Welcome to NE 204!

Advanced Concepts in Radiation Detection | Fall 2018

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- Class Website: https://ne204-fall2018.github.io/
- Class Announcements: bcourses

Course Overview and Objectives

In this course, students will...

- Be exposed to advanced concepts in radiation detection relevant for instrumentation research and a wide variety of applications
    - Varying degrees of detail for many topics - driven by lab work and individual interest
- Gain practical experience with advanced detector systems
    - Set of predefined experiments that will be conducted by all students using modern digital signal processing tools
- Learn how to be a scientific/engineering researcher
    - How to write up, present, and peer-review technical work, emphasizing reproducibility and collaboration

Focus Areas

- Digital signal processing in conventional (coax) HPGe
  - Basic DSP, spectroscopic and timing filters, comparison to analog processing
- Pulse-shape analysis in semiconductor and scintillator detectors
- Segmented electrode semiconductor detectors
  - Position sensitivity, signal generation, charge collection
- Charge transport in semiconductor detectors
  - Experimentally determine charge carrier properties in various semiconductor detectors
- Gamma-ray imaging
  - Collimated modalities (pinhole, multiple aperture, coded aperture)
  - Compton imaging
  - Mobile detector systems
- Neutron detection and imaging
  - Neutron/gamma discrimination, kinematic & time-encoded imaging

Experiments

- Digital signal processing in HPGe - spectroscopy
- Digital signal processing in HPGe - timing and pulse shape
- Digital signal processing with liquid scintillators
  - Pulse shape discrimination (PSD) for n/gamma determination
- Segmented HPGe detectors
  - Position determination
  - Charge transport characteristics
- Segmented CZT detectors
  - Position determination
  - Charge transport characteristics
- Gamma-ray imaging
  - Collimated (pinhole, parallel-hole, coded aperture), non-collimated (Compton)
- Neutron imaging
  - Kinematic imaging with neutron scatter camera

Lab Procedure & Reports

- Lab teams for *at least* the first two experiments
  - Data collection & in-lab work will be done in teams
  - Students will have general access to lab, after-hours work is allowed
- Experimental objectives
  - All experiments have **required** and **optional** objectives
  - How the objectives are addressed is left to the student
- Number of labs
  - At least 2 - largely dictated by class enrollment and equipment availability
- Lab reports
  - All lab reports are required to be written in LaTeX
  - LaTeX source files, code, and code tests will be submitted via github
    - Lab report will be compiled from submitted source
  - All data analysis must be done with open-source tools (Python, C/C++ via GCC)

Final Project

- Similar in scope and style to the predefined experiments, with objectives entirely defined by the student teams
- Should be done in teams
  - Doesn’t necessarily have to be the same as your assigned lab teams
  - Team selection should be driven entirely by overlapping interests
- Topics can be drawn from the labs we don’t get to, expanding on one of the existing labs, or something entirely different
- Each project will have 3 components
  - **Proposal**: <2 pages, due sometime in the middle of the semester.
    - Provide executive summary, motivation, and specific objectives of project
  - **Final report**: In essence, the same as a lab report
    - Generated collaboratively (1 report per team)
    - Due at end of semester
  - **Final presentation**: Conference-style talk to be delivered by the team near the end of the semester

Reading Assignments

- Over the course of the semester, readings will be assigned from the published literature
- Readings drawn from journal articles, white papers, thesis chapters, etc.
- One reading every 1 to 2 weeks depending on length/detail of the reading
- Evaluation of the reading "assignment" requires you to discuss the article amongst your peers
  - Structure and organization of discussion is up to you (class-wide journal club, set aside 30 min during lab group meetings, etc.)
  - If you miss a discussion you can submit a 1-2 paragraph write up instead
- Discussion should be centered around how the paper topic is relevant to the course, lab, and your own individual research

Requirements & Grading

- Attendance of lectures and lab sessions is required
- The course grade will be determined according to the following breakdown:
  - Lab reports: 45%
  - Final project: 45%
    - Final report: 30% of total
    - Final presentation: 15% of total
  - Participation and readings: 10%
- Reports will be judged primarily on their technical merits
  - Accuracy of and evidence for claims
  - Uncertainty analysis
  - Clarity and correctness of figures, images, numerical results, etc.
- Individual contribution to final project determined via version control and peer review

Course Philosophy

- Student-driven
  - A handful of topics (DSP, charge transport, signal generation) will be covered in depth in both lab and lecture
  - Final project: student-defined, iterative feedback on proposal
  - Lab reports are just guidelines - scope and procedure defined by individual students
- Effective autodidactism
  - Literature review is the bedrock of graduate study
  - Learn to read and review published work, provide context for new work
- “First author” paradigm
  - How to effectively collaborate while maintaining ownership of your work
- Strongly encouraged to define projects & pursue avenues relevant to your personal research interests

Questions?

For further detail and up-to-date information, please refer to the course website

Housekeeping (your first assignment…)

- Please complete the online training EH&S 401.3 **before the first lab session on 8/29!**
- This is only necessary if you are not already on RUA #8905