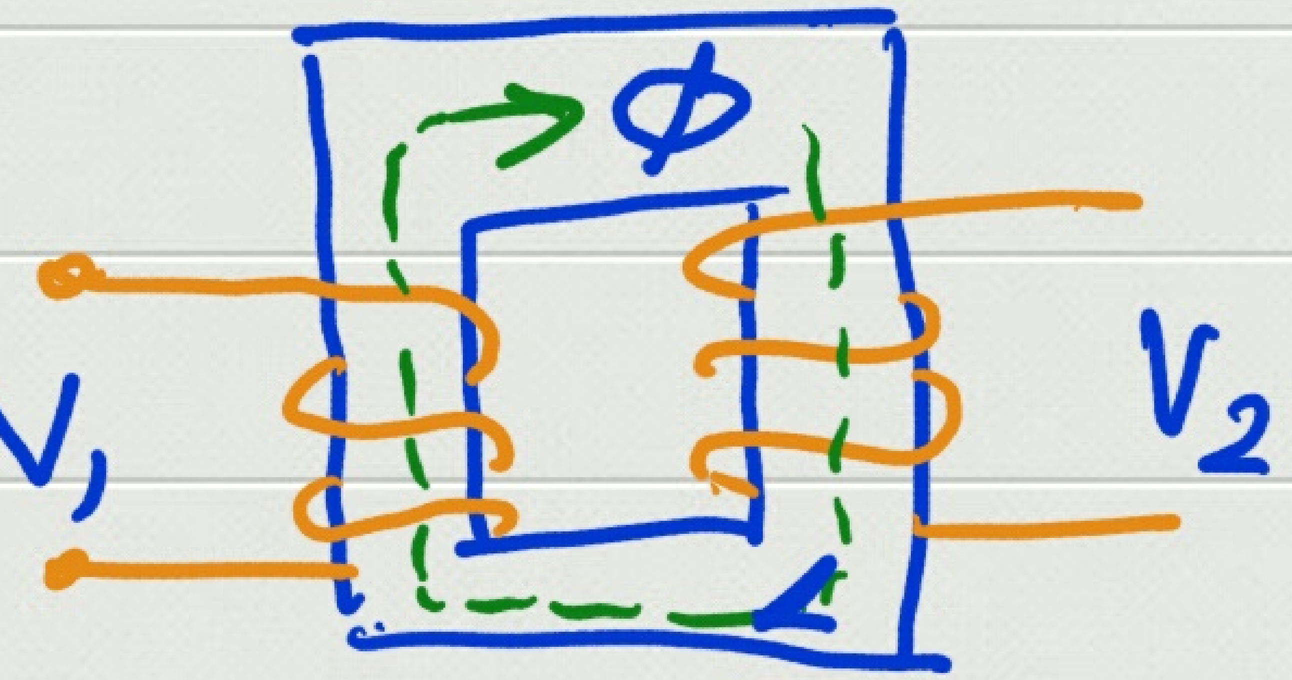
Why RMS ?

AC v DC

It was Tesla's idea to change from D.C. to A.C. to minimize transmission loss in cables

Coil

$v_1 = \frac{d\phi}{dt}$ per one turn,



for N_1 turns

$v_1 = N_1 \frac{d\phi}{dt}$ Same

$v_2 = N_2 \frac{d\phi}{dt}$

$\frac{v_1}{v_2} = \frac{N_1}{N_2}$

Power in both sides of the Trans. are the same;

$i_1 v_1 = i_2 v_2$

$\frac{v_1}{v_2} = \frac{i_2}{i_1} = \frac{N_1}{N_2}$

1MW ac & d.c. system
220V & for a.c. 33kV
$(1-\phi)$ Cable resist. R

$P = 1\,MW = V_{ac}\, i_{ac} = V_{dc}\, i_{dc}$

$33 \times 10^3 \times i_{ac} = 10^6$

$i_{ac} = \dfrac{1000}{33} = 30\ A$

Power loss in cables;

