Lecture 8 — Exam 1 Recap

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- Consumed real power (average power) from a linear circuit may be expressed as:

$$P = \frac{1}{2}V_{max}I_{max}\cos(\phi)$$
$$\phi = \theta_v - \theta_i$$

  - With functions:

$$v(t) = V_{max}\cos(\omega t + \theta_v)$$
$$i(t) = I_{max}\cos(\omega t + \theta_i)$$

- The reactive power can then be defined as:

$$Q = \frac{1}{2}V_{max}I_{max}\sin(\phi) \quad \text{(in VArs)}$$

- The complex power becomes:

$$S = P + jQ,\ |S| = \frac{1}{2}V_{max}I_{max}$$

- RMS values are define as:

$$V_{rms} = \frac{1}{\sqrt{2}}V_{max}$$
$$I_{rms} = \frac{1}{\sqrt{2}}I_{max}$$

- The frequency can be written as:

$$\omega = 2\pi f$$

- For a capacitor:

$$v_c(t)i(t) = p_c(t)$$
$$\text{Ave}\{p_c(t)\} = 0$$

- And for an inductor:

$$v_l(t)i(t) = p_c(t)$$
$$\text{Ave}\{p_l(t)\} = 0$$

- Frequency of power is double that of voltage/current
- For 3-Phase Circuits:

$$Q_{3\phi} = \sqrt{3}V_{LL}^{rms} I_L \sin(\phi)$$
$$P_{3\phi} = 3P = 3|V_{rms}||I_{rms}|(pf) = \sqrt{3}|V_{LL}^{rms}||I_L|(pf)$$
$$S_{3\phi} = \sqrt{3}\hat{V}_{LL}^{rms}\hat{I}_{rms}^{*} = 3\hat{V}_{LN}\hat{I}_{rms}^{*}$$

- Per-unit system (actual/base)
  - Select S_{base} for the entire system
  - Then, select V_{base} for one zone
  - Calculate V_{base} for all other zones, using transformer turn ratios between them and zone one
  - Calculate z_{base}, I_{base} for all zones

$$I_{base(i)} = \frac{S_{base}}{V_{base(i)}} \text{ and } z_{base} = \frac{V_{base(i)}^2}{S_{base}}$$

- 3-Phase Per-unit system:
  - $I_{base(i)} = \dfrac{S_{base}}{\sqrt{3}V_{LLbase(i)}}$
  - $z_{base(i)} = \dfrac{V_{LLbase(i)}}{S_{base}} = \dfrac{V_{LNbase(i)}}{S_{base}/3}$
  - Solving in this manner will give solutions in per-unit
- Balanced 3π circuits
  - Sources are balanced, their magnitudes equal, with phase angles $\mp 120°$ apart
  - Loads, lines, all impedance/phase will be identical

- To convert from delta to 'Y' connection, we may write:

$$\hat{V}_{an} = \frac{\hat{V}_{AB}}{\sqrt{3}} e^{-j30}$$

- Or:

$$\hat{V}_{AB} = \sqrt{3}\hat{V}_{an} e^{j30}$$

- We can find voltages of other phases simply by offsetting the angle of one by 120°
- We can compensate for Q by adding a capacitor in parallel with the load
- The power factor may be computed as: $pf = \cos(\phi)$