Topic 9 recap

Instantaneous power

- Instantaneous power is $p(t) = v(t)i(t)$.
- For **sinusoidal** voltage and current:

$$p(t) = \frac{1}{2}V_m I_m \cos(\theta_v - \theta_i) + \frac{1}{2}V_m I_m \cos(2\omega t + \theta_v + \theta_i)$$

Average power

- The average power P is the **average** of instantaneous power over **one period.**

$$P = \frac{1}{T}\int_0^T p(t)dt$$

- For **sinusoidal** voltage and current: $P = \frac{1}{2}V_m I_m \cos(\theta_v - \theta_i) = \frac{1}{2}\mathrm{Re}[\mathbf{V}\mathbf{I}^*]$
- **Average power** absorbed by a **resistor** R is:

$$P = \frac{1}{2}V_m I_m = \frac{1}{2}RI_m^2 = \frac{1}{2}R|\mathbf{I}|^2 = \frac{1}{2}\frac{V_m^2}{R} = \frac{1}{2}\frac{|\mathbf{V}|^2}{R}$$

- **Average power** absorbed by **inductor** and **capacitor** is **zero.**

Topic 9 recap

Maximum average power transfer

- Using **Thevenin** equivalent circuit, maximum average power is transferred to a complex load $\mathbf{Z}_L$ when:
  - $\mathbf{Z}_L = \mathbf{Z}_{\mathrm{Th}}^*$, and maximum average power is $P_{\max} = \frac{|\mathbf{V}_{\mathrm{Th}}|^2}{8R_{\mathrm{Th}}}$.
  - For **pure resistive load** R_L, **maximum average power** is transferred when $R_L = |\mathbf{Z}_{\mathrm{Th}}|$ and $P_{\max} = \frac{1}{2} R_L |\mathbf{I}_L|^2 = \frac{1}{2}\frac{|\mathbf{V}_L|^2}{R_L}$.

Topic 9 recap

Effective or RMS value

- **DC** signal that can deliver **the same average power** to a **resistor** as the AC signal.
- Effective or RMS value take the form of the **square root** of the **average (mean)** of the **square** of the periodic signal.

$$X_{\mathrm{eff}} = X_{\mathrm{rms}} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

- For **sinusoidal** voltage and current:

$$V_{\mathrm{eff}} = V_{\mathrm{rms}} = \frac{V_m}{\sqrt{2}}$$

$$I_{\mathrm{eff}} = I_{\mathrm{rms}} = \frac{I_m}{\sqrt{2}}$$

- **Average power** can be calculated using RMS values of current and voltage.

$$P = V_{\mathrm{rms}} I_{\mathrm{rms}} \cos(\theta_v - \theta_i)$$

- **Average power** absorbed by a **resistor** R using RMS value:

$$P = V_{\mathrm{rms}} I_{\mathrm{rms}} = R I_{\mathrm{rms}}^2 = \frac{V_{\mathrm{rms}}^2}{R}$$