Course Specification
(Bachelor)

Course Title:	**Analytical Mechanics**
Course Code:	**363MATH-3**
Program:	**B. Sc. in Mathematics**
Department:	**Mathematics**
College:	**Science**
Institution:	**Jazan University**
Version:	**2024**
Last Revision Date:	**9/2024**

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A. General information about the course:

1. Course Identification

1. Credit hours: 03 Hours

2. Course type

A.	University ☐	College ☐	Department☒	Track☐	Others☐
B.	Required ☒		Elective☐		

3. Level/year at which this course is offered:

Level 5 / Year 3

4. Course General Description

This course is designed to provide students with

- **Generalized Coordinates**: Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy).
- **Lagrange's Method and Applications**.
- **Hamilton's Method:** Hamilton's principle, principle equation, Jacobi equation and their use in solving the harmonic oscillator, variability of the principles and the principle of minimum action.

5. Pre-requirements for this course (if any): 362 MATH

6. Co- requirements for this course (if any): None

7. Course Main Objective(s)

After finishing the course, the student is expected to be familiar with the following:

- Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion.
- Hamilton's method: canonical momenta, Legendre transformation, phase space, the Hamiltonian,
- Hamiltonian dynamics, Liouville's theorem, canonical transformations, the Poisson bracket, integral invariants, transformation theory, integrable systems, and action-angle variables.
- Hamilton-Jacobi's method: Hamilton-Jacobi and the Schrödinger equation. Periodic and chaotic motions.
- Analytical mechanics and its relation to classical statistical and quantum mechanics.

2. Teaching mode (mark all that apply)

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

No	Mode of Instruction	Contact Hours	Percentage
3.	Hybrid • Traditional classroom • E-learning		
4.	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	42
2.	Laboratory/Studio	
3.	Field	
4.	Tutorial	3
5.	Others (specify)	
	Total	45

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

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Distinguish mathematical concepts relevant to Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.	K1	Lectures, Web-based work, Classroom discussions	Written examination (Solve the problems, MCQs, true/false, proof of the theorem, Short answer), Quizzes, Assignments
1.2	Identify background science, features and structure of mathematical problem in Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum,	K2	Lectures, Web-based work, Classroom discussions	Written exams (Problem-solving, MCQs, true/false, Proof, Short answer), Quizzes, Assignments

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.			
1.3	Explain notations and concepts required for the solution of Mathematical problem in Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.	K3	Lectures, Web-based work, Classroom discussions	Written exams (solve the problems, MCQs, true/false, Proof, Short answer), Quizzes, Assignments
2.0	Skills			
2.1	Apply theoretical, computational or practical aspect relevant to Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.	S1	Lectures, problem-solving, web-based work, and Classroom discussions.	Written exam (solve the problems, MCQs, true/false, Proof, Short answer), Quizzes, Assignments
2.2	Compute numerical quantities for various parameters to approximate the solution in Conservative and non-	S2	Lectures, problem-solving, web-	Written exams (solve the problems,

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.		based work, and Classroom discussions.	MCQs, true/false, Proof, Short answer), Quizzes, Assignments
2.3	Apply various mathematical rules, techniques and theorems in Application in Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.	S3	Lectures, problem-solving, web-based work, and Classroom discussions.	Written exams (solve the problems, MCQs, true/false, Proof, Short answer), Quizzes, Assignments
2.4	Solve mathematical problem using critical thinking in Conservative and non-conservative groups, constraints of power, employment and the amount of motion in generalized coordinates - the principle of Drop (the amount of linear motion, angular momentum, total energy, Lagrange's method: mechanical systems, degrees of freedom, generalized coordinates, the Lagrange, variational principles, Euler-Lagrange's equations, cyclic coordinates, constants of motion and Hamilton's.	S4	Lectures, problem-solving, web-based work, and Classroom discussions.	Written exams (solve the problems, MCQs, true/false, Proof, Short answer), Quizzes, Assignments
3.0	Values, autonomy, and responsibility			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.1	Cultivate a mathematical attitude and nurture interest	V1	Group work, problem-solving, web-based work	Assignments and discussion
3.2	Realize the importance of responsibilities through different modes of practice, competition and related activities.	V2	Group work, problem-solving, web-based work	Assignments and discussion
3.3	Inculcating values and ethics in thought, expression and deed.	V3	Group work, problem-solving, web-based work	Assignments and discussion

C. Course Content

No	List of Topics	Contact Hours
1.	Generalized Coordinates	6
2.	Conservative and non-conservative force	6
3.	Lagrange's Method and Applications.	7
4.	Hamilton's Method	6
5.	Canonical Transformations and Generating Functions	7
6.	Euler-Lagrange's equations	6
7.	Hamilton's Lagrange's equations	7
Total		45

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Homework and Quiz	3	5
2.	First Exam	6	20
3.	Homework and Quiz	10	5
4.	Second Exam	12	20
5.	Final Exam	15	50

*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	Lindstrom P.: Lecture Notes on Analytical Mechanics. Div. of Mechanics. Lund University. 2007.

Supportive References	Goldstein, Poole & Safko: Classical Mechanics. 3rd ed. Addison Wesley. 2002.
Electronic Materials	**Websites dedicated to Dynamics are available on the internet.**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classroom, Computer Lab, Library.
Technology equipment (projector, smart board, software)	Smart Board, Data Show, Mathematical software, MATLAB.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Peer and program leader	Indirect (Course Evaluation Survey)- Indirect peer evaluation
Effectiveness of students assessment	Students, Program assessment committee	Direct/ Indirect
Quality of learning resources	Students, Faculty members	indirect
The extent to which CLOs have been achieved	Instructor	Direct/Indirect
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data

COUNCIL /COMMITTEE	**Board Of Mathematics Department**
REFERENCE NO.	**2417**
DATE	**29/03/1446 A. H.; 2/10/2024 A. D.**