

PhysLab 300/500 Daily Log

Fall 2019

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3 –Sept-2019

Basic Introduction

- A detailed introduction to physlab website, especially the academic section where all the course material has been uploaded.
- Things we'll be exploring in the lab,
 - Analysis of data and further building of experiments
 - Relating the experiment to theory.
 - Learning how to use tools---from basic to advanced ones.
 - How to write an accurate scientific report (discussed the common mistakes students perform)?
- How to maintain a lab notebook?
- Basic rules for the lab
- Think a lot activity
- Smart Physics using phone

5-Sept-2019

Graphical Representation of Data

- Explored different ways to graph data points, linear, nonlinear, exponential, using the data from the photo-electric effect experiment.
- How to linearize graphs
- Inset graphs to focus on a specific region.
- Best fit line: how to define the merit of best fit (least square curve fit)
- Discussed different exponential graphs that would fit a charging or discharging capacitor.
- Discussed the formulae for the sum of square errors (SSE)

Uncertainty in the least-squares fit

- Mean of the x and y should lie on the best fit line.
- Formulae to calculate uncertainty in slope and intercept.
- Weighted fit to give more importance to points with smaller uncertainty.
- Reasonable number of significant figures in the table.
- Uncertainty up to 1 or 2 sig. figures.
- Discussed Hall effect.

12-Sept-2019

Uncertainty and probability measurement

- Difference between repeatable and reproducible.
- Two types of errors: random and systematic
- Two types of uncertainty: Type A and Type B.
- Probability distribution functions: probability of finding a function within a range.
- Different degrees of moment and what statistical quantity they correspond to.
- First moment: mean.
- Second moment: variance.
- Third moment: skewness.
- Fourth moment: Kurtosis.
- Different types of distributions:
 - Normal distribution
 - Cumulative distribution function
 - Poisson distribution
- Standard error and standard deviation
- Central limit theorem

Matlab Session – led by Shiraz AHmad

- Basics,
- Vectors and matrices, operations using indexing,
- Making customized functions,
- Plotting,
- For loop,
- Creating *.m scripts.

17-Sept-2019

Propagating Uncertainty

- Propagation from fundamental to derived quantities, using formulae.

Maximum likelihood

- How to draw the line of best fit?
- The two parameters determining line: m , c .
- Choosing such values for the parameters to minimize the distance between the experimental and theoretical values.
- For each point in data, there is a normal distribution associated with it. Maximize the probability of the point to be located near the mean of the distribution.
- Uncertainty in m and c .
- Error surface.

Writing workshop – led by Fatima Perwaiz

- LaTeX basics
- Report writing rules

19-Sept-2019

Different methods to minimize a function

- Newton-Raphson method: finding the roots
- Grid Search Technique: keeping one parameter constant and finding minimum along the axis of the other parameter.
- Gradient Descent Method: on making iso-bar contours, the maximum change will occur in the direction of the normal. For minimum, we'll move against the gradient.
- Hessian.
- Levenberg Marquadt Algorithm.

Circuits workshop – led by Rizwan Hafiz

- How to use basic to advance equipment in lab?
- Hand-on training with slide cutting, wire stripping, circuit design, etc.

24-Sept-2019

Simulated annealing

- Step-by-step method to go about it.
- Concept of Hessian using the covariance matrix.