الجامعة الاردنية

The University of Jordan

Form: Course Syllabus	Form Number	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or ModificaAon	15/10/2023
	Deans Council Approval Decision Number	265/2024/24/3/2
	The Date of the Deans Council Approval Decision	2024/1/23
	Number of Pages	06

1.	**Course Title**	Classical mechanics 2
2.	**Course Number**	0332352
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	3
4.	**Prerequisites/ Corequisites**	
5.	**Program Title**	B.Sc. Degree in Physics
6.	**Program Code**	
7.	**School/ Center**	School of science
8.	**Department**	Physics department
9.	**Course Level**	Third year
10.	**Year of Study and Semester (s)**	Second semester 2024-2025
11.	**Program Degree**	Bachelor
12.	**Other Department(s) Involved in Teaching the Course**	-

13.	**Learning Language**	English
14.	**Learning Types**	xFace to face learning ☐Blended ☐Fully online
15.	**Online Platforms(s)**	☐Moodle xMicrosoft Teams
16	**Issuing Date**	1 Feb 2025
17.	**Revision Date**	10 Feb 2025

18. Course Coordinator:

Name: Dr Ala'a Azzam Contact hours: Contact hours: Mon 10:00-11:00, Sun 12:30 - 13:30 Office number: 303 Phone number: 22023 Email: alaa.azzam@ju.edu.jo

19. Other Instructors:

20. Course Description:

Lagrangian mechanics; Hamiltonian mechanics; dynamics of systems of particles; dynamics of rigid bodies; coupled oscillators.

21. 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)

PILO's	*NaAonal QualificaAons Framework Descriptors*

	Competency (C)	Skills (B)	Knowledge (A)
1. Iden4fy, formulate, and solve broadly-defined technical or scien4fic problems by applying knowledge of Mathema4cs and Science and/or technical topics to areas relevant to the discipline	☐	X	☐
2. Formulate or design a system, process, procedure or program to meet desired needs	☐	X	☐
3. Develop and conduct experiments or test hypotheses, analyze and interpret data and use scien4fic judgment to draw conclusions	☐	X	☐
4. Communicate effec4vely with a range of audiences in oral or wriRen forms and exhibit ethical and professional values.	X	☐	☐
5. Reflect the impact of technical and/or scien4fic solu4ons in economic, environmental, and societal contexts.	X	☐	☐

6. Func4on effec4vely on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.	X	☐	☐

* Choose only one descriptor for each learning outcome of the program, whether knowledge, skill, or competency.

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

Course ILOs #	The learning levels to be achieved						Competencies
	Remember	Understand	Apply	Analyse	Evaluate	Create	
1. **Explain** the principles of Lagrangian and Hamiltonian formulations of classical mechanics		**X**					**Not directly a competency — this is primarily knowledgebased.**

2. **Apply** Lagrange's equations to derive the equations of motion for mechanical systems with constraints.			**X**				**Not directly a competency — this is a technical skill outcome.**

3. **Analyze** the dynamics of systems of particles and rigid bodies using generalized coordinates.				**X**			**Not directly a competency — technical/ analytical skill.**

4. **Formulate** and **solve** problems involving Hamiltonian mechanics, including canonical transformations and conservation laws.				**X**			Indirectly related to **scientific judgment and decisionmaking** (PO4, PO11 — problemsolving under uncertainty)
5. **Model and interpret** physical systems such as coupled oscillators and small oscillations using normal modes.				X			Indirectly supports lifelong learning and complex problemsolving by developing modeling capability.

6. **Evaluate** the physical significance of conserved quantities (energy, momentum, angular momentum) in the context of symmetries.					X		Competency: Scientific judgment, ethical implications of conservation principles (PO8, PO7).

23. The matrix linking the intended learning outcomes of the course -CLO's with the intended learning outcomes of the program -PILOs:

PILO's * CLO's	1	2	3	4	5	Descriptors**		
						A	B	C
1	X					X		
2	X	X					X	
3	X						X	
4	X		X				X	X
5		X	X				X	
6			X		X			X

***Linking each course learning outcome (CLO) to only one program outcome (PLO) as specified in the course matrix.**

****Descriptors are determined according to the program learning outcome (PLO) that was chosen and according to what was specified in the program learning outcomes matrix in clause (21).**

24. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to Topic	Learning Types	Platform Used	Synchronous / Asynchronous	Evaluation Methods	Learning Resources
1	1	Introduction to Lagrangian Mechanics	SO1, SO2	FF	Teams	Synchronous	Quiz, Problem Set	Marion & Thornton Chap. 1, Lecture slides

