4. ELECTRICAL PRINCIPLES

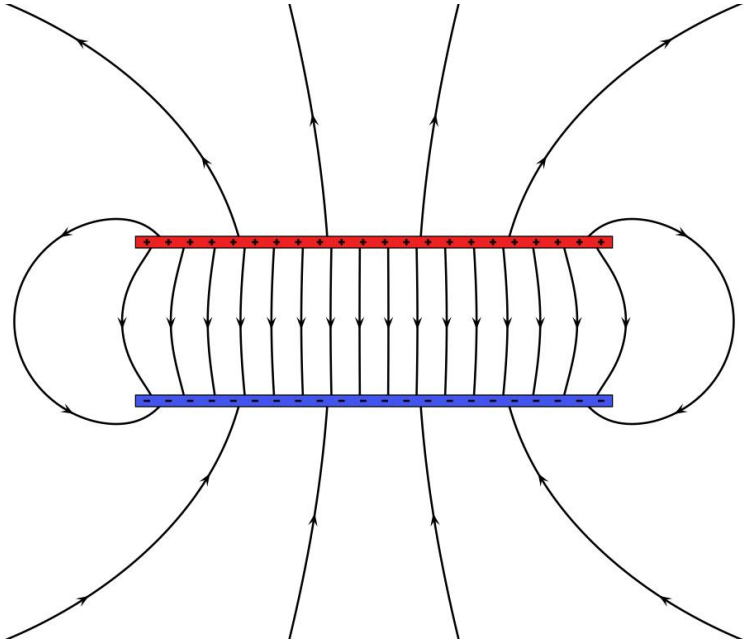
Chapter 4.2
Electrical and magnetic fields

