Course Specification

(Postgraduate Programs)

Course Title: Computational Physics
Course Code: PHYS 611
Program: Master of Science in Physics
Department: Physics
College: College of Sciences
Institution: Majmaah University
Version: 1
Last Revision Date: 30/12/2024

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐ College	☒ Department	Track	Others
B.	☒Required		Elective		
3. Level/year at which this course is offered: (1st/1)					
4. Course General Description:					
This course introduces students to scientific programming in MATLAB or Python, with a focus on computational techniques for solving mathematical, scientific, and engineering problems. Students will learn fundamental programming concepts, numerical methods, data analysis, and visualization techniques essential for research and professional practice. The course emphasizes practical implementation through hands-on exercises, projects, and real-world applications. In addition to technical skills, students will develop autonomy, collaborative abilities, and ethical responsibility in the practical and sustainable application of computational tools.					
5. Pre-requirements for this course (if any):					
n/a					
6. Co-requisites for this course (if any):					
n/a					
7. Course Main Objective(s):					

- **Provide foundational knowledge of scientific programming concepts** to enable students to understand and apply computational techniques in problem-solving.
- **Develop practical skills in writing, testing, and debugging programs** for mathematical, scientific, and Physical applications.
- **Enhance students' ability to analyze, visualize, and interpret data** using computational tools for research and professional practice.
- **Foster ethical responsibility, autonomy, and collaborative skills** in applying programming solutions to real-world challenges in Physics.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		

3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
Total		**45**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Explain core programming concepts** such as variables, data types, control structures, and functions in a scientific computing environment.	**k2**	Lectures-Class discussions	Exams-Writing reports
2.1	**Describe principles of numerical computation and data visualization**, including arrays, matrices, and plotting techniques for problem-solving.	**k2**	Lectures-Class discussions	Exams-Writing reports
2.3	**Discuss algorithmic approaches to solving mathematical and scientific problems, including** iterative methods and optimization.	**k3**	Lectures-Class discussions	Exams-Writing reports

2.4	**Interpret documentation and libraries** relevant to scientific programming environments for effective problem-solving.	**k3**	Lectures-Class discussions	Exams-Writing reports
2.0	**Skills**			
2.1	**Apply programming techniques to implement algorithms for mathematical and scientific problems**, such as linear algebra, differential equations, and data analysis.	**S1**	Solving Problems-Class discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.2	**Develop, test, and debug programs to model and simulate real-world systems**, demonstrating proficiency in code optimization and visualization.	**S1**	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.3	**Utilize built-in libraries and toolboxes** for advanced computations and visualization tasks.	**S2**	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
2.4	**Optimize code for efficiency and accuracy**, demonstrating proficiency in handling large datasets and computational challenges.	**S4**	Solving Problems-Class Discussions-Presentations	EXAMS Assignment Quizzes-Observation
3.0	**Values, autonomy, and responsibility**			
3.1	**Demonstrate ethical responsibility** in writing and sharing code, ensuring proper citation of sources and adherence to academic integrity.	V2	Presentations -Small group supervisions	Small projects Presentations Survey
3.2	**Work independently and collaboratively** to complete programming tasks, showing accountability for assigned roles and deadlines.	V2	Presentations -Small group supervisions	Small projects Presentations Survey
3.3	**Demonstrate professional conduct by adhering to** best practices in coding standards,	V3	Presentations -Small group supervisions	Small projects Presentations Survey

	documentation, and version control.			
3.4	**Reflect on the societal and environmental impacts of computational solutions and on how to promote the** sustainable and responsible use of technology.	V3	Presentations -Small group supervisions	Small projects Presentations Survey

C. Course Content

No	List of Topics	Contact Hours
1	Introduction to Programming Environment	3
2	Basic Syntax and Data Types	3
3	Vectors and Matrix Operations	6
4	Solving Linear Systems	6
5	Control Structures (Loops, Conditionals)	6
6	Functions and Modular Programming	3
7	File I/O and Data Handling	3
8	Plotting and Visualization	3
9	Numerical Methods – Part 2 (Integration, Differentiation)	6
10	Advanced Topics / Libraries	6
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	4,10	10%
2.	Assignment	Entire semester	10%
3.	Midterm 1 Examination	6,7	15%
4.	Midterm 2 Examination	12,13	15%
5.	Project	14	10%
6.	Final Exam	15,16	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- An Introduction to Scientific Computing with MATLAB® and Python Tutorials, Sheng Xu, Chapman and Hall/CRC, 2022

Supportive References	- Scientific Computing with Python – Second Edition, Packt Publishing, 2023 - MATLAB for Engineers (Global Edition, 6th Edition), Holly Moore, 2025
Electronic Materials	- MATLAB Academy – Free Online Courses with Certificates - MIT OpenCourseWare – Introduction to Computer Science and Programming in Python
Other Learning Materials	- Matlab software/Python Software

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classroom (must be the same for the same subject) • Seminar room • Computer lab for (e-Quiz)
Technology equipment (projector, smart board, software)	Blackboard software/login • MS software suite • Origin Graphic software • Smart board that maintains feedback • Whiteboard
Other equipment (depending on the nature of the specialty)	Library, Seminar Room, and Wi-Fi /internet connections

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students/ internal committee	Indirect

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Physics Department
REFERENCE NO.	16
DATE	30/12/2024