1	2	Principle of Least Action & Variational Principles	SO1, SO2, SO3	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 2

1	3	Derivation of Lagrange's Equations	SO1, SO2, SO3	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 3
2	4	Applications of Lagrangian Mechanics	SO2, SO3	FF	Teams	Blended	Homework, Quiz	Marion & Thornton Chap. 4
2	5	Hamiltonian Mechanics: Introduction	SO1, SO4	FF	Teams	Blended	Group Discussion	Marion & Thornton Chap. 5
2	6	Canonical Equations and Transformations	SO1, SO4	FF	Teams	Blended	Homework	Marion & Thornton Chap. 6
3	7	Conservation Laws and Symmetries	SO4, SO5	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 7
3	8	Dynamics of Systems of Particles: Overview	SO1, SO2	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 8
3	9	Generalized Coordinates and Constraints	SO1, SO2	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 9
4	10	Equations of Motion for Particle Systems	SO1, SO2	FF	Teams	Synchronous	Problem Set	Marion & Thornton Chap. 10
4	11	Dynamics of Rigid Bodies: Rotational Motion	SO1, SO3	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 11
4	12	Euler's Equations of Motion	SO1, SO3	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 12

5	13	Motion of a Symmetric Top	SO1, SO3	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 13
5	14	Coupled Oscillators: Introduction	SO1, SO2	FF	Teams	Blended	Homework, Quiz	Marion & Thornton Chap. 14
5	15	Normal Modes of Oscillation	SO1, SO3	FF	Teams	Blended	Group Project	Marion & Thornton Chap. 14
6	16	Energy Transfer in Coupled Oscillators	SO1, SO3	FF	Teams	Blended	Problem Set	Marion & Thornton Chap. 14
6	17	Small Oscillations and Stability Analysis	SO1, SO3	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 15
6	18	Phase Space and Hamiltonian Dynamics	SO1, SO4	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 16
7	19	Poisson Brackets and Canonical Transformations	SO1, SO4	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 16
7	20	Hamilton-Jacobi Theory	SO1, SO4	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 17
7	21	Action-Angle Variables	SO1, SO4	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 17
8	22	Central Force Motion and Effective Potential	SO1, SO2	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 18
8	23	Two-body Problem	SO1, SO2	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 18

8	24	Perturbation Methods	SO1, SO3	FF	Teams	Blended	Homework	Marion & Thornton Chap. 19
9	25	Variational Principles for Continuous Systems	SO1, SO2	FF	Teams	Synchronous	Problem Set	Marion & Thornton Chap. 20
9	26	Rigid Body Kinematics	SO1, SO3	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 21
9	27	Inertia Tensor and Principal Axes	SO1, SO3	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 21
10	28	Gyroscopic Motion	SO1, SO3	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 22
10	29	Stability of Motion in Rigid Bodies	SO1, SO3	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 23
10	30	Advanced Coupled Oscillator Systems	SO1, SO3	FF	Teams	Blended	Group Project	Marion & Thornton Chap. 24
11	31	Nonlinear Oscillations	SO1, SO3	FF	Teams	Blended	Homework	Marion & Thornton Chap. 25
11	32	Dissipative Systems	SO1, SO3	FF	Teams	Blended	Quiz	Marion & Thornton Chap. 25
11	33	Resonance Phenomena	SO1, SO3	FF	Teams	Blended	Problem Set	Marion & Thornton Chap. 26
12	34	Application of Lagrangian to Electromagnetic Systems	SO1, SO3	FF	Teams	Synchronous	Homework	Marion & Thornton Chap. 27

12	35	Hamiltonian Chaos Introduction	SO1, SO4	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 28
12	36	Symplectic Integrators	SO1, SO4	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 28
13	37	Numerical Methods in Classical Mechanics	SO1, SO4	FF	Teams	Blended	Homework	Marion & Thornton Chap. 29
13	38	Project Work Introduction and Guidelines	SO2, SO6	FF	Teams	Synchronous	Project Proposal	Custom material
13	39	Student Presentations and Discussions 1	SO4, SO6	FF	Teams	Synchronous	Presentation	Studentprepared materials
14	40	Student Presentations and Discussions 2	SO4, SO6	FF	Teams	Synchronous	Presentation	Studentprepared materials
14	41	Review of Lagrangian Mechanics	SO1, SO2, SO3	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 1-4
14	42	Review of Hamiltonian Mechanics	SO1, SO4	FF	Teams	Synchronous	Quiz	Marion & Thornton Chap. 5-7
15	43	Review of Rigid Body Dynamics	SO1, SO3	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 11-13
15	44	Review of Coupled Oscillators	SO1, SO3	FF	Teams	Synchronous	Problem Solving	Marion & Thornton Chap. 14-16
15	45	Comprehensive Problem Solving Session	SO1SO6	FF	Teams	Synchronous	Comprehensive Exam Prep	Full course material
16	46	Final Exam Preparation	SO1SO6	FF	Teams	Synchronous	Exam Review	Full course material