ARRL Amateur Extra Class

Electric field

Caused by a difference in charge

Field lines from + to –



Magnetic field

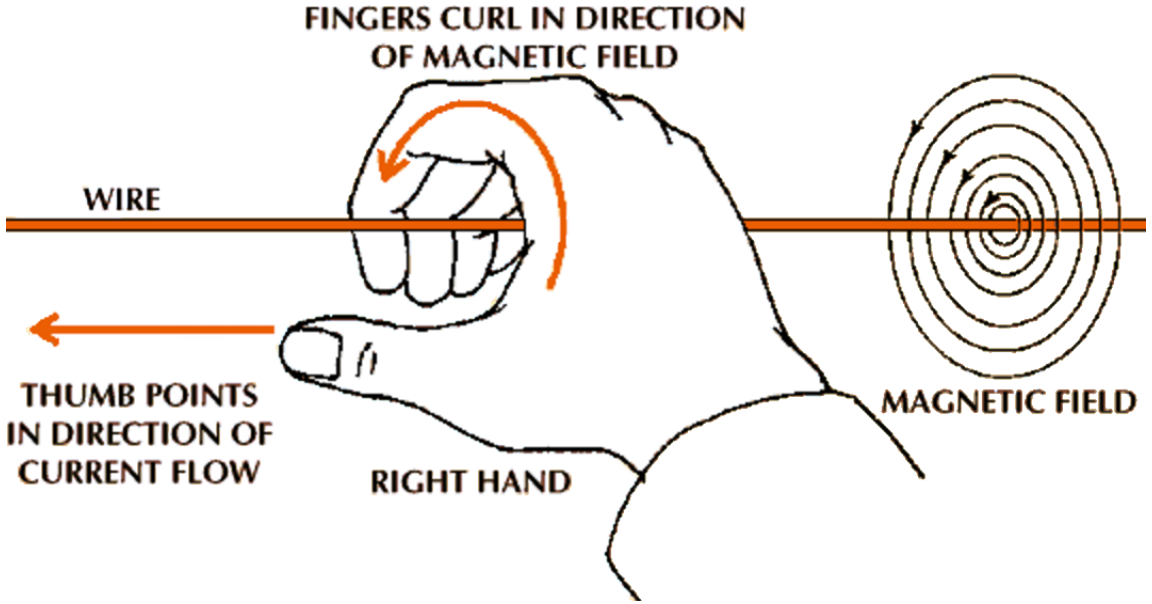
Magnetic field around a wire

Proportional to the current

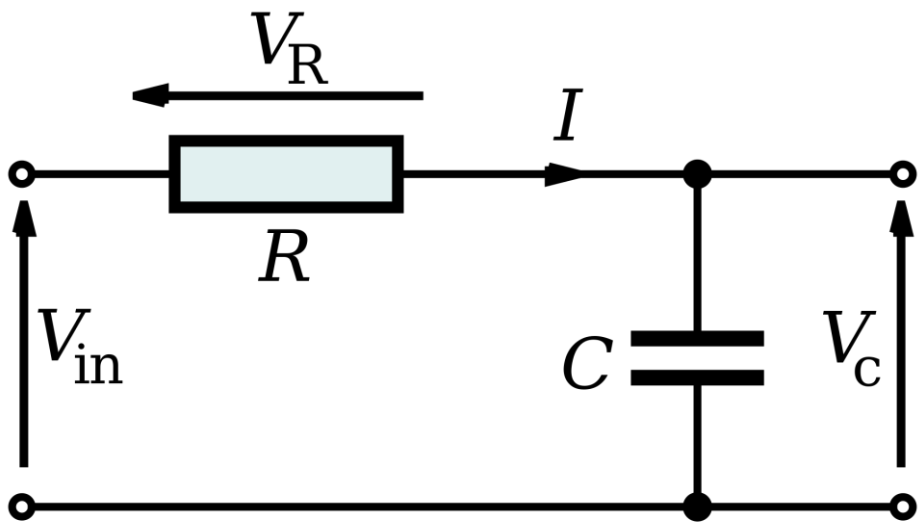
Direction depends on direction of the current flow

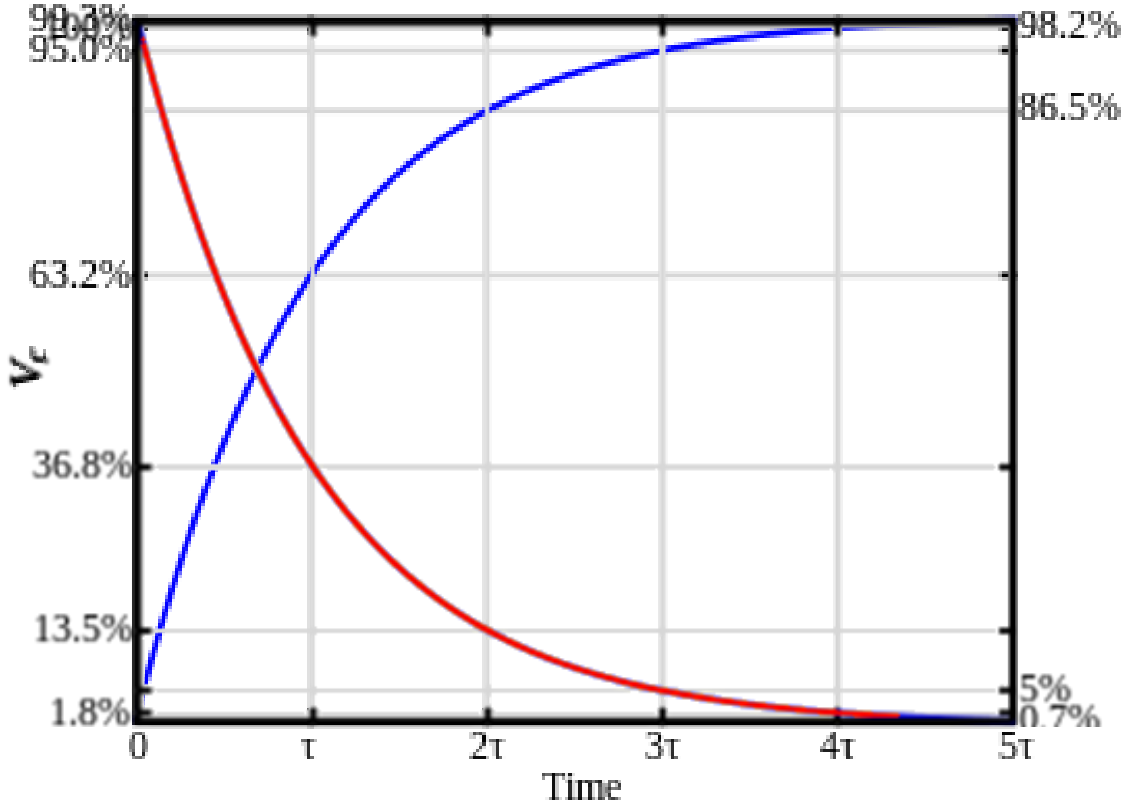
Current flow :
positive -> negative
Use RIGHT hand rule

