ESSEX COUNTY COLLEGE

MATHEMATICS and PHYSICS DIVISION

COURSE OUTLINE

COURSE DESIGNATION: PHY 110 COURSE TITLE: Introduction to Data Reduction with Applications

NUMBER OF CREDITS: 3.0

CONTACT HOURS: 3.0 LECTURE: 3.0 LAB: 0.0 OTHER (Specify):N/A

PREREQUISITES: Grade of “C” or better in PHY 103 and MTH121

CONCURRENT COURSES: None

COREQUISITES: None

CATALOG DESCRIPTION:

This is a one semester course in which the theory and application of data reduction and error analysis are introduced. Topics include the binomial distribution, the Gaussian and Poisson probability density functions, estimation of moments, and propagation of uncertainty. Data modeling, including least-squares fitting of linear and polynomial functions, is presented. Using computer software, students are expected to apply the concepts of data reduction and error analysis to real data sets derived from the physical sciences.

COURSE OBJECTIVES:

Upon successful completion of this course, students should specifically be able to do the following:

1. explain and apply data reduction and error analysis concepts;

2. analyze one- and two-dimensional data sets to find determine computational estimates of probability distribution functions (PDFs) and moments as well as to address the appropriateness of various forward models;

3. devise an experiment capable of making a measurement to a pre-determined level of precision.

4 draw graphs that are journal-quality; and

5. conduct literature searches on databases.

**Measurable Course Performance Objectives (MPOs)**: Upon successful completion of this course, students should specifically be able to do the following:

1. Explain and apply data reduction and error analysis concepts.

1.1 define the concepts of measuring errors, parent sample distributions and mean and standard distributions and apply them to data analysis;

1.2 define and apply instrumental and statistical uncertainties, propagation of errors and specific error equations.

2. Analyze one- and two-dimensional data sets to find determine computational estimates of probability distribution functions (PDFs) and moments as well as to address the appropriateness of various forward models.

2.1 define binomial distributions, Poisson distributions and Gaussian distributions and apply them to data analysis;

2.2 Define and apply, including least-squares fitting of linear and polynomial functions data modeling.

3. Devise an experiment capable of making a measurement to a pre-determined level of precision.

3.1 discuss and analyze the pros and cons of various methods of measurement;

3.2 implement and analyze various measurement techniques so as to best experimentally determine PDFs, moments, and the appropriateness of various forward models.

3.3 communicate the results by writing reports using spreadsheets and other computer programs

4. Draw graphs that are journal-quality.

4.1 use data collected to construct graphs and charts.

COURSE CONTENT OUTLINE:based on the text *Data Reduction and Error Analysis for the Physical Sciences, 3rd ed.,* by Bevington, P.R. and D. K. Robinson, McGraw-Hill, Boston, 2003.

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| **Week** | **Chapter/Topics** |
| 1 – 2 | Databases and Literature Searches |
| 3 | Methods of Measurement  1. How to Make a Measurement,  2. Choosing a plot scale, data vs. histograms |
| 4 | **Chapter 1** **Uncertainties in Measurement**   1. Parent distributions 2. Sample mean and sample standard deviation 3. Percent error, SNR—reduction of noise through repeated measurements |
| 5 | **Chapter 2 Probability Distribution Functions**   1. Binomial 2. Gaussian 3. Poisson 4. Other [Lorentzian, Cauchy, etc.] 5. Moments, focusing on the first and second moments |
| 6 | **Chapter 3 Error Analysis**   1. Statistical uncertainty 2. Bias 3. Propagation of errors 4. Designing an experiment to make measurements to a particular precision |
| 7 | **Chapter 4 Estimators**   1. Chi-square, Student’s t-Test 2. Moments: mean, variance, skew, and kurtosis |
| 8 | **Chapters 6 and 7 The Forward Model Part I**  Linear and log-linear forward model and least-squares fitting to a linear data set |
| 9 | **Chapters 6 and 7 The Forward Model Part II**  Polynomial forward model and least-squares fitting to a polynomial data set |
| 10 | **Chapter 8 The Forward Model Part III:**  Generalized forward model and generalized least-squares fitting |
| 11 | **Data Fittings** |
| 12 | **Chapter 11 Testing the Fit Part I**  F-test, t-test |
| 13 | **Chapter 11 Testing the Fit Part II [and some Chapter 5]**  F-test, t-test, Monte-Carlo methods |
| 14 – 15 | **Final Project Presentation and Discussions** |

METHODS OF INSTRUCTION:

Instruction will consist of a combination of lectures, class discussions, project presentations and discussion, group work and individual study**.** Students will use C++ and Fortran data analysis programs provided by

COURSE REQUIREMENTS:

All students are required to:

##### 1. Complete assignments before each class.

2. Complete all projects on time.

3. Complete a Final Report and deliver a Final Project Presentation.

METHOD OF EVALUATION:

Final course grades will be computed as follows:

**%** of

Grading Components final course grade

* Weekly Presentations 50%
* Final Presentations 20%
* Final Report 30%