



**CALICUT UNIVERSITY – FOUR-YEAR UNDER
GRADUATE PROGRAMME (CU-FYUGP)**

BSc PHYSICS HONOURS

SEC2 consists of 3 hrs. of lecture and hands-on work per week.

Evaluation: Considering the nature of the SEC2 course, the internal evaluation for the 25 marks, including the 5 marks in the open ended module, may be entirely based on the performance of the student during the hands-on work and viva.

Programme	B.Sc. Physics Honours				
Course Title	PYTHON FOR DATA ANALYSIS				
Type of Course	Skill Enhancement Course 2				
Semester	V				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	1. Fundamentals of Programming Concepts				
Course Summary	This course explores the fundamental concepts of algorithms, control statements, functions, Numpy arrays, Matplotlib, and Seaborn for data visualization and practical application.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate Python for data analysis, including numerical operations, file handling, control flow, functions, and NumPy arrays.	U	C	Instructor-created exams / Quiz
CO2	Understand and master Pandas functionalities for data manipulation, sorting, handling missing data, statistical analysis and data merging/concatenation techniques in Python.	Ap	P	Instructor-created exams / Home Assignments
CO3	Master the visualisation tools in Pandas and Seaborn libraries using physics data. Draw various plots, interpret findings, and utilise the Seaborn library for advanced visualisation techniques.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Understand the various data file formats and learn to read and handle data files in Jupyter Notebooks, including CSV, XLS, TAB, and DAT formats.	U	C	Instructor-created exams / Home Assignments
CO5	Demonstrate problem-solving skills to solve practical physics problems by creating programs for real data analysis and utilise the different functionalities available in Pandas and Seaborn Python Packages.	Ap	P	One Minute Reflection Writing assignments/Viva Voce
CO 6	Develop skills in data manipulation and analysis using the pandas library, including dataframe creation, data wrangling, descriptive statistics, and visualization techniques using matplotlib and seaborn	Ap	P	Practical Assignment / Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
 # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)
 Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36 +9)	Marks (50)
I	Python Core programming		9	12
	1	Python - variable, operators, data types - numerical - int, float, complex - list - list operations	2	
	2	Tuples - Set - Dictionary, input(), file operations - open() - close()	2	
	3	Conditional & control statements - break & continue	2	
	4	Functions:define functions - Passing Arguments - Return Values Demonstration/ Hands-on training: Write a function that accepts a list of numbers and returns the largest and smallest numbers in the list.	1	
	5	Numpy - Arrays - creation, access, array operations Demonstration/ Hands-on training: Create a 3x3 NumPy array with random integers between 1 and 10. Perform and print the results of basic arithmetic operations (addition, subtraction, multiplication, division) on this array with another 3x3 array.	2	
	Sections from References: 1. Sections of Chapter 3 pages 46 - 62, Chapter 4 pages 73 - 87, Chapter 6 pages 117 - 139, Chapter 7 pages 151 - 174, Chapter 17 pages 441 - 451 of Book 1 2. Sections of Chapter 8 pages 129 - 140 of Book 2 [Topic 4 from this book]			
II	Pandas Dataframe		12	15

	6	Python Dataframe - Create Dataframe	1	
	7	Dataframe attributes - Pivoting dataframe - Sort - Sort by labels	2	
	8	Missing Data - fill, drop and replace missing values - Combining Data Frame - Descriptive statistics - describe() - min and max index values	3	
	9	Statistical values - count and mode function - Covariance - Correlation - Quantiles	2	
	10	Aggregation() - Grouping columns - Data wrangling - merging data - joining, concatenating dataframes. Demonstration/ Hands-on training: Example problem showing the operations of pandas dataframe- Illustrate the operations of table read, merge and groupby() in pandas using the data generated by charging three different capacitors using ExpEYES or the raw data of phone sensors using Phyphox/Physics Toolbox Sensor Suite app.	4	
	Sections of Chapter 5.1 - 5.10, 5.14 of Book 4 https://phyphox.org/sensors/ https://www.vieyrasoftware.net/			
III	Visualisation Tools		10	15
	11	Importance of data Visualisation - Bar chart Demonstration/ Hands-on training: practice the generation of a bar chart using the data generated for three capacitors using ExpEYES or the raw data of phone sensors using Phyphox/Physics Toolbox Sensor Suite app.	2	
	12	Histogram - frequency polygon - Box plot - Scatter Plot - markers - xlabel - ylabel - title - different arguments in scatterplot Demonstration/ Hands-on training: Illustrate the operations of box plot using the data generated by finding the refractive index of a convex lens by liquid lens arrangement.	2	

