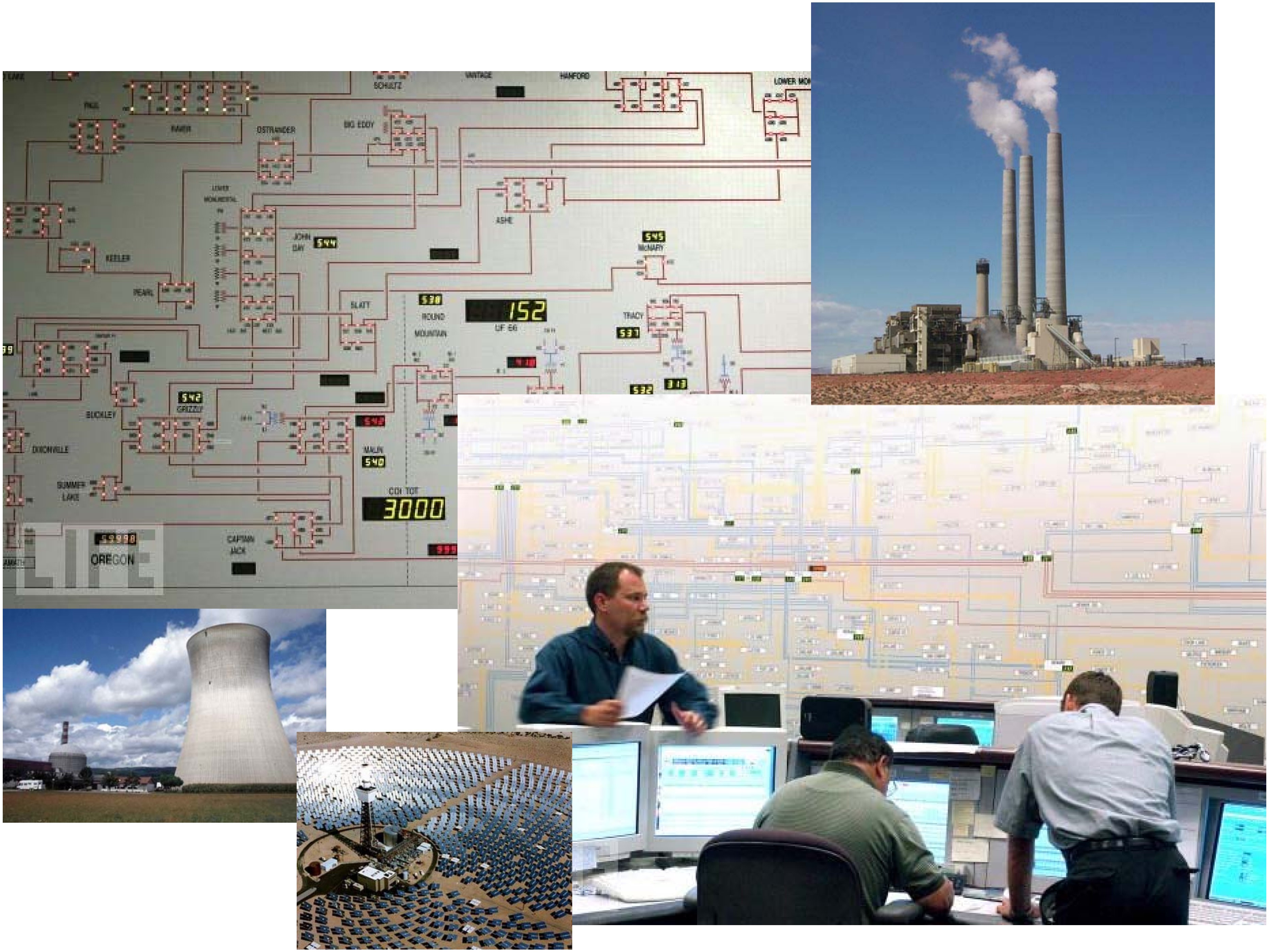
Announcements:
1. Announcement #1

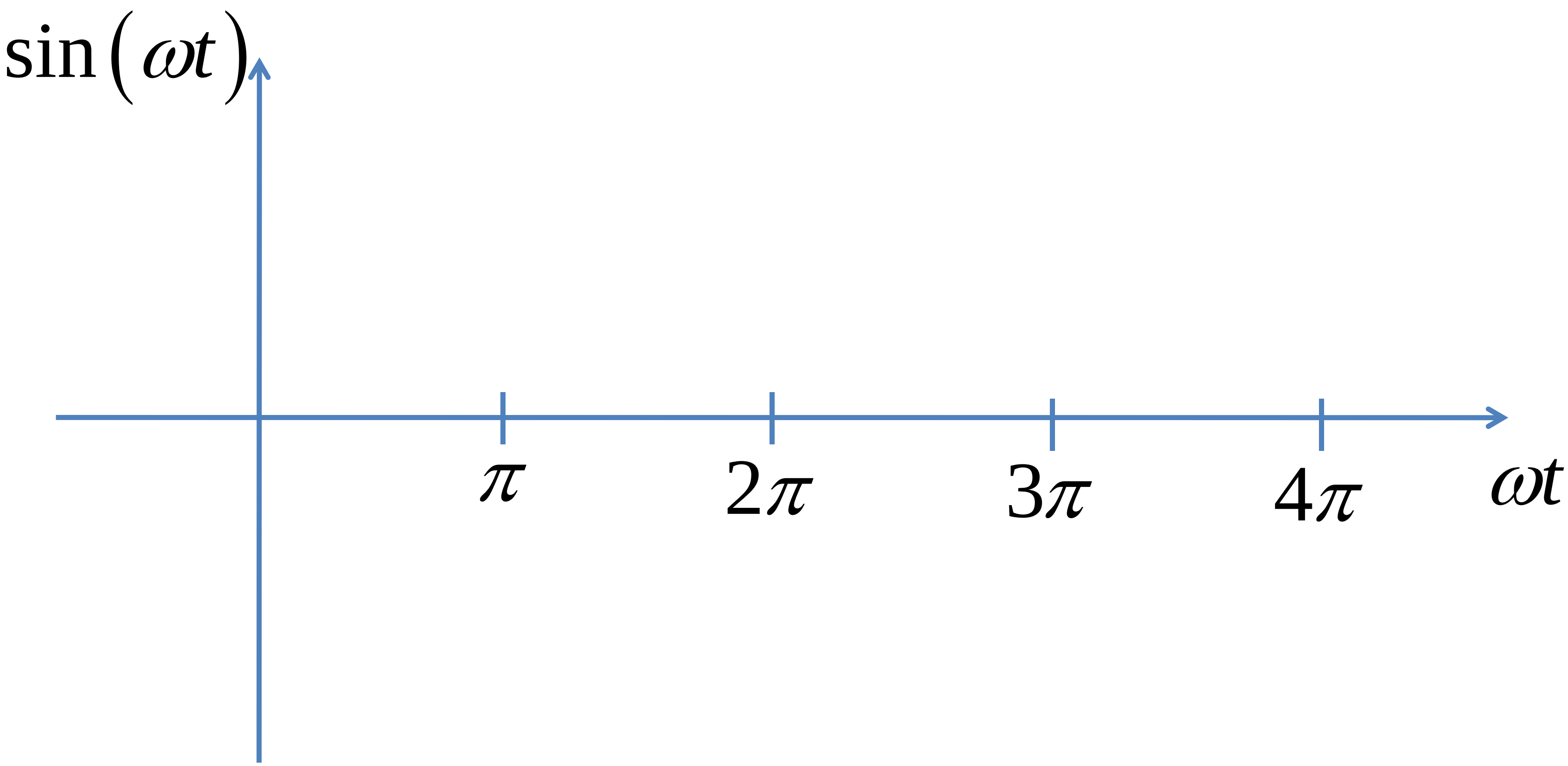
EECS 70A: Network Analysis

Lecture 11


SCHULTZ
VANTAGE
HANFORD
BIG EDDY
OSTRANDER
ASHE
JOHN DAY
KEELER
PEARL
McNARY
SLATT
ROUND MOUNTAIN
152
TRACY
BUCKLEY
GRIZZLY
DIXONVILLE
SUMMER LAKE
MALIN
COI TOT
3000
CAPTAIN JACK
OREGON
LIFE