Electron flow :
negative -> positive
Use LEFT hand rule



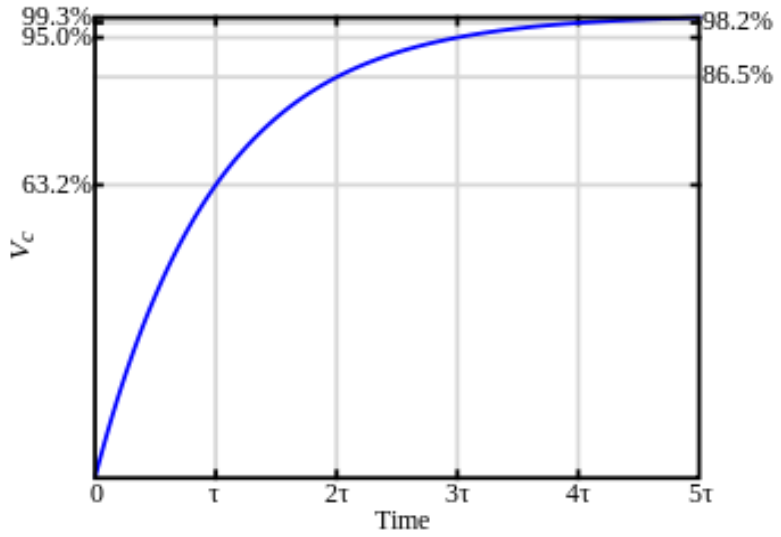
Time constant - capacitor



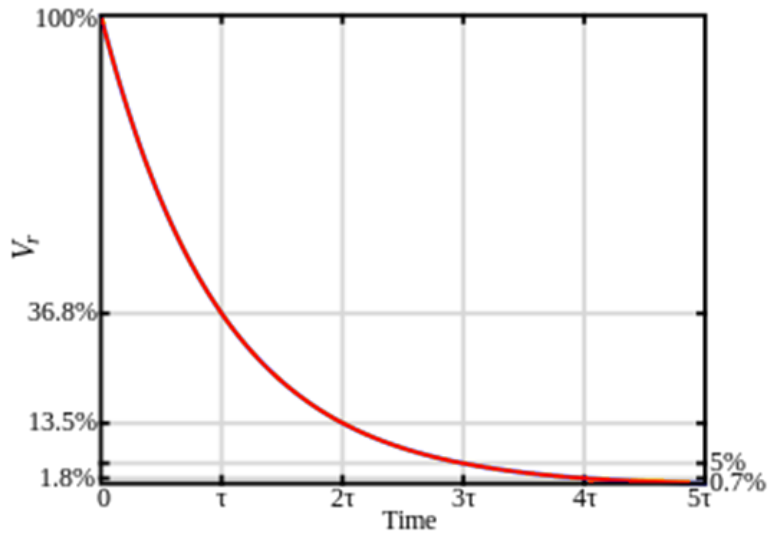


Time constant – capacitor : math

Charging $V(t) = V_0(1 - e^{-t/\tau})$



Discharging $V(t) = V_0(e^{-t/\tau})$



$$\tau = RC \text{ [seconds]}$$

Time constant – capacitor : math example

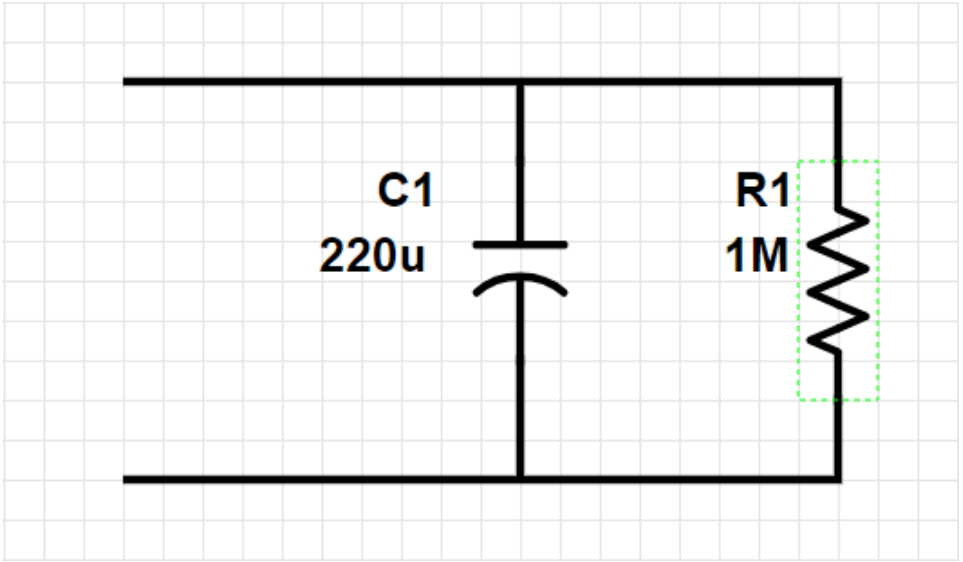
Q: What is the time constant ?

