Course Syllabus

1	**Course title**	**Computational Physics**
2	**Course number**	**0352752**
3	**Credit hours**	**3**
	Contact hours (theory, practical)	**3 (theory)**
4	**Prerequisites/corequisites**	**None**
5	**Program title**	**MSc. in Physics**
6	**Program code**	
7	**Awarding institution**	**The University of Jordan**
8	**School**	**School of Science**
9	**Department**	**Department of Physics**
10	**Course level**	**Master**
11	**Year of study and semester(s)**	**1st Semester 2023/2024**
12	**Other department(s) involved in teaching the course**	**None**
13	**Main teaching language**	**English**
14	**Delivery method**	**☒ Face to face learning ☐ Blended ☐ Fully online**
15	**Online platforms(s)**	**☒ Moodle ☐ Microsoft Teams ☐ Skype ☐ Zoom ☐ Others……**
16	**Issuing/Revision Date**	**October 2023/January 2024**

17 Course Coordinator:

Name: Dr. Hanan Sa'adeh
Contact hours: Announced on the website: eacademic.ju.edu.jo/hanan.saadeh/default.aspx
Office number: Physics Building, 2nd Floor, Room 220 Phone number: 065355000 Ext. 22029
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18 Other instructors:

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19 Course Description:

This course gives a modern introduction to the basic methods in computational physics. Computational physics is a rapidly growing subfield of physics and computational science in large part because computers can solve previously intractable problems or simulate natural processes that do not have analytic solutions. The broad categories of computational physics are Simulation, Visualization and Modeling. This course is basically intended to provide students with the ability of solving difficult problems by using computational methods and to learn and use programming languages.

20 Course aims and outcomes:

A- Aims:

- To gain an appreciation of how important a role computer plays in doing physics.
- To acquaint students with the basics of computational physics and the use of basic numerical techniques.
- To utilize computer software to assist in solving physical problems, with emphasis on the Mathematica system.

B- Intended Learning Outcomes (ILOs):

For purposes of mapping the course SLOs to the physics program SLOs, at the successful completion of the physics program, graduates are expected to be able to:

SLO (1) Master professionally a broad set of knowledge concerning the fundamentals in the basic areas of physics: Quantum Mechanics, Classical Mechanics, Electrostatics and Magnetism, Thermal Physics, Optics, Theory of Special Relativity, Mathematical Physics, Electronics.
SLO (2) Apply knowledge of mathematics and fundamental concepts in the basic areas of physics to identify and solve physics related problems.
SLO (3) Utilize computers and available software in both data collections and data analysis.
SLO (4) Utilize standard laboratory equipment, modern instrumentation, and classical techniques to design and conduct experiments as well as to analyze and interpret data.
SLO (5) Develop a recognition of the need and ability to engage in life-long learning.
SLO (6) Demonstrate ability to use techniques, skills, and modern scientific tools necessary for professional practice.
SLO (7) Communicate clearly and effectively in both written and oral forms.
SLO (8) Apply proficiently team-work skills and employ team-based learning strategies.
SLO (9) Apply professional and ethical responsibility to society.

Upon successful completion of this course, students will be able to:

Program SLOs / Course SLOs	SLO (1)	SLO (2)	SLO (3)	SLO (4)	SLO (5)	SLO (6)	SLO (7)	SLO (8)	SLO (9)
1. Use computer for modeling, simulation, and visualization of physical problems.	✓	✓							
2. Deal with numerical and mathematical tools to enhance problem solving.	✓	✓							
3. Translate a physical problem into a form solvable by a computer.	✓	✓							
4. Have the practical and theoretical knowledge necessary to use specific computer systems to implement the steps of the solution; and in particular to use the programming language and facilities provided by the Mathematica system to do so.	✓	✓							
5. Be acquainted with the general scene of scientific software available and the modern trends in scientific software industry.	✓	✓							

21. Topic Outline and Schedule:

Week	Lecture	Topic	Teaching Methods*/platform	Evaluation Methods**	References
1	1	Overview of the Course	Synchronous lecturing & Elearning	Questionnaire	All references
	2	Installation of Mathematica 13	Synchronous Lecturing & Elearning		
2	3	Introduction to Computational Physics	Synchronous lecturing	Discussion	A-2 B-2
	4	Computers and Physics	Synchronous lecturing		
3	5	Computer-Aided Problem Solving	Synchronous Lecturing	Discussion	A-2 B-2
	6	Computer-Related Errors	Synchronous lecturing		
4	7	Overview of Mathematica 13	Synchronous lecturing & Wolfram Cloud	Assignment # 1	A-1 B-1
	8	First Encounter with Mathematica	Synchronous lecturing & Wolfram Cloud		
5	9	First Encounter with Mathematica	Synchronous lecturing & Wolfram Cloud	Assignment # 2	A-1 B-1
	10	First Encounter with Mathematica	Synchronous lecturing & Wolfram Cloud		
6	11	Interactive Use of Mathematica	Synchronous lecturing & Wolfram Cloud	Assignment # 3	A-1 B-1
	12	Interactive Use of Mathematica	Synchronous lecturing & Wolfram Cloud		
7	13	Interactive Use of Mathematica	Synchronous lecturing & Wolfram Cloud	Assignment # 4	A-1 B-1
	14	Interactive Use of Mathematica	Synchronous lecturing & Wolfram Cloud		
8	15	Programming in Mathematica	Synchronous lecturing & Wolfram Cloud	Discussion	A-1 B-1