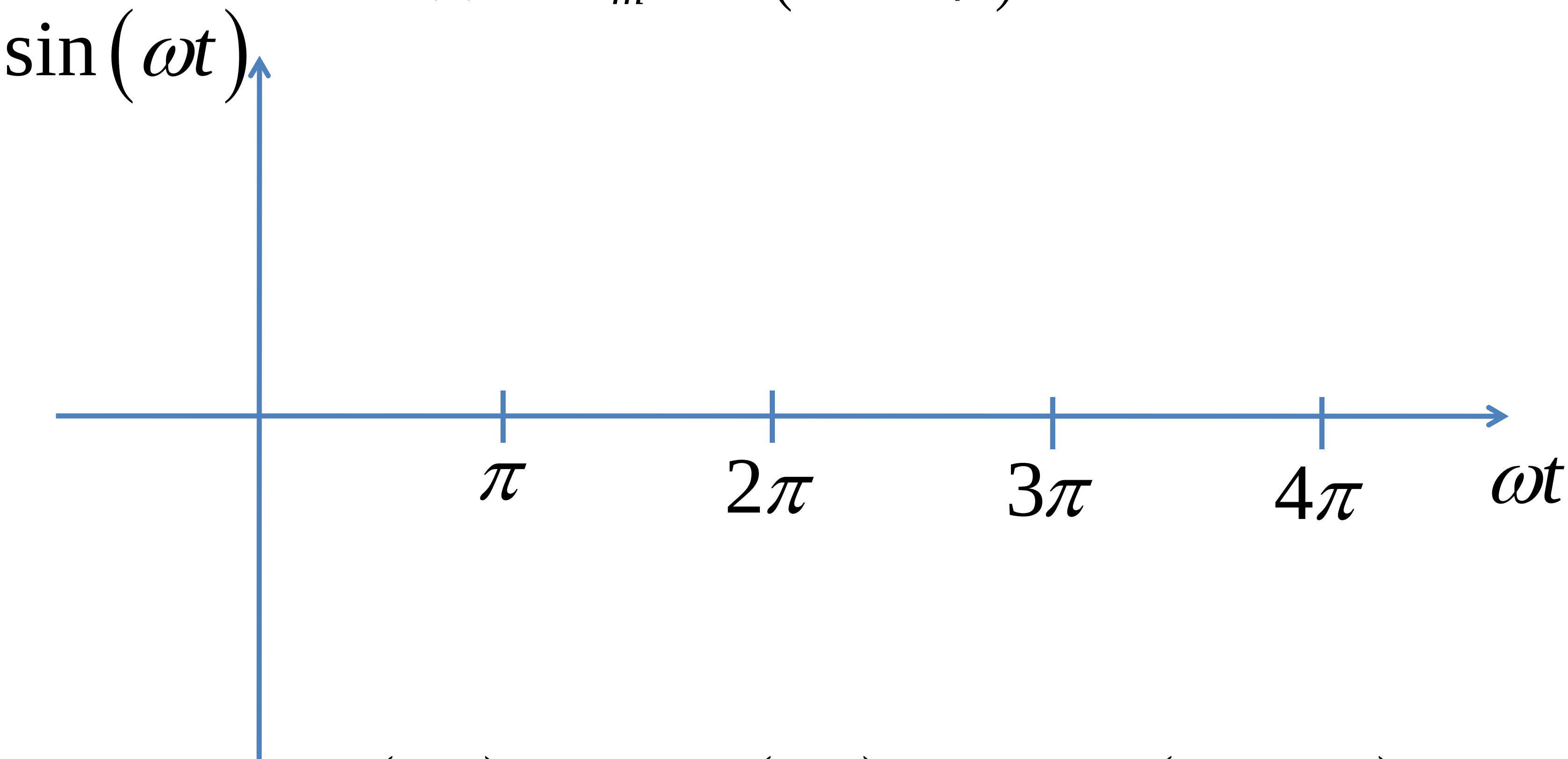
Sine waves

$$V(t) = V_m \sin(\omega t)$$



Phase

$$V(t) = V_m \sin(\omega t + \phi)$$



$$A\cos(\omega t) + B\sin(\omega t) = C\cos(\omega t - \theta)$$

$$\theta = \tan^{-1}\left(\frac{B}{A}\right) \qquad C = \sqrt{A^2 + B^2}$$

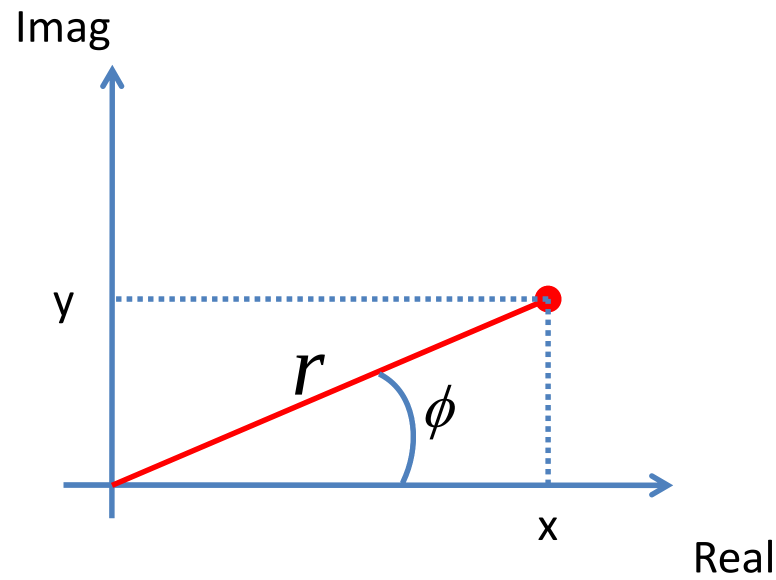
Complex numbers

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

$$z = x + jy$$

$$z = re^{j\phi}$$

$$z = r\angle\phi$$



Complex algebra

$$z_1 = x_1 + jy_1 = r_1 e^{j\phi_1} \qquad z_2 = x_2 + jy_2 = r_2 e^{j\phi_2}$$

Addition:

$$z_1 + z_2 = (x_1 + x_2) + j(y_1 + y_2)$$

Subtraction:

$$z_1 - z_2 = (x_1 - x_2) + j(y_1 - y_2)$$

Multiplication:

$$z_1 z_2 = \left(r_1 e^{j\phi_1}\right)\left(r_2 e^{j\phi_2}\right) = r_1 r_2 e^{j\phi_1} e^{j\phi_2} = r_1 r_2 e^{j(\phi_1 + \phi_2)} = r_1 r_2 \angle(\phi_1 + \phi_2)$$

Division:

$$z_1 / z_2 =$$

Inversion:

$$1/z_1 =$$

Square root:

$$\sqrt{z_1} =$$

Complex conjugate:

$$Z^* = x - jy = re^{-j\phi}$$

Euler relationship

$$e^{j\phi} = \cos\phi + j\sin\phi$$

$$\Rightarrow \cos\phi = \mathrm{Re}(e^{j\phi})$$

Phasors:

