مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

Course Syllabus

1	**Course title**	Computer Packages in Physics	
2	**Course number**	0302280	
3	**Credit hours**	Theory 1 credit hours,	Practical 1 credit hours
	Contact hours (theory, practical)	Contact hours (theory: 1 hour, practical: 3 hours)	
4	**Prerequisites/corequisites**	Modern Physics / PHYS 0302261	
5	**Program title**	B.Sc. Physics	
6	**Program code**	0302	
7	**Awarding institution**	University of Jordan	
8	**School**	School of Science	
9	**Department**	Physics	
10	**Course level**	Bachelor	
11	**Year of study and semester (s)**	2nd year	
12	**Other department (s) involved in teaching the course**	--	
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**	Spring 2024	

17 Course Coordinator:

Name: Dr. Khaled Bodoor Contact hours: 12:30-1:30 pm Sun,Tue and by appointment
Office number: Phone number: 22023

Email: kbodoor@ju.edu.jo

مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

18 Other instructors:

Name: Office number: Phone number: Email: Contact hours: Name: Office number: Phone number: Email: Contact hours:

19 Course Description:

Mathematica software will be used as a computational and programming tool. Students will be trained to solve problems in real and complex algebra, trigonometry, linear algebra, differential equations, and special functions.

مركز الاعتماد وضمان الجودة

20 Course aims and outcomes:

A- Aims:

Mathematica is a software package and a computer algebra system widely used by mathematicians, physicists, scientists, engineers, and students. It is based on the Wolfram Language, conceived by Stephen Wolfram, and developed by Wolfram Research, based in Champaign, Illinois. Its first release was in 1988..Compared to other commercial software packages, Mathematica has the most extensive set of abilities, so that a wide range of computational problems and topics can be explored without needing to switch environments. In addition, the notebook interface of Mathematica is excellent for teaching because it holds everything you do (code, graphics, etc) in a single document. Therefore, this course will serve as an introduction into the various capabilities of Mathematica and their applications in mathematics and physics, especially as they pertain to the courses offered at the undergraduate level.B- Students Learning Outcomes (SLOs):

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

مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

Program SLOs / Course SLOs	SLO (1)	SLO (2)	SLO (3)	SLO (4)	SLO (5)	SLO (6)	SLO (7)	SLO (8)	SLO (9)
Differentiate between the different computing paradigms (procedural, functional, object-oriented, etc.) and understand the strengths and weaknesses of each.	☐	☐	☐			☐	☐		
Understand the power and range of computing applications (symbolic manipulation and processing, numerical solutions and simulation, linear algebra, data processing, basic statistical analysis, etc.). Understand the process of modeling a problem and translating a proposed solution into an algorithm and then into actual code. Use *Mathematica* to solve undergraduate-level problems from mathematics and physics, including problems from linear algebra, calculus, curvilinear coordinates, vector calculus, electricity and magnetism, etc.	☐	☐	☐		☐	☐	☐	☐	
Master writing *Mathematica* code that is readable, through the use of prefix and postfix notation, comments, etc. Understand the specifics of functional programming, such as how to use *Mathematica* to repeatedly apply a function and apply functions to lists and matrices.	☐	☐	☐			☐	☐		
Understand that a list is the data structure in *Mathematica* from which other structures are derived. Understand that the Wolfram Language represents mathematical formulas, lists, graphics, etc in one uniform way as expressions.		☐	☐			☐	☐		
Plot functions in Cartesian and polar coordinates and master use of the Graphics package for the creation of 2D and 3D plots, including contour and density plots.	☐	☐	☐	☐		☐	☐		

Understand various operations on strings, text, and other expressions, such as matching, searching, and tokenizing text, as well as operations involving pattern finding and matching, and manipulate expressions and strings so as to extract, exclude, replace, and count items that do or do not match particular patterns.		☐	☐			☐	☐		
Learn importing and exporting of data, graphics, and other types of files in different formats.		☐	☐	☐		☐	☐		

21. Topic Outline and Schedule:

Week	Lecture	Topic	Student Learning Outcome	Learning Methods (Face to Face/Blended/ Fully Online)	Platform	Synchronous / Asynchronous Lecturing	Evaluation Methods	Resources
1	1.1			Face to Face			Exams	
2	2.1							
3	3.1							
4	4.1							
5	5.1							
6	6.1							
7	7.1							
8	8.1							
9	9.1							
10	10.1							
11	11.1							
12	12.1							
13	13.1							
14	14.1							
15	15.1							

مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

22 Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	SLOs	Period (Week)	Platform
First Exam/Quizzes	20%				Paper Exam
Midterm Exam	30%				Paper Exam
Final Exam	50%	All topics			Paper Exam

23 Course Requirements

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

Textbook, computer, Internet access, Microsoft Teams

24 Course Policies:

A- Attendance policies:

Students are expected to attend all classes. Absence should not exceed 15%.

