A New Sequence of Advanced Laboratory Courses at the University of Wisconsin Oshkosh

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Two credit sophomore, junior, and senior advanced laboratory courses have recently replaced a one credit Modern Physics lab and a three credit Experimental Physics course. Physics Lab I, II, and III are offered in the spring and are coordinated with the two theory courses physics majors have most recently completed or are currently enrolled in. Physics Lab I for sophomores, for example, contains experiments in Modern Physics (a class they complete in the Fall semester) and Classical Mechanics (a class in which they are concurrently enrolled in the Spring semester). Junior-Senior level theory courses are offered on an alternate year basis; therefore, Physics Labs II and III typically contain experiments from two of the following four courses – Optics, Thermodynamics & Statistical Mechanics, Electricity & Magnetism, and Quantum Mechanics.
A: What Once Was

First Year: General Physics Sequence – Fall & Spring
one credit lab each semester
closely linked (temporally & content) to in-class material
goals: reinforce basic concepts with reliable experiments

Second Year: Modern Physics – Fall
one credit lab
not closely linked to in-class material
many computer simulations
goals: reinforce theory via simulation (???)

Third Year or Fourth Year: Experimental Physics
three credit, stand-alone course
one hour lecture, three hours lab
collection of experiments from across curriculum
some simple, some more sophisticated
flexible lab-group scheduling
formal lab write-ups, posters, oral presentations
goals: acquisition & analysis techniques
presentation skills
B: What Has Taken Its Place

First Year: General Physics Sequence – Fall & Spring
one credit lab each semester
closely linked (temporally & content) to in-class material
goals: reinforce basic concepts with reliable experiments

Second Year: Physics Lab I – Spring
two credit, stand-alone lab
closely linked to most recent core theory courses
Modern Physics & Classical Mechanics

Third Year or Fourth Year: Physics Lab II – Spring
two credit, stand-alone lab
closely linked to most recent core theory courses
Optics & Electrodynamics

Fourth Year or Third Year: Physics Lab III – Spring
two credit, stand-alone lab
closely linked to most recent core theory courses
Thermodynamics & Quantum Mechanics

Physics I, II, & III goals:
*do something, think* about results, *pursue* discrepancies
acquisition & analysis techniques, independent work
presentation skills (lite)
C: Physics Lab I Curriculum

Modern Physics related:
  Speed of Light in a Co-axial Cable & Error Propagation
  Planck’s Constant from LEDs
  The Photoelectric Effect
  e/m for an Electron
  Nuclear Gamma Spectroscopy
  Gamma Absorption by Lead
  Nuclear Half-Life
  Millikan Oil Drop

Classical Mechanics related:
  Coupled Harmonic Oscillators
  More Coupled Harmonic Oscillators
  Torsion Constant & Torsion Pendulum
  Nonlinear Oscillations
  Motion of a Ball on a Rotating Turntable

plus:
  formal lab write up (rough draft + revision)
  short oral presentation
D: Physics Lab II Curriculum (so far)

Optics related:
  - Laws of Geometrical Optics
  - Beam Expander
  - Lasers and Coherence
  - Polarization
  - Interferometry I
  - Interferometry II

Electrodynamics related:
  - Bragg Diffraction with Microwaves
  - Ampere’s Balance
  - Electric Potential Mapping

other:
  - Phase Diagrams (Mechanics)
  - Chaotic Pendulum

plus:
  - formal lab write up (rough draft + revision)
  - short oral presentation

possibilities for future development:
  - Wheatstone Bridge & Kelvin Bridge
  - Self & Mutual Inductance
  - Magneto Optic Kerr Effect
E: Physics Lab III Curriculum (so far)

Thermodynamics related:
  Calibration of a Thermistor
  NMR: Negative Temperatures

Quantum Mechanics related:
  Polycrystalline Electron Diffraction
  High Energy Electron Diffraction
  Electron Paramagnetic Resonance
  Numerical Solutions to Schrödinger’s Equation

plus:
  formal lab write up (rough draft + revision)
  short oral presentation

possibilities for future development:
  Mach-Zehnder Interferometer (that’d be nice...)
  Calorimetry: Specific Heats
  Calorimetry: Latent Heats
  Rückhardt’s Experiment
  Surface Tension & Surface Energy
What Has Been Discovered

Physics Lab I has been taught three times
Physics Lab II has been taught two times
Physics Lab III has not been taught

students like the focus on recent/current courses
dredging material from previous Fall difficult, though
many students have a hard time working independently
procrastination runs rampant
Culture of the Incomplete is tenacious
instructor trying to change nice-guy image
a desire to find out what went wrong is not a general trait
how do we combat acceptance of crummy results?
how do we teach recognition of good data?
how do we teach inclination to explore?
despite all that... some students do excellent experimental work