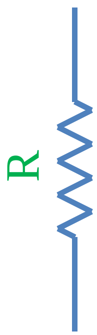
$$V(t) = V_m \cos(\omega t + \phi) = \mathrm{Re}\left(V_m e^{j(\omega t + \phi)}\right)$$

$$= \mathrm{Re}\left(\underbrace{V_m e^{j\phi}}_{\text{"Phasor"}} e^{j\omega t}\right)$$

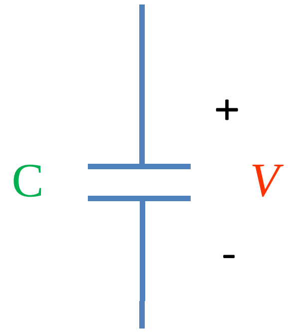
"Phasor" $\mathbf{V}$

(Complex #)

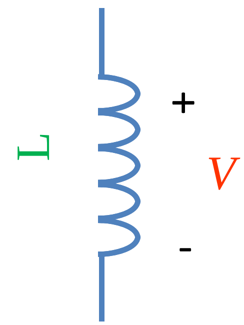
Circuits



$\mathbf{V} = \mathbf{I}\,R$



$\mathbf{V}=\mathbf{I}/j\omega C$



$\mathbf{V}=j\omega L\,\mathbf{I}$

"Impedance"

$Z = R$ $\qquad$ $Z=1/j\omega C$ $\qquad$ $Z = j\omega L$

KCL, KVL hold for relationship between **V**, **I**.

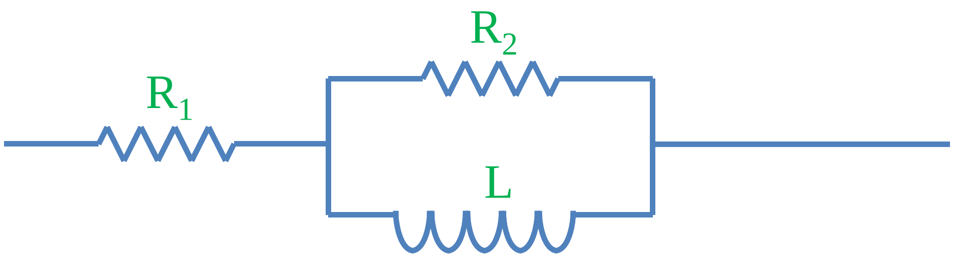
Series/Parallel Impedances

$$Z_{eq} = Z_1 + Z_2 + Z_3$$

$$Z_{eq}^{-1} = Z_1^{-1} + Z_2^{-1} + Z_3^{-1}$$

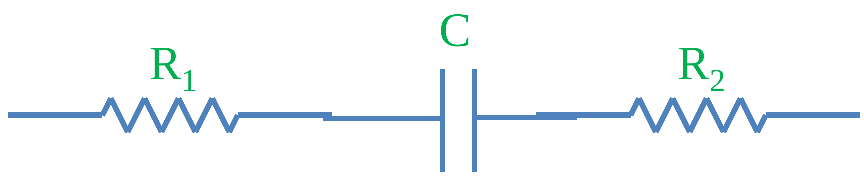
Example problem #1

Find Z_{eq} for this circuit: (instructor)