$$\tau = RC \text{ [seconds]}$$

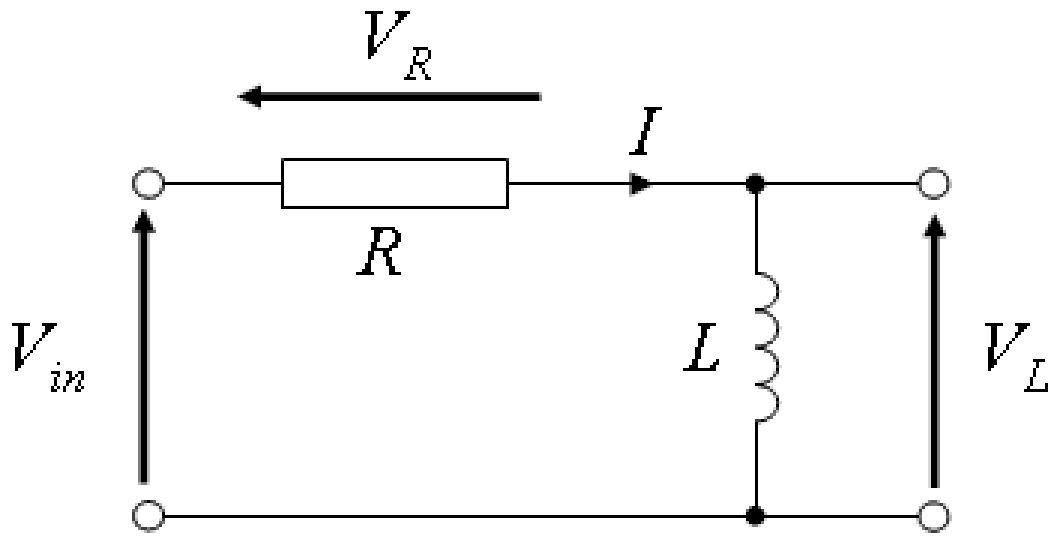
$\tau = 220\mu F \cdot 1M\Omega$

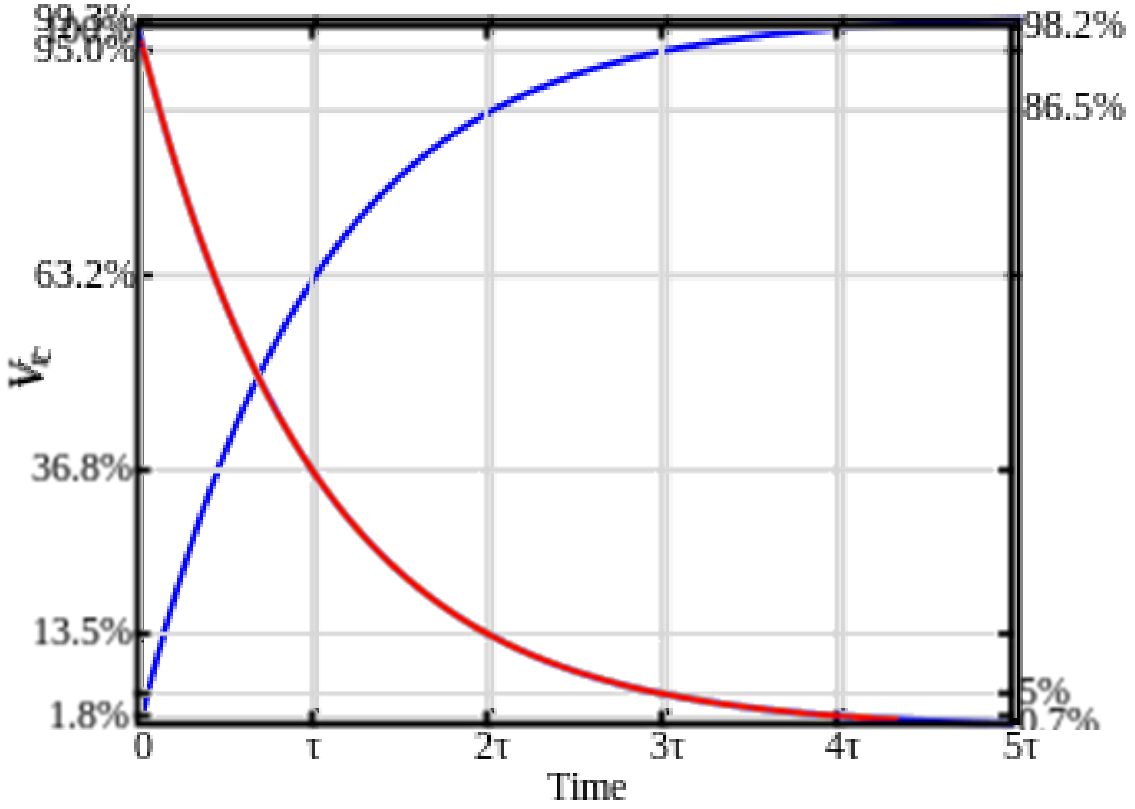
$\tau = 220 \cdot 10^{-6} \cdot 1 \cdot 10^{6}$