	16	Programming in Mathematica	Synchronous lecturing & Wolfram Cloud		
9	17	Programming in Mathematica	Synchronous lecturing & Wolfram Cloud	Discussion	A-1 B-1
	18	Programming in Mathematica	Synchronous lecturing & Wolfram Cloud		
10	19	Physics with Mathematica	Synchronous lecturing & Wolfram Cloud	Assignment # 5	A-1 B-1
	20	Physics with Mathematica	Synchronous lecturing & Wolfram Cloud		
11	21	Numerical Analysis	Synchronous lecturing & Wolfram Cloud	Discussion	A-2 B-2
	22	Numerical Analysis	Synchronous lecturing & Wolfram Cloud		
12	23	Interpolation and Extrapolation	Synchronous lecturing & Wolfram Cloud	Discussion	A-2 A-1
	24	Midterm Exam	On campus	Midterm Exam	
13	25	Optimization	Synchronous lecturing & Wolfram Cloud	Discussion	A-2 A-1
	26	Least-Squares Curve-Fitting	Synchronous lecturing & Wolfram Cloud		A-2 A-1
14	27	Students Presentations	Synchronous meeting	Presentation	--
	28	Students Presentations	Synchronous meeting		
15	29	Students Presentations	Synchronous meeting	Presentation	All references
	30	Final Exam (written + practical)	On campus	Final Exam	

22 Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	Period (Week)	Platform
Questionnaire	-----	Mathematica 13 and other Software	Weeks 1	On campus
Assignment # 1	15	Physics Simulations	Week 4	On campus
Assignment # 2		Flowcharting	Week 5	On campus
Assignment # 3		Pseudo-code	Week 6	On campus
Assignment # 4		A First Encounter with Mathematica	Week 7	On campus
Assignment # 5		Physics with Mathematica	Week 10	On campus
Midterm Exam	30	Ch 1 & Ch 2	Week 12	On campus
Presentation	15	Selected subjects in Computational Physics	Week 14	On campus
Final Exam	40	All Material	Week 15	On campus

23 Course Requirements (e.g: students should have a computer, internet connection, webcam, account on a specific software/platform…etc):

Students and Instructor should have a laptop with Mathematica 13 software installed, and good internet connection.
Instructor should have an account on Wolfram Cloud (recommended).

24 Course Policies:

A- Attendance policies:

Class attendance is mandatory.
A student whose absence exceeds 15% of lectures will be dismissed.

B- Absences from exams and submitting assignments on time:

Absence from exams without an acceptable excuse means ZERO.
No delayed submission of homework assignments.

C- Health and safety procedures:

No special precautions.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

All these issues will be considered according to the regulations and laws adopted at the University of Jordan.

E- Grading policy:

Homework: 15%
Midterm Exam: 30%
Project: 15%
Final Exam: 40%

F- Available university services that support achievement in the course:

E-learning Portal, E-Library

25 References:

A- Required book(s), assigned reading and audio-visuals:

1- A Physicist's Guide to Mathematica, 2nd Edition (2008), by Patrick T. Tam.
2- Numerical Recipes: The Art of Scientific Computing, 3rd Edition (2007), by W. H. Press, S. A. Teukolsky, W. T. Vetterling, & B. P. Flannery.

B- Recommended books, materials, and media:

1- Wolfram Research Inc. (The makers of Mathematica). This is a huge site, with many useful sub-sites, such as:

- Mathematica Information Center
- MathWorld
- ScienceWorld
- Wolfram Functions Site
- Wolfram Integrator
- The Mathematica Journal
- Stephen Wolfram

2- NAG Library: The world's largest collection of robust, documented, tested and maintained numerical algorithms.

3- 3D Physics Simulations http://www.euclideanspace.com/physics/index.htm

26 Additional information:

Name of Course Coordinator: **Dr. Hanan Sa'adeh** Signature: ---------- Date: 0/01/2024

Head of Curriculum Committee/Department: ---------- Signature: ----------

Head of Department: ---------- Signature: ----------

Head of Curriculum Committee/Faculty: ---------- Signature: ----------

Dean: ---------- Signature: ----------