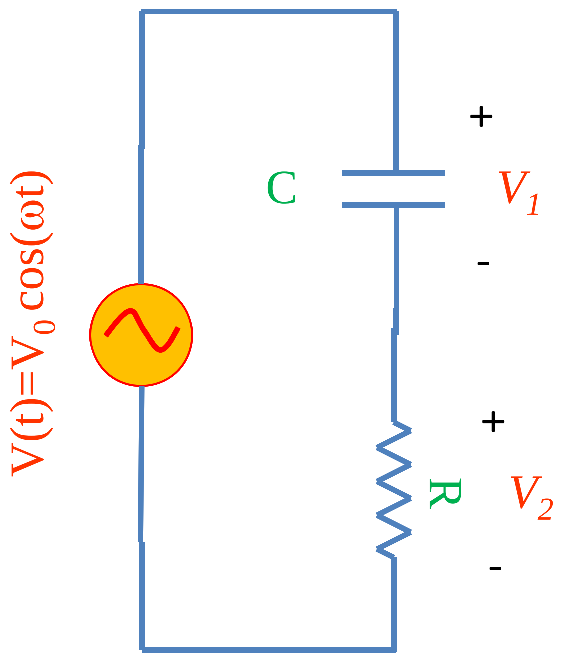
Example problem #2

Find Z_{eq} for this circuit: (students)



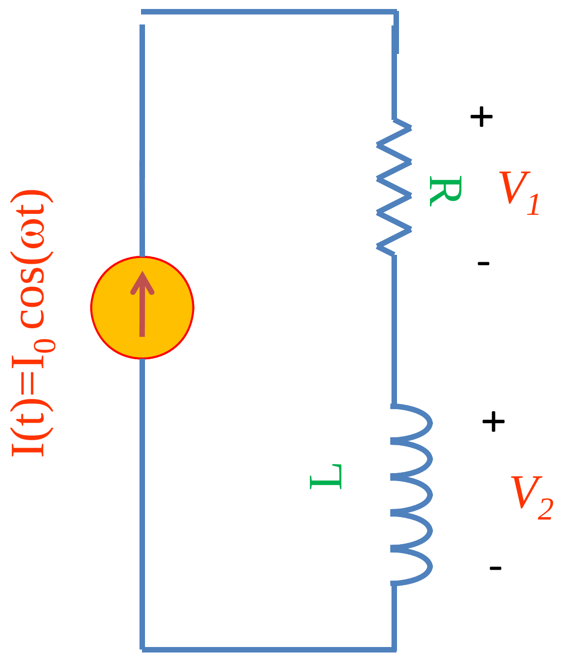
Example problem #3

Find i(t), V_1(t), V_2(t) for this circuit: (instructor)