$\tau = 220 \cdot 1 = \mathbf{220s}$



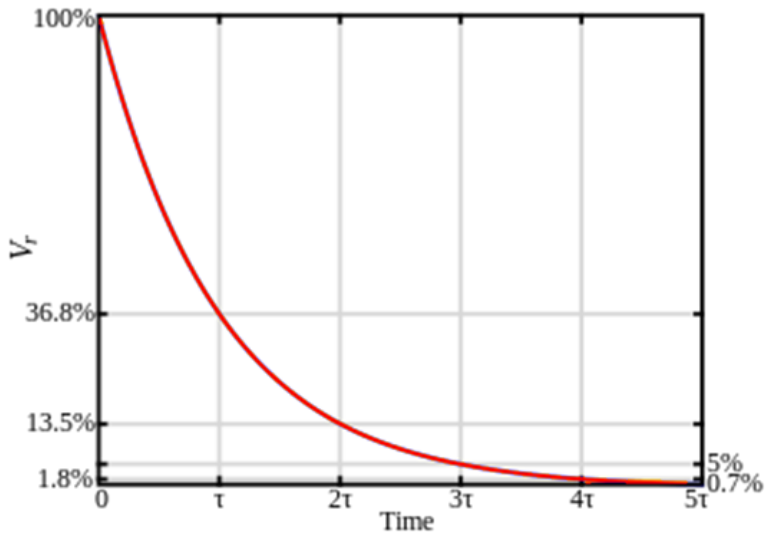
Time constant - inductor



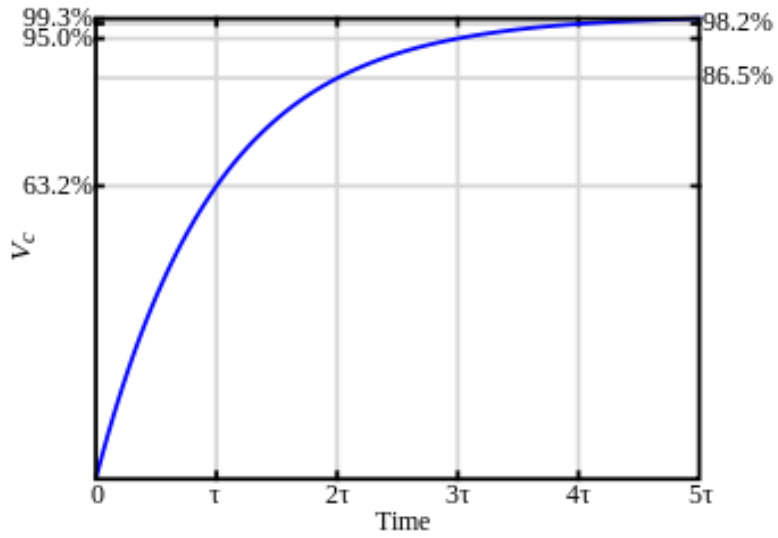


Time constant – inductor : math

Charging $V(t) = V_0(e^{-t/\tau})$



Discharging $V(t) = V_0(1 - e^{-t/\tau})$



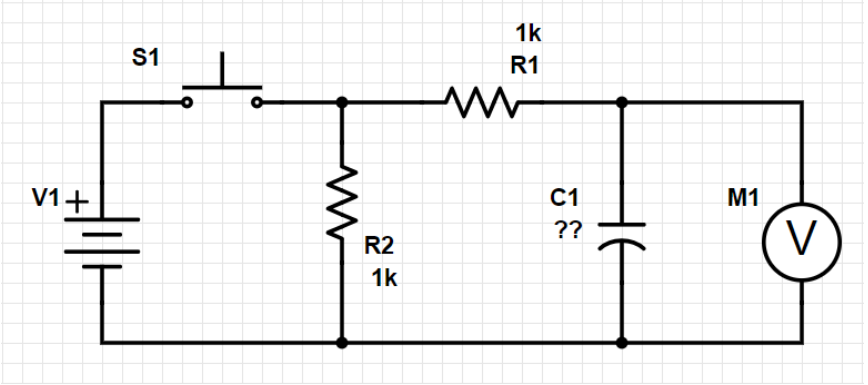
$$\tau = \frac{L}{R} \text{ [seconds]}$$

