University of Alabama
Department of Physics and Astronomy
PH 491/591 Fall 2022

Instructions:

1. This can be turned in individually or as a team
2. If you work in a team, submit one response with all members' names
3. Nominal due date: 30 August 2022

Assignment: Mock Project Outline

Pick an experiment or project you have already done (e.g., PH255 or another lab course you have completed, current research project). The key point is that it should be something *finished* so you can see in retrospect what worked and what did not.

The objective is to re-design what you have already done with a view toward the four design criteria, going through each of them and their sub-categories at a high level. Think of this as a rich outline rather than a full-blown design proposal or final report. Charts and sketches are a plus but not required. An outline of the requirements is given below, followed by a grading rubric and an abbreviated example.

Your outline must address, in brief, these points:

1. Phase 1: Defining the Problem
   - State the problem
   - Identify functional requirements
   - Recognize constraints & limitations
   - Assemble team (roles not names) & create schedule (rough timing, sequential)
2. Phase 2: Formulating Solutions
   - Identify alternatives
   - Define parameters
   - Evaluate & analyze alternatives
   - Select a potential solution
3. Phase 3: Models & Experiments
   - Select overall model/algorithm/approach
   - Analyze the design
   - What are the preliminary tests?
   - Revise and refine: action if test succeeds or fails?
4. Phase 4: Implementation & Presentation (abbreviated)
   - What last details might be needed to finish?
   - What would come next?
   - How would you best present the results?

Table 1: *Mock Project Grading Rubric*

Item (points)	Unacceptable (0-5)	Developing (6-7)	Proficient (8-9)	Exemplary (10)
Problem definition points x 2	Not identified or not appropriate	Appropriately identified but not realistic	Appropriately identified, specific, and realistic	Meet proficient criteria, clearly stated, meaningful
Solutions formulated points x 3	Not identified or not appropriate	Appropriately identified but not realistic	Appropriately identified, specific, and realistic	Meet proficient criteria, clearly stated, meaningful
Models & Experiments points x 3	Not identified or missing key details	Too vague or lacking in but not realistic	Clear and further goals, all key steps present	Multiple strategies and outcomes planned for
Implementation/presentation points x 2	Not present or not appropriate	Present but minimal	Specific ideas and tailored to project	Selected proficiently to meet diverse criteria

Example Project Outline: PH255 Planck-LED experiment

1. Phase 1: Defining the Problem
   - State the problem: the threshold voltage for a light-emitting diode that emits only one color of light should depend on the energy per photon of light emitted. Knowing the frequency of light emitted should thus allow determination of Planck's constant. We must measure the threshold voltage and emission frequency/wavelength.
   - Identify functional requirements: measurement of current-voltage characteristic for diode, measurement of emission wavelength/frequency. Objective tree below.
   - Recognize constraints & limitations: LED size (able to connect and measure) and power (enough to see, not too high); matching power supply and meters, visible emission and capable spectrometer, equipment available in electronics shop; equipment control - software or manual
   - Assemble team (roles not names) & create schedule (rough timing, sequential): person fluent in analog electronics; person with spectroscopy experience; person with instrumentation/control experience. pick LEDS, identify hardware, then come up with control scheme. spectrometer and current-voltage parts can run in parallel, software must come later.
2. Phase 2: Formulating Solutions
   - Identify alternatives: sweeping current or voltage - former is simpler but latter is available and more appropriate for finding a threshold voltage. spectrometer: grating or Ocean Optics? Latter is more capable and already set up, compromise is accessibility
   - Define parameters: mostly as above. Need voltage range from 0 to about 5V with similar meter to measure. Need currents in the 1-10mA range based on LEDs available. Need spectrometer covering around 300-800nm wavelengths
   - Evaluate & analyze alternatives: voltage-swept measurement requires 2 meters (I, V) and one source (V) but directly determines threshold voltage. hardware already available in Gallalee Hall by appointment. Ocean Optics spectrometer is functional and appropriate.
   - Select a potential solution: Bamalab I(V) tracer plus Ocean Optics spectrometer.
3. Phase 3: Models & Experiments
   - Select overall model/algorithm/approach: measure I(V) for an LED, observe threshold voltage (extrapolate from I(V) curve) and qualitatively what color light is emitted. Supply voltage for constant operation and use fiber-coupled Ocean Optics spectrometer to determine dominant emission wavelength and FWHM.

- Analyze the design: need uncertainty estimates for threshold voltage and I/V measurements.
- What are the preliminary tests? Various precision resistors to verify I(V) hardware functionality, atomic discharge lamps to verify spectrometer. Begin with known LED with manufacturer-specified emission wavelength and electrical characteristics.
- Revise and refine: action if test succeeds or fails? If I(V) test fails: select new LEDs, verify I(V) hardware is not out of spec. If spectra cannot be measured and LED has no visible output, select new LED. If no spectra but LED light visible, spectrometer issue.

4. Phase 4: Implementation & Presentation (abbreviated)

   - What last details might be needed to finish? Uncertainty propagation and hardware limitations.
   - What would come next? More precise spectra measurements, couple spectrometer and I(V) hardware to determine threshold by when first photons are visible rather than by extrapolation of I(V) curve.
   - How would you best present the results? Talk with powerpoint would be best, easier to explain verbally/visually than write down.

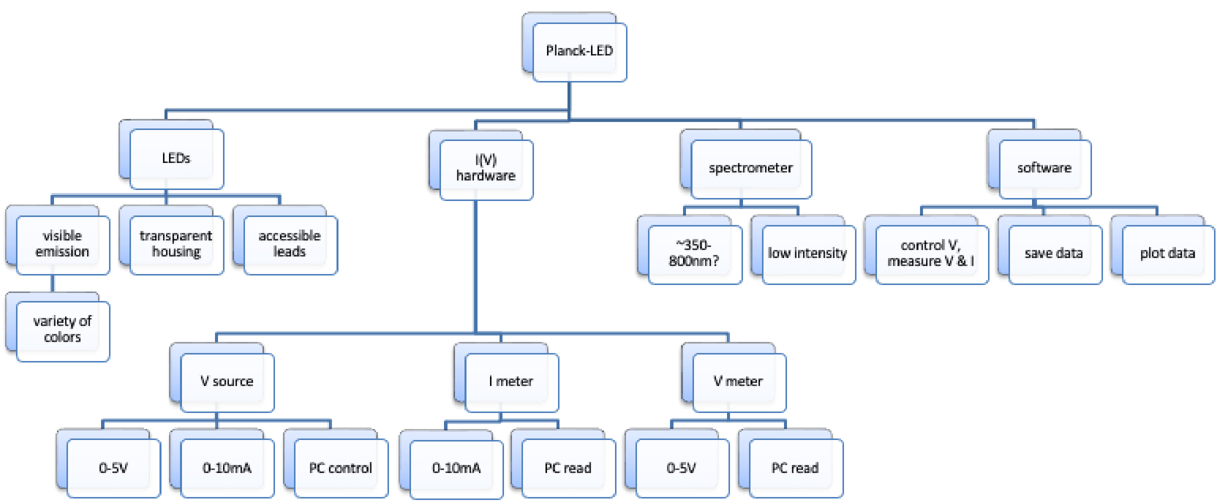

Figure 1: *Objective tree for Planck-LED experiment*