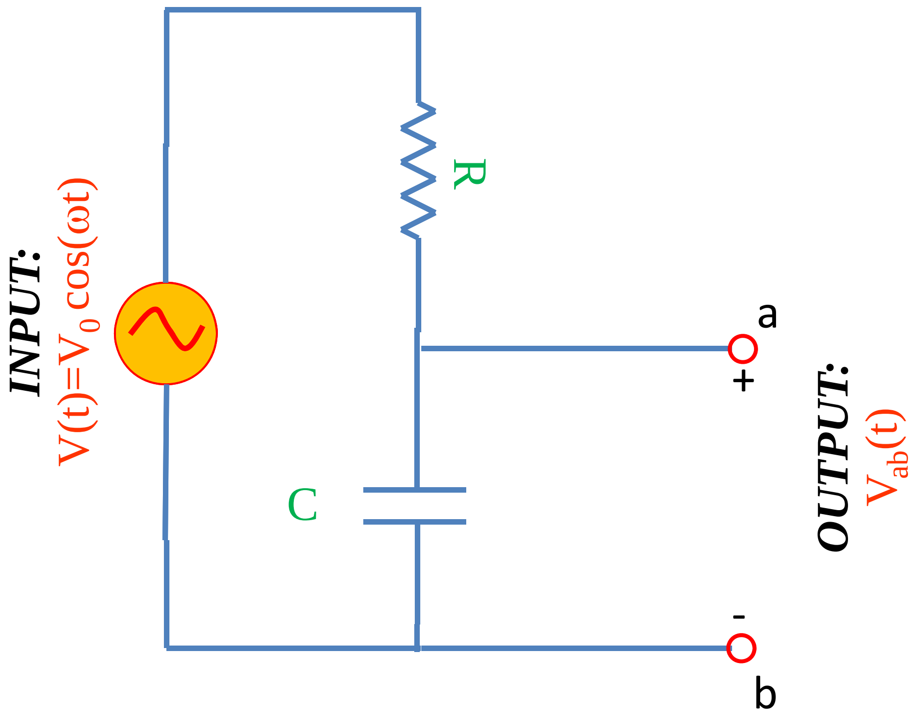


Example problem #4

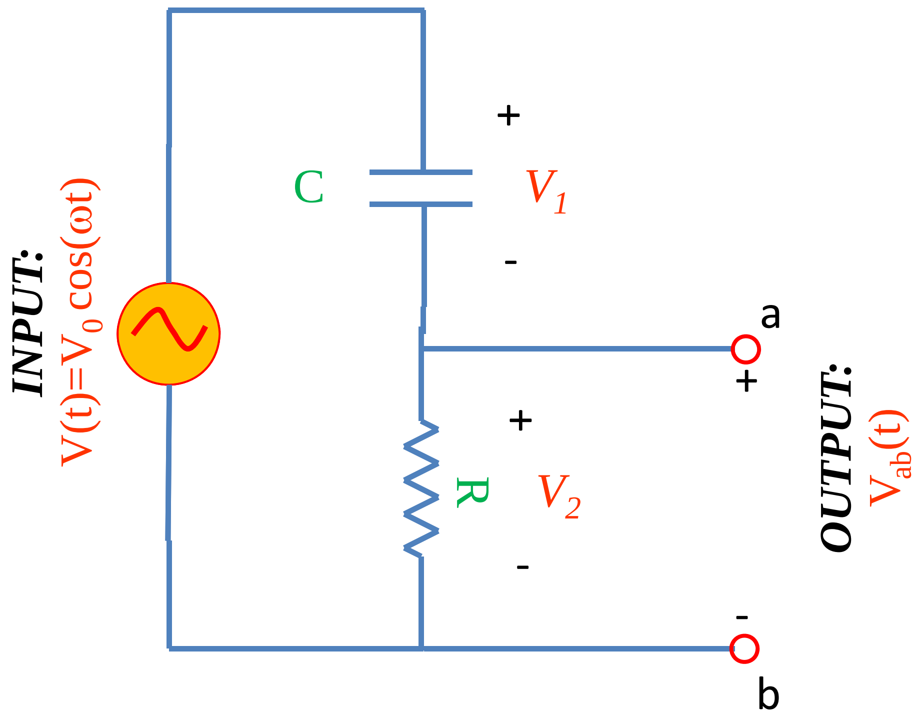
Find i(t), V_1(t), V_2(t) for this circuit: (students)