Time constant – demo

Time constant:

$$\tau = RC \text{ [seconds]}$$

$$C = \frac{\tau}{R}$$

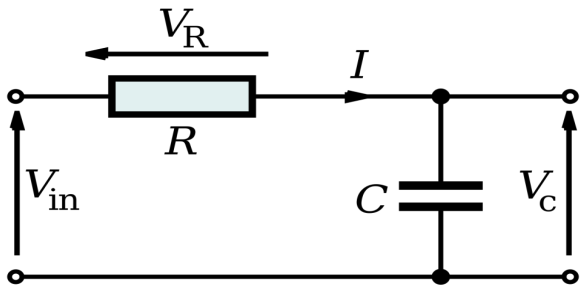


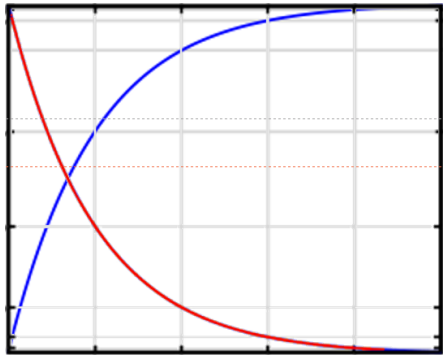
Prefix cheat-sheet:

M = 10^{6}
k = 10^{3}
m = 10^{-3}
µ = 10^{-6}
p = 10^{-9}

Phase angle

Current flows when capacitor charging

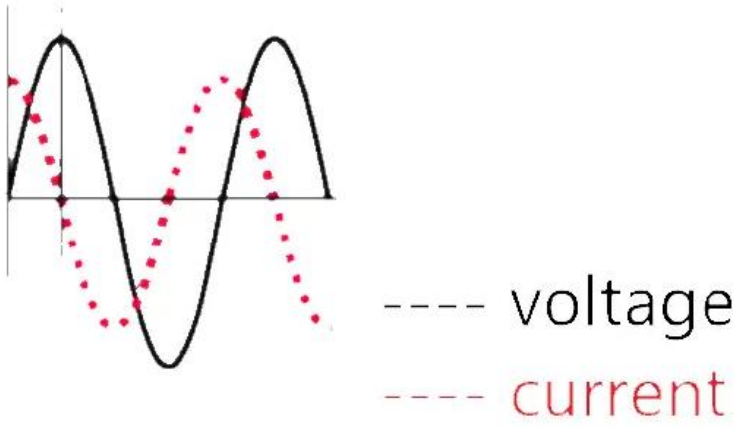




When capacitor fully charged, no current flows

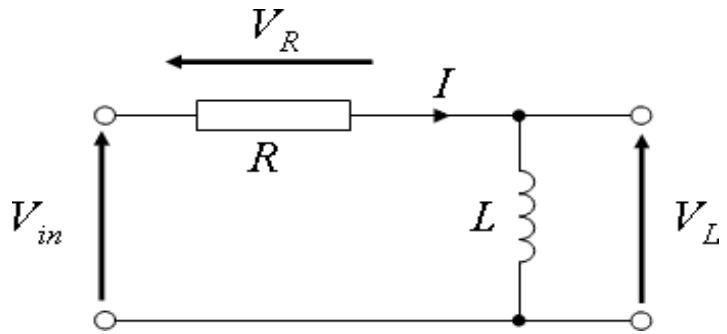
If we feed it with sinus wave (AC);

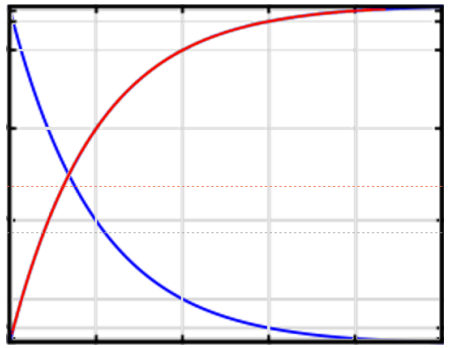
Current Leads Voltage: ’I’ leads ’E’



