PHYS225
Lecture 13
Electronic Circuits
Last lecture

– Precision versus accuracy
  • Want both!
  • But sometimes one is enough
  • Related to the difference between systematic and random noise

– Dynamic range
  • Range over which measurements can be made

– Distortion and other sorts of non-linearities
  • CMRR
  • RRIO
  • Stability and drift

– Error Budgets are good ways to organize

– Block diagrams of functional sub-systems help simplify plan
  • Each block can have an error budget
Design Example: photometer

• Scientific objectives
  – What do you want to measure?

• Technical requirements
  – How well does the instrument have to perform

• System design
  – Block diagram

• Error budget and component choice

• Integration, Assembly, and Test
Science objectives

- Measure the intensity of a light source
- Estimate expected source intensity/spectrum
  - Distant galaxy? The Sun?
  - Wavelength?
- Frequency of measurement
  - Once?
  - Once a minute? Day? Week? Century?
- Precision/Accuracy goals
  - 1%? 10%?
- Estimate expected noise from nature
  - Source
  - Backgrounds
  - Etc.
- Think about other goals of the experiment/measurement
Technical requirements

• Estimate quantitatively what the instrument has to do and how well it has to do it!
  – Noise should be less than nature!
  – Measurement timescale should correspond to science objectives
  – Etc.

• Note: in the real world you may have to stop here and iterate
System Design

• Create system design that meets technical requirements

• Make block diagram of system
  – Include a block for all functions
  – Include power, output/recording device, etc.

• Create Error budget and look for flaws in design
  – Think about all systematic errors that could occur
System Design

• Re-create the system now that you have thought about all the things that can go wrong
• Make a schematic with parts identified
  – Include all pinouts
    • Even NC!
  – Power connections
  – Etc.
• Estimate the time, cost, personnel, etc. of the project
  – Use a Gantt chart!
    • Include milestones
• Submit proposal to funding agencies
  – Wait a long time and hope for the best
Integration, Assembly, and Test

• Get funding and people!
• Build something
• Build by blocks and test a lot
  – Useful to predict block performance
    • Test against expectations
• Final Assembly and full system test
  – Simulate conditions
Science

• Execute science experiment
• Become famous and wealthy
  – All because of good system design and complete testing plan
  – Organization is critical
    • Although it won’t fix a bad design!