$P = i^2 R \times 2$

$= 30^2 \times 2 \times R$

$= 1800\, R$

$= 1.8 \times 10^3\, R$

$P = V_{dc}\, I_{dc}$

$10^6 = 220 \times I_{dc}$

$I_{dc} = \dfrac{1{,}000{,}000}{220}$

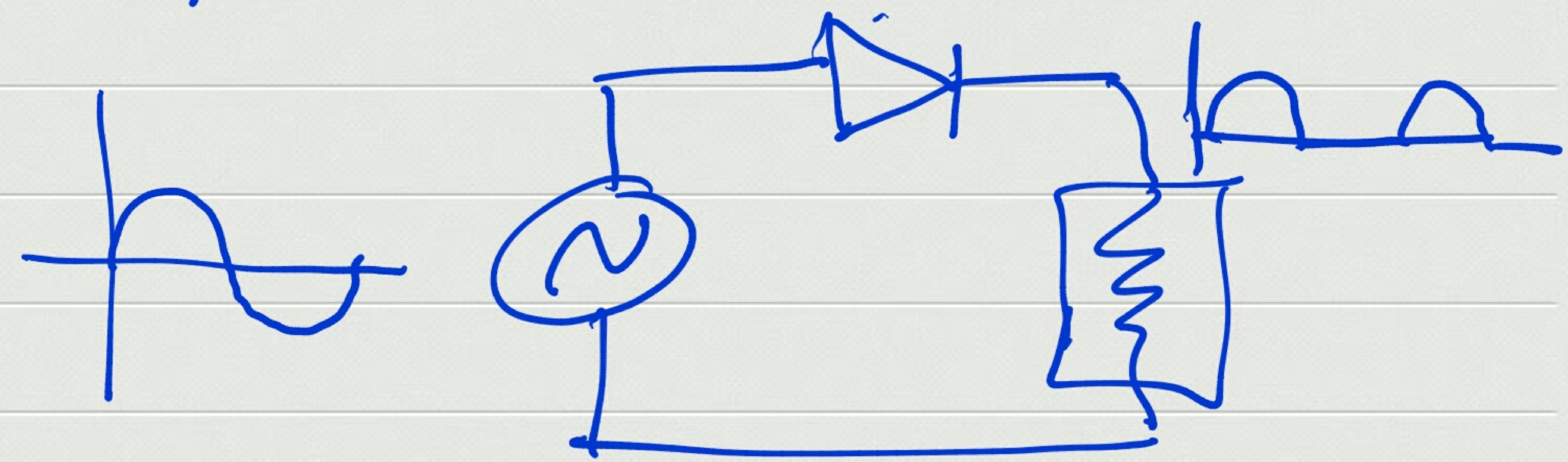
$= 4545\ A$

$P = I^2 \times 2 \times R$

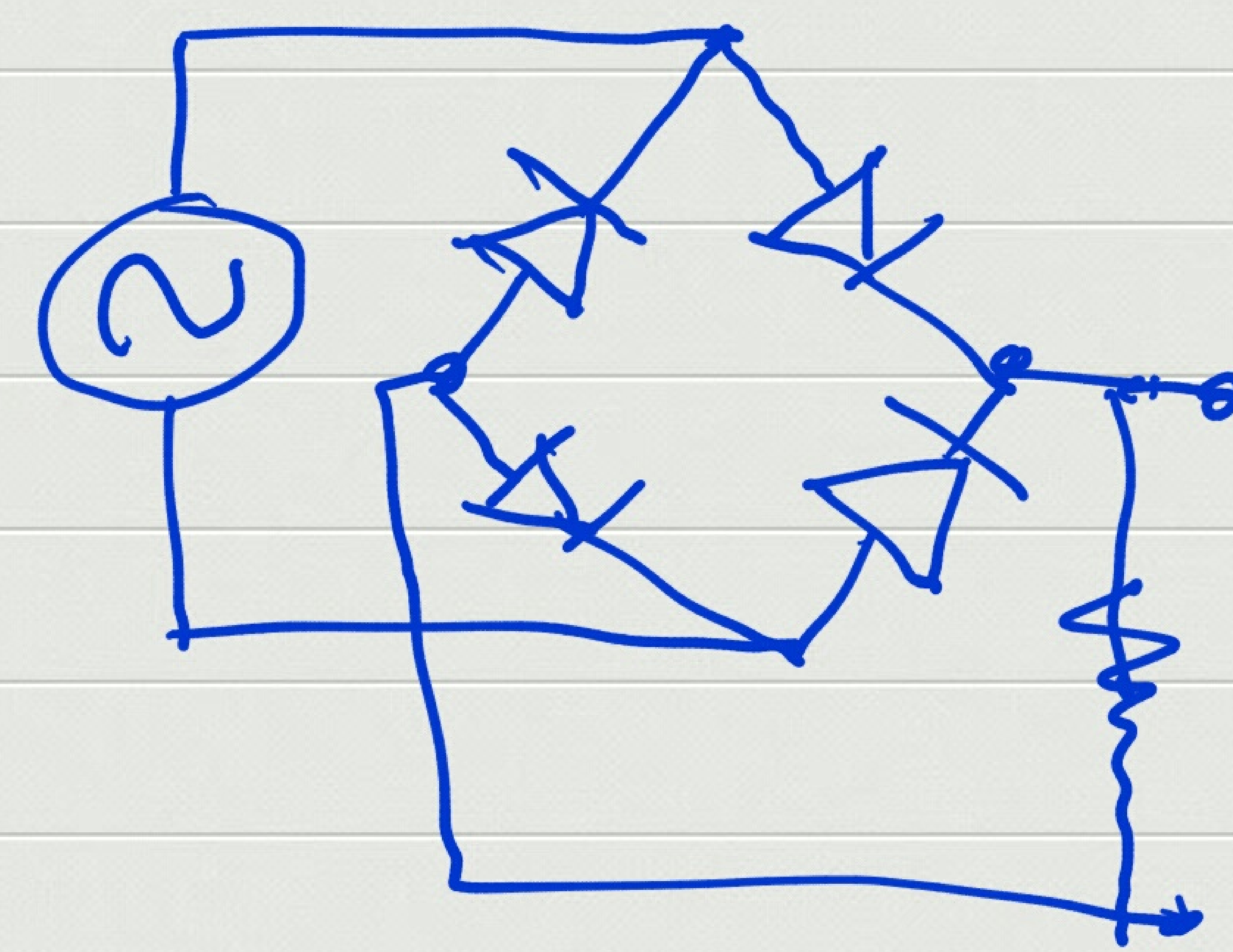
$= 41 \times 10^6\, R$

Ratio is 23,000

Half wave rectifier



Full wave rectifier



TISHK WORKSHOP

PIS

Courses
Section

Management / student
HOD

Dept
TI
Grade

Coordinator
For shared courses