Phase angle

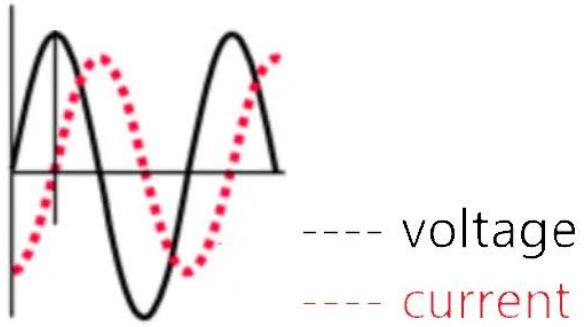
Current flows magnet field is static





If we feed it with sinus wave (AC);

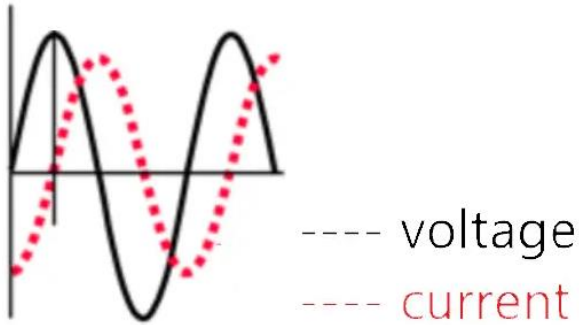
Voltage leads Current: ’E’ leads ’I’



Phase angle

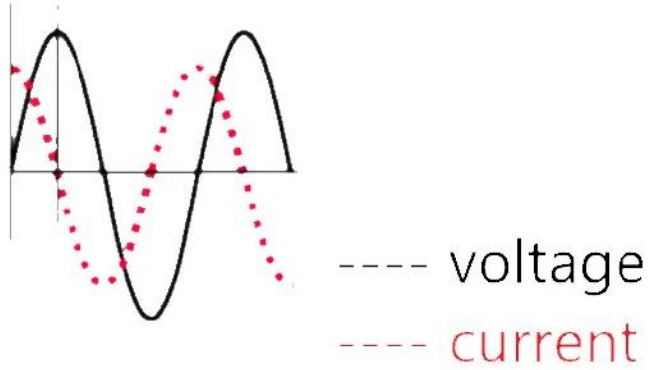
Inductive (L)

’E’ leads ’I’



Capacitive (C)

’I’ leads ’E’



E-L-I the I-C-E man

Complex impedance

Combining Resistance (R) and Reactance (X)

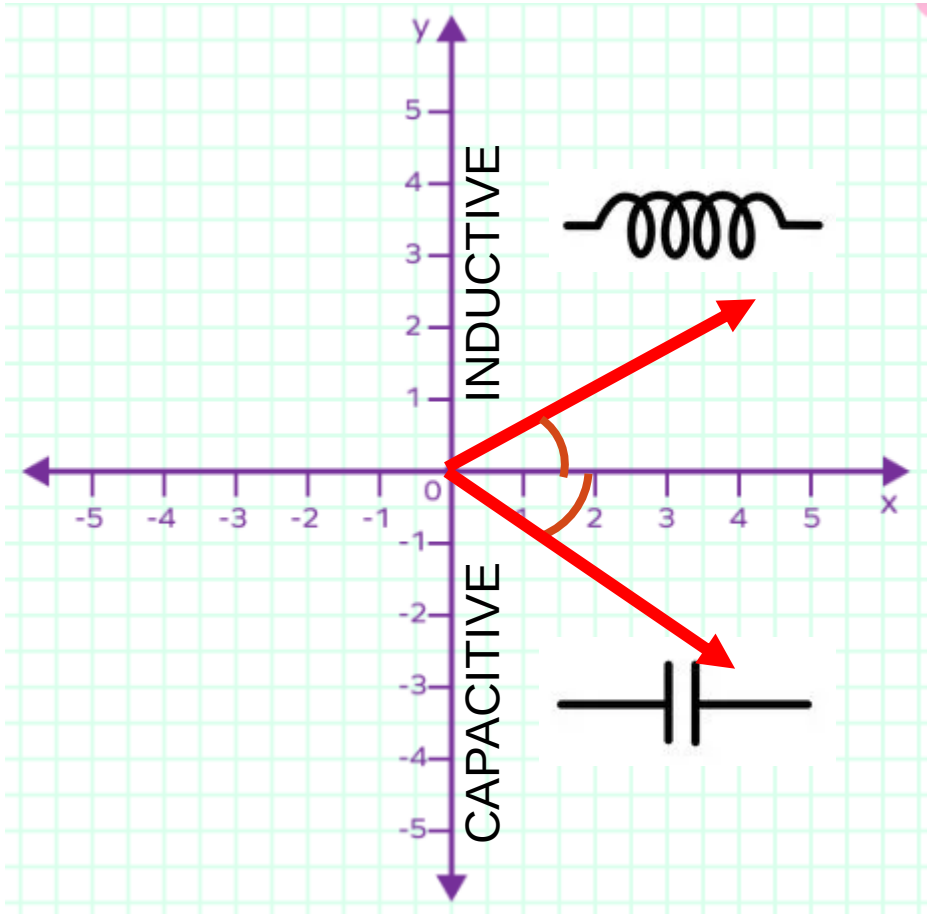
= Impedance (Z)

