# EC2015 Electric Circuits and Networks - Tutorial 7

October 4, 2019

***Topics covered*—Phasors, Sinusoidal steady state analysis and Phasor Relationships for Circuit Elements.**

**Phasor:** Any vector rotating (anti clockwise) with constant frequency is called phasor. In general phasors are represented in the form of $r\angle\theta$. Where $r$ is magnitude of the vector and $\theta$ is phase angle.

**Sinusoidal steady state analysis:** Frequency domain analysis of an ac circuit via phasors is much easier than analysis of the circuit in the time domain.

**Steps:**

1.Neglect all initial conditions.

2.Transform the circuit to the phasor or frequency domain by replacing all elements with their phasor or frequency domain equivalents as given below.

| Element | Time domain | Frequency or Phasor domain |
|---|---|---|
| Co-sine source | Acos(wt+$\theta$) | A$\angle\theta$ |
| Sine source | Asin(wt+$\theta$) | A$\angle(\theta - 90^\circ)$ |
| Resistor | R | R |
| Inductor | L | $jwL$ (or) $wL\angle 90^\circ$ |
| Capcitor | C | $\frac{1}{jwc}$ (or) $\frac{1}{wc}\angle -90^\circ$ |

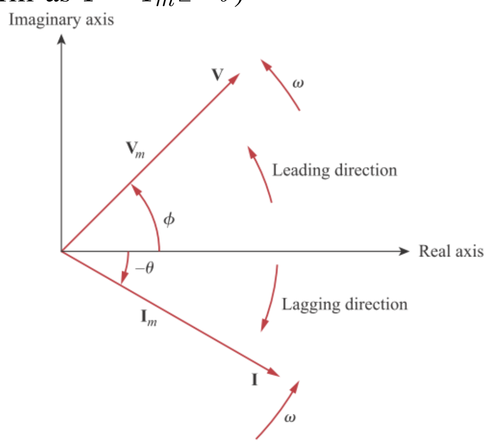
3. Solve the problem using circuit techniques (nodal analysis, mesh analysis and network theorems, etc.).

4. Transform the resulting phasor to the time domain.

**Note:**

In this case, If any circuit has sources operating at different frequencies, we must have a different frequency domain circuit for each frequency (since the impedances depend on frequency). The total response must be obtained by adding (**Superposition Theorem**) the individual responses in the time domain not in frequency domain (because addition of responses at different frequencies in the phasor domain is not possible)

**Phasor Relationships for Circuit Elements:**
The figure shown below represents two sinusoidal functions $v(t) = V_m cos(wt + \phi)$ (Phasor form as $V = V_m\angle(\phi)$ and $i(t) = I_m cos(wt - \theta)$ (Phasor form as $I = I_m\angle -\theta)$




The following figure shows the voltage and current relationship between different circuit elements. For resistance $V = IR$; current and voltage are in-phase. For inductor $V = jwLI = wLI\angle 90^\circ$; I lags V by $90^\circ$. For capcitor $V = \frac{1}{jwC}I = \frac{I}{wc}\angle -90^\circ$; I leads V by $90^\circ$.

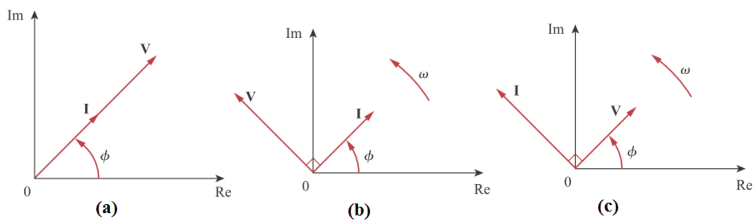



Fig. 1. Phasor Relationships for Circuit Elements: (a) resistor (b) inductor and (c) capacitor.

Phasor relationship between circuit elements is the basis for constructing phasor diagram of any circuit. To avoid the confusion between phasor relationship of inductor and capacitor, a code word **CIVIL** is used as follows,

**CIV**- In **C** (Capacitor) **I** leads **V** by $90^\circ$

**VIL**- **V** leads **I** by $90^\circ$ in **L** (Inductor)