	13	Correlation Matrix Plot - Calculate the correlations - correlation matrix - correlation plot Demonstration/ Hands-on training: Plot the values obtained from sonometer mass versus length*2. Find the correlation matrix for the graph	1	
	14	Seaborn library - features - color palette -univariate distribution plot	1	
	15	Seaborn - Histogram - density plot - Bivariate Distribution plots - hexbin plot - violin plots Demonstration/ Hands-on training: Example plot using the standard data set, Iris (https://archive.ics.uci.edu/dataset/53/iris)	2	
	16	Statistical estimation - bar plot - Plotting categorical data, Heatmap - cmap attribute.	1	
	Sections 6.1 – 6.8, 6.8.1, 6.8.3, 6.9, 6.10, 6.11.2, 6.12, 6.14, 6.15.1, 6.16, 6.20, 6.21 of Book 4			
IV	Data File Formats		5	8
	17	Series and Dataframes - Introducing different data file formats: csv, xls, tab, dat formats. Create Dataframe from the above mentioned format.	2	
	18	Viewing Data frame using loc and iloc - Operations on Dataframes	2	
	19	Jupyter Notebooks using Anaconda and Google Colab: introduction - Familiarization with Google Colab and Anaconda	1	
	Sections from References: Chapter 12 - Page 232 - 248 of Book 3 https://colab.google/ https://www.anaconda.com/			
V	OPEN ENDED MODULE: Additional Training on Data Analysis		9	
	Implement the following: 1. Data File Creation and File Operations: <i>Example1:</i> Write a python program to generate a CSV file using the data generated from Simple Pendulum Experiment as two separate columns as Length and Period using Pandas Dataframe.			

	<p>2. File Read & Plot Data: <i>Example2:</i> Write a Python program to read the data generated using example 1 and calculate the mean period for each pendulum length. Use Seaborn to plot a regression line and analyze the relationship between period and length.</p> <p>3. Pandas merge, group by: <i>Example3:</i> Use the data generated by verifying Hooke's Law by measuring the relationship between the force applied to a spring and its resulting extension. Also, use different materials to see how Spring Constant changes with material properties.</p> <p>4. Learn different visualisation tools in Pandas: Plot Histogram, Barchart, Scatter plot and their functionalities</p> <p>5. Learn different visualisation tools in Seaborn: <i>Example4:</i> Using the data generated by example3, draw the linear relationship between the force applied and extension using regplot functions.</p>		
	<p>Sections from References:</p> <ol style="list-style-type: none"> 1. Example plots can be seen in https://www.geeksforgeeks.org/pandas-built-in-data-visualization-ml/ 2. https://www.datacamp.com/tutorial/types-of-data-plots-and-how-to-create-them-in-python 3. https://www.datacamp.com/tutorial/seaborn-python-tutorial 4. https://www.geeksforgeeks.org/data-visualisation-in-python-using-matplotlib-and-seaborn/ 		
<p>Books and References:</p> <ol style="list-style-type: none"> 1. <i>Core Python Programming</i> 2nd edition or higher, Dr. R. Nageswara Rao, Dreamtech press, 2020 (Book 1) 2. Python Crash Course - 3rd Edition by Eric Matthes (Book 2) 3. Machine Learning in Data Science using Python by Dr R Nageswara Rao (Book 3) 4. Data Science and Machine Learning using Python by Dr Reema Thareja (Book 4) 			

Mapping of COs with PSOs and POs :

	PS O1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
--	----------	----------	----------	------	----------	----------	-----	-----	-----	-----	-----	-----

CO 1	2	1	1	0	2	1	1	1	1	1	1	0
CO 2	2	1	1	0	2	1	1	1	1	1	1	0
CO 3	2	1	1	0	2	1	1	1	1	1	1	0
CO 4	1	1	1	0	2	1	1	1	1	1	1	0
CO 5	2	2	3	1	2	1	1	1	1	1	1	0
CO 6	2	2	1	1	2	1	1	1	1	1	1	0

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments/Viva
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Theory /Practical Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓		✓	