Z = (resistive part) + j·(reactive part)

Z = R + jX

Positive jX = inductive

Negative jX = capacitive

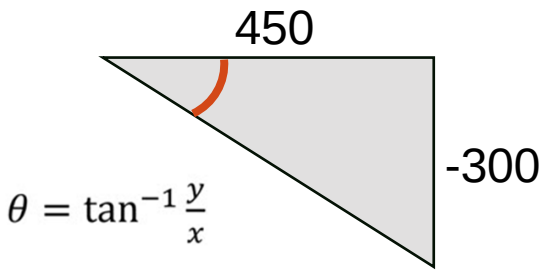


Complex impedance

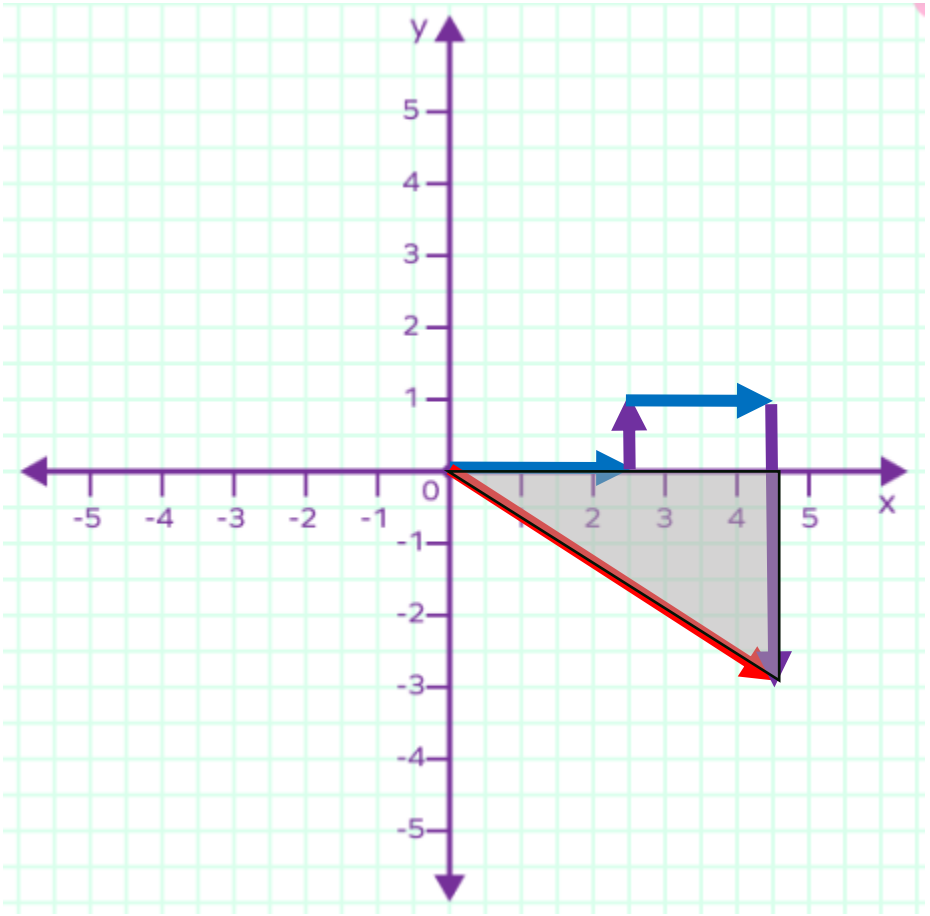
Calculate phase angle of two reactances in series:

Z = (250 + j100) + (200 - j400)

Z = 450 - j300



$\Theta = tan^{-1}(\frac{-300}{450})$ = -33.7



QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview