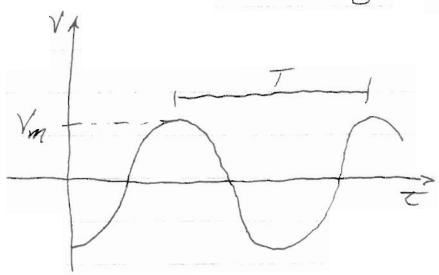
(1)

Alternating Currents (AC)

Consider circuit where voltage supplied
varies sinusoidally w/time

$V = V_m \sin \omega t$
→ voltage amplitude



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

period

frequency in cycles/sec. (Hz.)

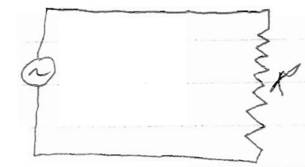
Each electrical outlet in US has AC
voltage @ $f = 60\,Hz$

(2)

Resistive Circuit

AC voltage (Emf)

$\underline{V = V_m \sin \omega t}$



Use Kirchoff's loop rule!

$V \quad V_R = 0$ (@ any time, t)

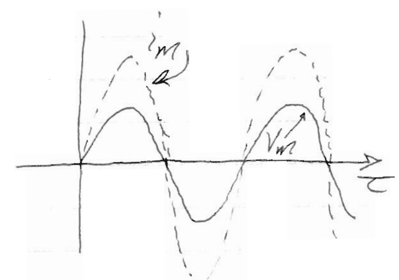
$\Rightarrow V_R = V_{R,m} \sin \omega t$ ($= V_m \sin \omega t$ here)

↳ instantaneous voltage across resistor

"in-phase" with Voltage

Since $R = V_R / I$

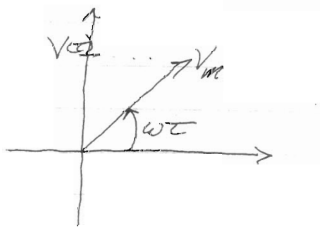
$i_R = \frac{V_R}{R} = \underbrace{\frac{V_{R,m}}{R}}_{i_m} \sin \omega t$ (maximum current)



Phasor Diagrams

amplitude (i_m, V_m) => length
phase $(\omega t, \phi)$ => angle

So a 'phasor' is a vector in a coordinate system whose vertical axis is the instantaneous value of the quantity

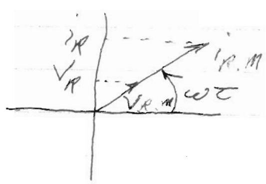


Project onto y-axis to get $i(t), V(t) \ldots$

We can use phasors to consider phase relationships between i's + V's

- reduced to vector arithmetic

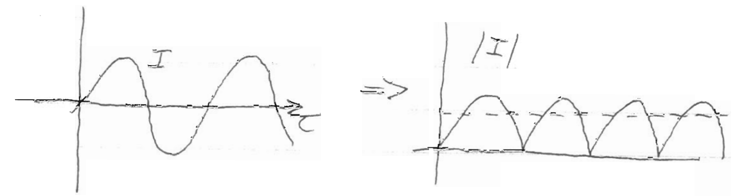
For a single R in a circuit



Power Delivered to a Resistor

I doesn't matter if have positive or negative current since $P = \underset{\rightarrow}{I^{2}}R$ (instantaneous current)

- but average I is different than DC case



average $\neq I_{max}$

We want the 'root-mean-square' of the current

$$I_{rms} = \sqrt{\langle I^2 \rangle} = \sqrt{\Sigma I^2 / N}$$

- Since $I^2 \propto \sin \omega t$, the average of $\sin^2 \omega t$ is $1/2$

$$\langle I^2 \rangle = \frac{1}{2} I_m^2 \Rightarrow I_{rms} = \boxed{I_m/\sqrt{2}} = 0.7 I_m$$

(also $V_{rms} = V_m/\sqrt{2}$)

Average Power $\boxed{P_{avg} = I_{rms}^2 R}$