25. Evaluation Methods:

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

Evaluation Activity	Mark wt. (%)	CILO 1	CILO 2	CILO 3	CILO 4	CILO 5	CILO 6
First Exam	20%	X	X	X			
Second Exam – If any	15%	X	X	X			
Final Exam	30%	X	X	X	X	X	
Class Work	35%	X	X	X	X		X
Total	**100%**						

*** According to the instructions for granting a Bachelor's degree.**

****According to the principles of organizing semester work, tests, examinations, and grades for the bachelor's degree.**

Mid-term exam specifications table*

No. of quesAons/ cogniAve level						No. of quesAons per CLO	Total exam mark	Total no. of quesAons	CILO/ Weight	CILO no.
Create **10%**	Evaluate **10%**	analyse **10%**	Apply 20%	Understand **20%**	Remember 30%					
	1	3	3	2	3	1	25	3	1/7.5	3

Final exam specifications table

No. of quesAons/ cogniAve level						No. of quesAons per CLO	Total exam mark	Total no. of quesAons	CILO Weight	CILO no.
Create **10%**	Evaluate **10%**	analyse **10%**	Apply 20%	Understand **20%**	Remember 30%					
1	3	3	3	3	3	3	50	13	0.23	1
	1	1	1	1	1	1	50	13	0.07	2

	1	1	1	1	1	1	50	13	0.07	3
	2	2	2	2	2	2	50	13	0.15	4
	4	4	4	4	4	4	50	13	0.3	5
	3	3	3	3	3	3	50	13	0.23	6

26. Course Requirements:

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

27. Course Policies:

A- Attendance policies:

- Students are expected to attend all scheduled lectures, tutorials, and laboratory sessions.
- Attendance will be recorded regularly.
- A minimum of **75% attendance** is required to be eligible for final examination, in line with university regulations.
- Repeated absences without valid justification may lead to **withdrawal from the course**.

B- Absences from exams and submitting assignments on time:

- Absence from **midterm or final exams** without prior approval or acceptable justification (e.g., certified illness, family emergency) will result in a grade of zero for the missed exam.
- Late submission of assignments will incur a **penalty of 10% per day**, up to 3 days. Beyond that, submissions may not be accepted unless a valid excuse is provided.

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

- Academic honesty is strictly enforced. Any form of **cheating, plagiarism**, or **academic misconduct** will be reported and penalized in accordance with university regulations.
- Penalties may include a **grade of zero**, course failure, or **disciplinary action**.
- Misbehavior during class or exams (including unauthorized device use) is also subject to disciplinary action.

E- Grading policy:

- **Midterm Exam**: 25%
- **Class Participation & Assignments**: 25%
- **Final Exam**: 50%

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

- **Library Services**: Access to course textbooks, reference materials, and academic databases.

28. References:

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

Main Textbook:

- *Classical Dynamics of Particles and Systems* by Jerry B. Marion and Stephen T. Thornton, 5th Edition.
    - This book covers Lagrangian and Hamiltonian mechanics, rigid body dynamics, and coupled oscillations — all core topics in this course.

B- Recommended books, materials, and media:

Recommended Books:

- *Introduction to Classical Mechanics* by David Morin — excellent for problem-solving practice.
- *Mechanics* by L.D. Landau and E.M. Lifshitz — more advanced theoretical treatment.
- *Analytical Mechanics* by Fowles & Cassiday — another widely used reference.

Online Resources:

- MIT OpenCourseWare Physics – Classical Mechanics (8.01)
- Khan Academy Physics – Classical Mechanics Topics **Simulation Tools & Software**

(Optional):

- PhET Interactive Simulations: https://phet.colorado.edu/
- Tracker Video Analysis (for motion and system modeling)

29. Additional information:

Name of the Instructor or the Course Coordinator: Signature: Date:

……Dr Ala'a Azzam…… …… ……

Name of the Head of Quality Assurance CommiRee/ Department ……	Signature: ……	Date: ……
Name of the Head of Department ……	Signature: ……	Date: ……
Name of the Head of Quality Assurance CommiRee/ School or Center ……	Signature: ……	Date: ……
Name of the Dean or the Director ……	Signature: ……	Date: ……