Duke University
Department of Physics

Physics 271 Spring Term 2017

# WUN2K FOR LECTURE 3

These are notes summarizing the main concepts you need to understand and be able to apply.

- **Equivalent Circuits:** Thevenin's theorem states the behavior of any 2-terminal network containing voltage sources, current sources and resistors can be reproduced by an ideal voltage source supplying voltage $V_{\text{Th}}$ in series with a *Thevenin equivalent resistance*, $R_{\text{Th}}$. The *Norton equivalent* circuit is an ideal current source supplying current $I_N$ in parallel with a Norton equivalent resistance $R_N$. It can be shown that $R_N = R_{\text{Th}}$ for the same network.
- How to find Thevenin and Norton equivalents for a given network:
  - The Thevenin equivalent voltage is $V_{Th} = V_{AB}(\text{open})$, the open-circuit voltage across the terminals A and B.
  - The Norton equivalent current is $I_N = I_{AB}(\text{short})$, the short-circuit current across terminals A and B.
  - $R_{\text{Th}} = V_{\text{Th}}/I_N$. However, the faster, almost-always-more-convenient method of finding $R_{\text{Th}}$ is to short all the EMFs in the network and open all the current sources, and just find the equivalent resistance.
- Measurement devices such as voltmeters and oscilloscopes can be treated as Thevenin equivalent devices with very large ($\sim 10^6\ \Omega$ or greater) $R_{\text{Th}}$.
- Error propagation reminder: if you derive quantity $w = f(x, y, z, ...)$ from measured quantities $x, y, z, ...$ known with uncertainties $\Delta x, \Delta y, \Delta z, ...$ respectively, *assuming uncorrelated uncertainties*, the uncertainty on $w$ is given by $\Delta w = ((\frac{\partial f}{\partial x})^2(\Delta x)^2 + (\frac{\partial f}{\partial y})^2(\Delta y)^2 + (\frac{\partial f}{\partial z})^2(\Delta z)^2 + ...)^{1/2}$.