B- Absences from exams and submitting assignments on time:

Exam makeups will be arranged for students with valid absence excuses.

C- Health and safety procedures:

Students are required to abide by all mandated health and safety procedures.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

Cheating, plagiarism, and misbehavior will be dealt with according to University regulations.

E- Grading policy:

Quizzes and First Exam: 20%, Midterm Exam: 30%, Final Exam: 50%.

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

Microsoft Teams, E-Learning platform, Moodle.

25 References:

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

Don, Eugene. "Mathematica: Schaum's outlines." (2019).

Recommended Textbooks:

1) The lectures of the course: Essential Mathematica for Students of Science - UMD Physics (URL: http://www.physics.umd.edu/courses/CourseWare/EssentialMathematica/)

2) "The Mathematica Book" by Stephen Wolfram. Publisher : Wolfram Media Inc; 5th edition (August 22, 2003)

3) "A Physicist's Guide To Mathematica" , By Patric T. Tam, Academic Press, 1997.

4) "Introduction to Mathematica for Physicists", By A. Grozin, Springer 2014.

5) Links for online resource will be provided on the Teams page of the course, including the *Mathematica* online documentation provided by Wolfram Research.

B- Recommended books, materials, and media:

26 Additional information:

The following methods will be used for teaching and student performance evaluation:

1) In lab lectures and demonstrations of concepts and problem solutions

2) Exercises during class

COURSE SYLLABUS

Getting started

1. The basic concepts of *Mathematica*: *Mathematica* as an environment. Front-End, Kernel, Notebooks, document structure and formatting. Executing code. Finding help. typesetting, cells, formulas, Help, Running *Mathematica* and interacting with the front end
2. Basic structures and operations, numerical and symbolic operations, variables, algebraic manipulations
3. Lists, vectors and arrays
4. Value setting (immediate and delayed), substitution rules, patterns
5. Quick survey of *Mathematica*'s capabilities: Algebra, Linear Algebra, Functions, Solving equations, Graphics, Calculus, Symbolic Manipulation, etc
6. Notebook operations: styles, stylesheets

Object types, assignments, functions, and Programming techniques

1. Structures, Types, Head, Head operations, type check, logical functions
2. The list as the foundation of *Mathematica* data structures
3. Function definitions
4. Types of functions: Implicit, explicit, pure, recursive, etc
5. Function Arguments and options

6. Variable scoping and modular programming
7. Piecewise or conditional definition of function and recursions
8. Functional programming
9. Recursive techniques
10. Examples
11. Programming paradigms in *Mathematica*: Procedural programming, Functional programming, Rule-based programming

Graphics and Plotting

1. Basic syntax
2. Plots of functions and lists
3. Parametric curves
4. Options and embellishments
5. Manipulating graphics objects
6. Plot types
7. Graphics primitives

Symbolic manipulation

1. Internal representation of expressions
2. List Processing
3. String and text manipulation
4. Pattern matching
5. Simplification, reduction

Algebra

1. Symbolic transformations
2. Solving equations and finding roots
3. Complex variables
4. Examples

Geometry

1. Solving analytical geometry problems using *Mathematica*
2. Coordinate systems
3. Equations of a line and a plane
4. Intersections, distances and angle

Calculus

1. Differentiation
2. Limits and expansions
3. Integration

Series, Limits and Residues

Linear Algebra with *Mathematica*

1. Vectors and vector operations
2. Matrices - entering, submatrices and elements of a matrix.
3. Matrix manipulation: transposing, multiplication, elementary transformations. Determinants, minors, cofactors. Inverse matrix, rank and basis
4. Orthogonality, Norms, etc.
5. Differential Vector Operators: Grad, Curl, Divergence
6. Applications

Elementary data handling, statistics (Optional)

1. Experimental data, plotting data, Calculating statistical descriptors of data
2. Curve fitting
3. Presentation graphics

Various Applications (Optional)

1. Fourier series
2. Special functions
3. Differential equations

12. **Files and external operations in *Mathematica* (Optional)**

Importing and exporting of data and graphics in different formats

Name of Course Coordinator: Dr.Khaled Boodor Signature: Date: Spring 2024
Head of Curriculum Committee/Department: ---------- Signature: ----------
Head of Department: ---------- Signature: ----------
Head of Curriculum Committee/Faculty: ---------- Signature: ----------
Dean: ---------- Signature: ----------