Course Title: Mathematical Computing with Python

Course Code: MATH-311

Course Type: Major Math

Prerequisites: Applications of ICT

Credit Hours: 3 (3 + 0)

Course Objectives:
After completion of this course, students should be able to :

- Master fundamental Python programming concepts and efficiently use development environments for mathematical programming.
- Utilize libraries such as Matplotlib, NumPy, SciPy, SymPy and Pandas to perform and visualize advanced mathematical computations.
- Apply mathematical programming techniques to analyze and solve real-world problems.

Course Contents:

Introduction to Data Science : What is Data Science? Factors making data science ubiquitous. Applications of data science in the domains of social media, banking, e-commerce, web-based search engines, travelling, health care, automation, credit and insurance.

Six Phases of Data Science Life Cycle: Business Problem, Data Acquisition, Data Processing, Exploratory Data Analysis (EDA) and Visualization, Machine Learning (ML) Model Creation-Training-Evaluation, Deployment and Monitoring. Industry job roles and salary trends in data science domain.

Basics of Python Programming: History of Python, Overview of mathematical programming, Installing and using a Python development environment (Jupyter note book/CoLab). Python syntax and semantics, Data types and variables Control structures (loops, conditionals), functions, Modules and packages.

Container Types: Lists, Arrays, Tuples, Dictionaries, Sets, Container conversions.

Python Libraries for Data Science:
The `matplotlib` **Library:** Basic plotting with Matplotlib, Customizing plots (titles, labels, legends), Subplots and multiple plots 3D plotting and other advanced visualizations.
The `numpy` **Library:** NumPy arrays and operations, Mathematical functions in NumPy, Array manipulations and broadcasting, Linear algebra operations with NumPy, Universal functions.
The `scipy` **Library:** Key submodules in SciPy (optimize, integrate, interpolate, etc.), Numerical integration, Interpolation techniques, optimization problems, Differential equations.
The `sympy` **Library:** Basic elements of SymPy, Symbolic Linear Algebra, Calculus with `sympy`, Graphics in `sympy`, Three dimensional Graphs.
The Pandas Library: Series and DataFrames, Data manipulation and cleaning with Pandas, Merging, joining, and concatenating DataFrames, Grouping and aggregating data.

Mathematics for Data Science: Probability & Statistics, Differential Calculus, Linear Algebra.

Recommended Books:

1. Cielen, D., Meysman, A., and Ali, M., *Introducing Data Science*, Manning, 1st Edition, 2016.
2. Dietel, P. and Dietel, H., *Python for Programmers*, Pearson, 2019.
3. Führer, C., J. E. Solem, and Verdier, O., *Scientific Computing with Python 3*, Packt Publishing, 2nd edition, 2021.
4. Johansson, R., Urayasu-shi, Chiba, *Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib*, Pearson, 4th edition, 2017.
5. Hazrat, R., *A Course in Python*, Springer, 2023.
6. Seroul, R., *Programming for Mathematicians*, Springer, 2000.