Class 16: Phasor analysis for AC circuits

- A **phasor** is a complex number that represents a cosine-valued AC function
- The Root Mean Square (RMS) for cosine is found by dividing the maximum value by $\sqrt{2}$
- In polar form, $R\angle\theta$, a phasor represents the RMS voltage or current and phase angle

$$R\angle\theta \rightarrow \sqrt{2}\, R\cos(2\pi f t - \theta)$$

- Conversions to rectangular form: a+jb, and back can be done with these identities:

$$R = \sqrt{a^2 + b^2} \qquad \theta = aTan\left(\frac{b}{a}\right) \qquad a = R\cos\theta \qquad b = R\sin\theta$$

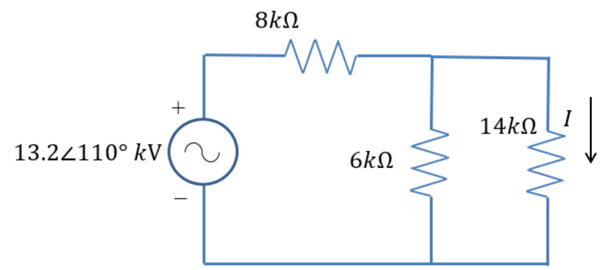
- Complex number addition can be done in rectangular form, and complex number multiplication can be done in polar form.
- Phasor diagrams have the real part on the x axis and imaginary part on the y axis.
- The angular frequency is $\omega = 2\pi f$.
- **KVL, KCL, and Ohm's law all apply with AC phasor analysis exactly as with DC**.
- This means you can use Node-Voltage and Mesh-Current analysis methods too.

Practice problems for phasor conversion

1. Convert $5\angle 12°$ A to rectangular form.
2. Convert $14\angle 20°$ V to the cosine time function, assuming a frequency of 14 kHz.
3. Find the polar form phasor for $20\cos(377t - 40°)$ kV.
4. Convert the phasor 12-j3 A to polar form.
5. Sketch a time plot of the phasor $18\angle 12°$ mA, assuming a frequency of 100 MHz.
6. Draw a phasor diagram for the phasor $35\angle - 110°$ V.
7. Convert $24 \angle - 60°$ A to rectangular form.
8. Convert $30\angle 0°$ V to the cosine time function, assuming a frequency of 50 Hz.
9. Find the rectangular form phasor for $20\cos((6.28 \times 10^6)t + 18°)$ kV.
10. Convert the phasor 30+j30 kA to polar form.
11. Sketch a time plot of the phasor $1.32\angle 10°$ MV, assuming a frequency of 60 Hz.
12. Draw a phasor diagram for the two phasors $3.5\angle 10°\ A$ and $2.7\angle 40°\ A$.
13. Convert $16\angle - 90°$ A to rectangular form.
14. Convert $100.5\angle 0°$ V to the cosine time function, assuming a frequency of 400 Hz.
15. Find the polar form phasor for $200\sin(377t)$ kV.
16. Convert the phasor j5 V to polar form.
17. Sketch a time plot of the phasor $300\angle - 90°$ V, assuming a frequency of 10 Hz.
18. Draw a phasor diagram for the phasor $3.25\angle 0°$ V.
19. Convert $2.0 \angle 90°$ MV to rectangular form.
20. Convert $74.5\angle 14°$ V to the cosine time function, assuming a frequency of 2500 Hz.
21. Find the rectangular form phasor for $55\cos(10^9 t - 108°)$ V. What is the frequency?
22. Convert the phasor 10-j30000 kA to polar form.
23. Sketch a time plot of the phasor $100\angle 90°$ A, assuming a frequency of 6000 Hz.
24. Draw a phasor diagram for the two phasors $90\angle 90°\ A$ and $90\angle - 90°\ A$.

Example 1

- Solve for I as a phasor using any method
- Assuming the frequency is 1 kHz, write the time signals for V and I



Example 2

- $i_s(t) = 7.1\cos(1256t - 10°)\ A$
- $v_s(t) = 113.1\cos(1256t + 45°)$ V
- Find $v_1(t)$ using phasor analysis
- Steps:
  - Convert time signals into phasors (complex numbers)
  - Solve the circuit using regular circuit techniques (just with complex numbers)
  - Convert the answer back into a time signal with the same frequency