Approval: 22nd Senate Meeting

IIT Mandi
Proposal for a New Course

Course Number: CS571

Course Name: Programming Practicum

Credits: 1-0-3-3

Prerequisites: Programming experience in any language (C/C++/Matlab/Python etc.)

Students intended for: MTech./M.S./Ph.D.

Elective or Core: Core for M.Tech. CSP, Elective for M.S./Ph.D.

Semester: Odd

Preamble:
Programming skills are essential for any engineer. This course builds upon previous programming courses done by students during their previous degrees. A modern programming language with a large set of libraries suitable for data analysis or machine learning (such as Python) will be used. Emphasis will be given on programming for problems relevant to data analysis and information processing from domains such as signal processing, machine learning and communications.

Suggested implementation: The course will have weekly lab evaluations (related to the topic covered in the lecture), followed by a 3-4 week mini project. It is desirable for the the mini project to have a pre-final evaluation and a final evaluation.

Learning outcome: After taking this course, students will become familiar in writing good code, using relevant libraries, using the right data structure, handling large data sets, plotting and visualizing information. They would have also become familiar with programming solutions to several problems in data analysis. They would also know how to do basic performance evaluation of programs.

Course Outline:
1 lecture per week, followed by 3 hours of lab.

Course Modules:

1. **Review of general programming constructs (4 hours)**
   Loops, conditionals, recursion, file i/o, data structures: strings, tuples, lists, dictionaries

2. **Introduction to scientific computing (1 hour)**
   Numerical precision in programs, IEEE 754 floating point representation, introduction to NumPy and Scipy

3. **Data manipulation (1 hour)**
   Pandas, handling large data files

4. **Data visualization (1 hour)**
   Various types of plots: histograms, scatter plots, box plots etc.
   Datasets can be provided and plots can be created from them

5. **Object oriented programming (1 hour)**
   Classes and objects, inheritance

6. **Implementing well known programs (4 hours)**
   Matrix factorizations, solving large order linear systems of equations, least squares approximations, simulating binary channels, signal denoising, K-means clustering, classification using Baye's rule etc.

7. **Introduction to parallelization (1 hour)**
   Cuda programming (conceptual level only)

8. **Program analysis (1 hour)**
   Performance tuning, profiling of programs, identifying performance bottlenecks

Text Books:

1. Python Data Science Handbook, Jake Vanderplas, O'Reilly, 2017

Reference Books:

1. Python Programming for the Absolute Beginner, Michael Dawson, Third Edition
2. How to Think Like a Computer Scientist: Learning with Python, Allen Downey, Jeffrey Elkner, Chris Meyers, Green Tea Press, 2016
3. Introduction to machine learning with Python, Muller and Guido, O'Reilly, 2017