Form: Course Syllabus		
	Form Number	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
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	Number of Pages	06

1.	**Course Title**	Nonlinear Dynamics
2.	**Course Number**	0332951
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	3
4.	**Prerequisites/ Corequisites**	-
5.	**Program Title**	PhD in Physics
6.	**Program Code**	
7.	**School/ Center**	Science
8.	**Department**	Physics
9.	**Course Level**	PhD
10.	**Year of Study and Semester (s)**	TBA
11.	**Other Department(s) Involved in Teaching the Course**	none
12.	**Main Learning Language**	English
13.	**Learning Types**	x**Face to face learning** ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐Moodle ☐Microsoft Teams
15.	**Issuing Date**	Dec. 2025
16.	**Revision Date**	

17. Course Coordinator:

Name: Usama Al Khawaja	Contact hours: TBA
Office number:	Phone number:
Email:	

18. Other Instructors:

19. Course Description:

One Dimensional Flows: Flows on the Line, Bifurcations, Flows on the Circle. Two Dimensional Flows: Linear system, Phase plane, Limit Cycles, Bifurcations. Chaos: Lyapunov Exponents, Chaotic Orbits, Logistic Map, Lorenz Equations, Strange Attractors, Two Dimensional Maps, Chaos in Differential Equations.

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

1. **SO1:** to be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.
2. **SO2:** to be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.
3. **SO3:** to be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.
4. **SO4:** to be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.
5. **SO5:** to be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.
6. **SO6:** to be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.
7. **SO7:** to be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.
8. **SO8:** to be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software.

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. (Knowledge A1)	**Explain flows, bifurcation, chaotic systems, and fractals**
2. (Skills B1)	**Derive Lyapunov exponents.**
3. (Skills B2)	**Derive the chaotic behavior of some physical systems including the logistic map, Lorentz equations, and their applications.**
4. (Competences C1)	**Formulate the chaotic theory for two-dimensional maps.**

Course ILOs	The learning levels to be achieved					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1		**x**				
2						
3			**x**	**x**		
4			**x**	**x**	**x**	**x**

٢٢. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program ILOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)
1	x	x	x	x	
2		x	x	x	
3		x	x	x	
4					
5					
6					
7					
8					

2٣. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types	Platform Used	Synchronous / Asynchronous	Evaluation Methods	Learning Resources
1	1.1	One Dimensional Flows: Flows on the Line, Bifurcations, Flows on the Circle. Two Dimensional Flows: Linear system, Phase plane, Limit Cycles, Bifurcations. Chaos: Lyapunov Exponents, Chaotic Orbits, Logistic Map, Lorenz Equations, Strange Attractors, Two Dimensional Maps, Chaos in Differential Equations.						
	1.2	One Dimensional Flows:						
	1.3	One Dimensional Flows:						
2	2.1	Flows on the Line						
	2.2	Flows on the Line						
	2.3	Flows on the Line						
3	3.1	Bifurcations						
	3.2	Bifurcations						
	3.3	Bifurcations						

4	4.1	Flows on the Circle						
	4.2	Flows on the Circle						
	4.3	Flows on the Circle						
5	5.1	Two Dimensional Flows						
	5.2	Two Dimensional Flows						
	5.3	Two Dimensional Flows						
6	6.1	Linear system						
	6.2	Linear system						
	6.3	Linear system						
7	7.1	Phase plane						
	7.2	Phase plane						
	7.3	Phase plane						
8	8.1	Limit Cycles,						
	8.2	Limit Cycles,						

	8.3	Limit Cycles,						
9	9.1	Lyapunov Exponents						
	9.2	Lyapunov Exponents						
	9.3	Lyapunov Exponents						
10	10.1	Chaotic Orbits						
	10.2	Chaotic Orbits						
	10.3	Chaotic Orbits						
11	11.1	Logistic Map						
	11.2	Logistic Map						
	11.3	Logistic Map						
12	12.1	Lorenz Equations						
	12	Lorenz Equations						

	.2							
	12.3	Lorenz Equations						
13	13.1	Two Dimensional Maps						
	13.2	Two Dimensional Maps						
	13.3	Two Dimensional Maps						
14	14.1	Chaos in Differential Equations						
	14.2	Chaos in Differential Equations						
	14.3	Chaos in Differential Equations						
15	15.1	Chaos in Differential Equations						
	15.2	Chaos in Differential Equations						
	15.3	Chaos in Differential Equations						

٢٤. Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
Test1	20	TBA	1,2	TBA	Paper exam
Test2	20	TBA	3,4	TBA	Paper exam
Project and presentation	30	TBA	1,2,3,4	TBA	presentation
Final exam	30	TBA	1,2,3,4	TBA	Paper exam

٢٥. Course Requirements:

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

٢٦. Course Policies:

A- Attendance policies:

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

E- Grading policy:

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

٢٧. References:

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

TBA

B- Recommended books, materials, and media:

TBA

2٨. Additional information:

Name of the Instructor or the Course Coordinator:	Signature:	Date:
……	……...……	……..……
Name of the Head of Quality Assurance Committee/ Department	Signature:	Date:
…….	……...……	……..……
Name of the Head of Department	Signature:	Date:
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Name of the Head of Quality Assurance Committee/ School or Center	Signature:	Date:
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Name of the Dean or the Director	Signature:	Date:
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