Lecture 33, Apr 4, 2022

Thevenin and Norton Equivalent Circuits for AC Circuits

- Thevenin and Norton equivalent circuits can be found for AC circuits as well
- Thevenin voltage and Norton current become the phasors for the Thevenin voltage and Norton current
- The Thevenin/Norton resistance becomes an impedance
- Thevenin voltage/resistance and Norton current can be found in the same way as in the DC case
- Source transformation also applies for AC circuits with impedances and phasors

Power in AC Circuits

- For AC circuits $P = vi$ also holds, but now v and i are time-variant, so additional complexity is involved
- Power is a function of time: $P(t) = v(t)i(t) = v(t)i(t)$
  - In the time domain, $v(t) = V_m \cos(\omega t + \theta_v), i(t) = I_m \cos(\omega t + \theta_i)$
  - Without loss of generality change the time reference so that $\theta_v = 0$
  - $P(t) = V_m I_m \cos(\omega t)\cos(\omega t - \theta)$ where $\theta = \theta_v - \theta_i$
  - Use $\cos(\alpha)\cos(\beta) = \frac{1}{2}(\cos(\alpha - \beta) + \cos(\alpha + \beta))$
  - $P(t) = \frac{V_m I_m}{2}(\cos(\theta) + \cos(2\omega t - \theta))$
  - This $P(t)$ is the *instantaneous power* (in volt-amps)
- Instantaneous power is split into two parts: $\frac{V_m I_m}{2}\cos\theta$, the constant part, and $\frac{V_m I_m}{2}\cos(2\omega t - \theta)$, the time-variant term
  - Plotting power against time shows a sinusoid offset above the time axis
  - Since $\cos\theta \leq 1$ we always have $P(t) \leq V_m I_m$
  - θ shifts the curve up or down as well as left and right