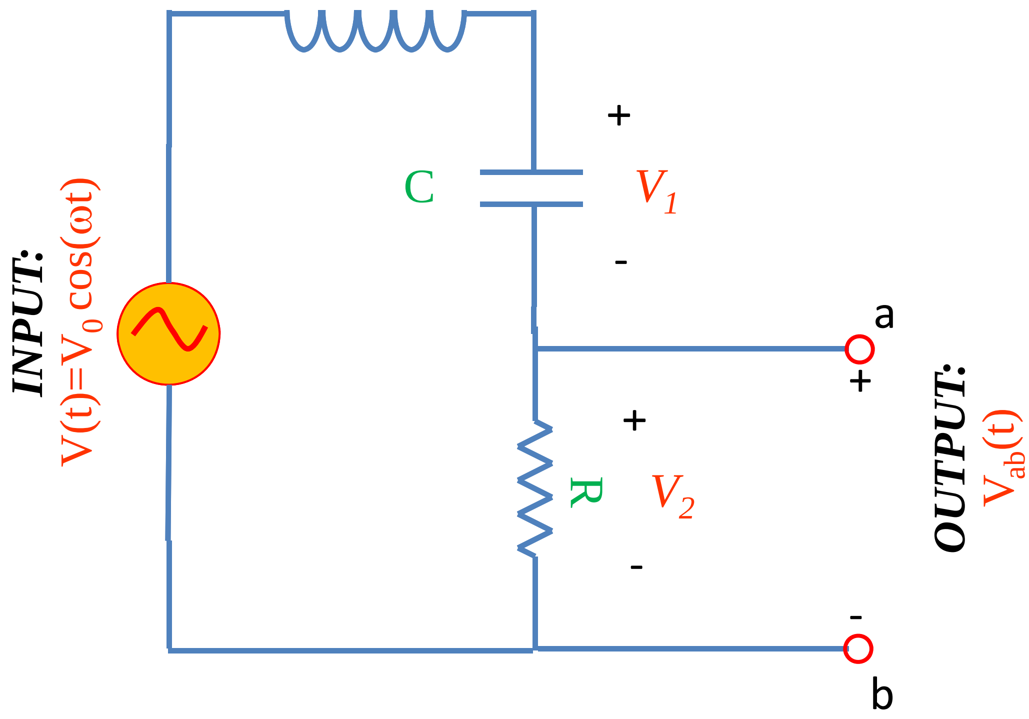
Low pass filter



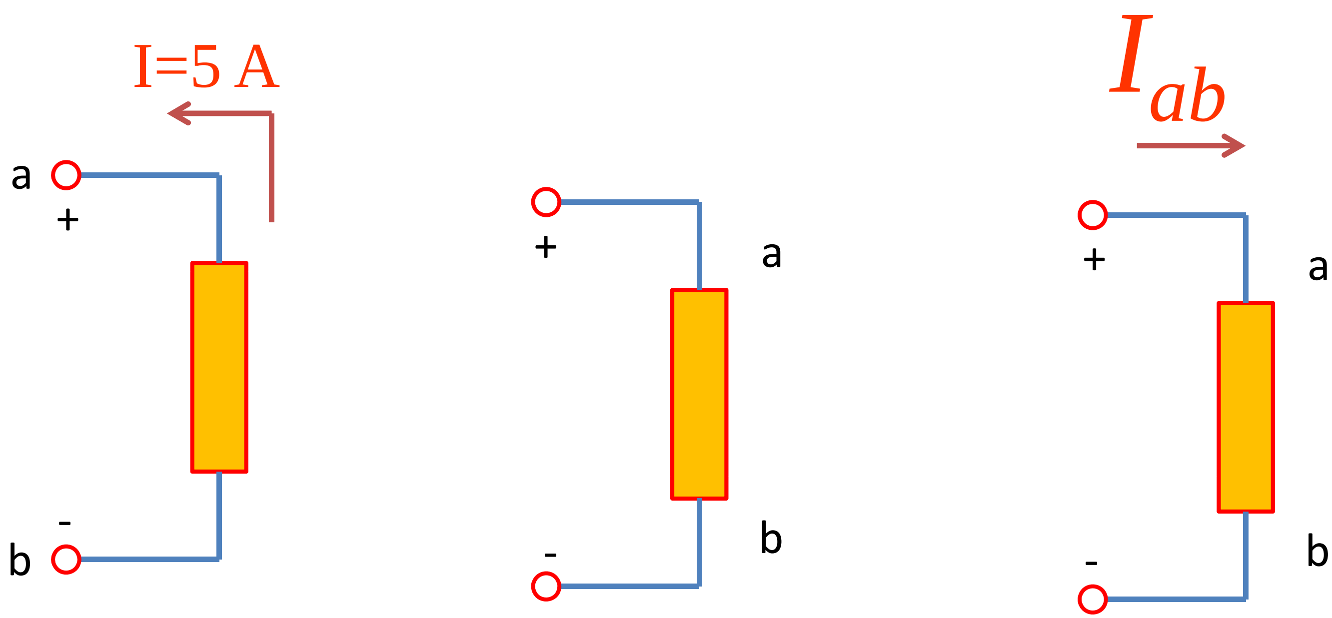
High pass filter



Band pass filter (RLC)



Symbol library



Symbol library