NATIONAL INSTITUTE OF PHYSICS
UNIVERSITY OF THE PHILIPPINES DILIMAN

Applied Physics 157: Computational Analysis and Modeling in Physics
2nd Semester AY 2022-2023

COURSE GUIDE

COURSE DESCRIPTION

Computational models in physics; numerical simulation of physical systems; stochastic simulation and algorithms; image processing; multidimensional detection techniques; pattern recognition.

INSTRUCTORS

Section: AP 157 WFY-FX1 , FX2
Lecture: Maricor Soriano (jing@nip.upd.edu.ph) 09209083305 Room R202
Lab: Rene Principe Jr, Kenneth Leo

COURSE OVERVIEW

Hands-on experience in using numerical/computational techniques for solving problems in applied physics is highlighted in this course. Topics covered include: Monte Carlo methods, complex network tools, image and video processing, and machine learning.

COURSE OUTLINE

There are 3 major topics in this course:

A. **Image and Video Processing**
    a. Digital image formation and enhancement
    b. Fourier Transform applications in image processing
    c. Feature extraction from images and video
B. **Machine Learning**
    a. Classification - Perceptron, Support Vector Machines, K-Nearest Neighbor Classifier; Decision Trees; Evaluating Classifiers (ROC Curves)
    b. Dimensionality Reduction - Principal Component Analysis
    c. Neural Networks and Convolutional Neural Networks
C. **Monte Carlo Methods and Complex Network Tools (Modules by Dr. May Lim)**
    a. Monte Carlo Methods: Population Dynamics, Diffusion-Limited Aggregation, Ising Model
    b. Individual-based Models: Cellular Automata, Agent-based Models
    c. Networks: Graph Models, Network Properties

COURSE REQUIREMENTS

- Reports - 80%
- Midterm and Final Exam - 20%

GUIDELINES

The scientific software we will use this semester is MATLAB. UP has a site-wide license for MATLAB. Please use your up.edu.ph account to access it. Although recommended, it is not required and you may use Python too. However, be warned that opencv does not work well with Google Collab so you may need to install Python offline. My examples will mostly be in Matlab and you kindly figure out what the equivalent in Python is. In addition, kindly install any of these free image processing software : GIMP (www.gimp.org) and ImageJ .

INDIVIDUAL REPORTS

1. For each activity you are to write a short report in a powerpoint or presentation style and upload it in UVLE.
2. The parts of the presentation are : Objectives, Results, Analysis, and Reflection- a short narrative why you think your results are valid or correct, how you felt about the activity (did you enjoy it, was it tedious), what went right or wrong with your experiment.
3. For each of your reports, grade yourself using the Rubric below as a guide. A perfect score is 100 but you can give yourself bonus points if you went above and beyond the minimum requirements. Write a short evaluation to justify your score.

RUBRIC FOR REPORT GRADE

CRITERIA	QUALIFICATIONS	SCORE
Technical correctness	● Met all objectives. ● Results are complete. ● Results are verifiably correct. ● Understood the lesson.	35
Quality of presentation.	● All text and images are of good quality. ● Code has sufficient comments and guides. ● All plots are properly labeled and are visually understandable. ● The report is clear.	35
Self Reflection	● Explained the validity of results. ● Discussed what went right or wrong in the activity. ● Justified the self score. ● Acknowledged sources (e.g. persons consulted, references, etc.)	30
Initiative	● Experimented beyond what was required ● Made significant improvements to existing code	10

Your self grade is final if your lab instructors agree with it. Otherwise, we'll change it to what we think is a more appropriate score.