NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES

ENGINEERING PHYSICS PROGRAM

CF371 – THEORETICAL MECHANICS

I. GENERAL INFORMATION

CODE	:	CF371 Theoretical Mechanics
SEMESTER	:	5
CREDITS	:	8
HOURS PER WEEK	:	10 (Theory – Practice)
PREREQUISITES	:	CF252 Mathematical Methods for Physics
CONDITION	:	Compulsory

II. COURSE DESCRIPTION

The course prepares students in the understanding and interpreting physical phenomena related to dynamics and momentum and energy conservation laws and their applications. Students also learn the Lagrange and Hamilton formulation of classical mechanics, as well as understand and apply variational principles. Physics problems with engineering applications are analyzed and solved.

III. COURSE OUTCOMES

1. Understand and apply Newton laws for analyzing the motion of bodies in gravitational and electric fields.
2. Understand D'Alembert principle and Hamilton principle and apply them to solve physics problems.
3. Understand the principles of Lagrange mechanics and apply them to solve physics problems.
4. Analyze the motion of rigid bodies under the action of central forces.
5. Analyze the dynamics of rigid body and solve complex motion problems.
6. Analyze the motion of coupled oscillations and apply them to solve physics problems.

IV. COURSE CONTENTS

1. CLASSICAL MECHANICS

Reference systems / Newton laws / One, two and three dimensional motion in gravitational and electric fields / Momentum conservation laws: linear and angular momentum / Energy conservation laws / Motion in resistive means.

2. WAVE MOTION

Restorative force / Harmonic motion: simple, damped and forced / Resonance / Pendulum / Nonlinear oscillations.

3. D'ALEMBERT AND HAMILTON PRINCIPLES

Links / Generalized coordinates / Displacement and virtual work / D'Alembert principle and Lagrange equations / Variational calculus / Hamilton principle / Application to non-conservative and non-holonomic systems.

4. CENTRAL FORCES

Electrical and gravitational forces / Potential / Conservation of angular momentum and Kepler second law / Orbits / Periods / First and third Kepler law / Planet and satellite motions / Dispersion / Effective section.

5. **TWO-PARTICLES COLLISION**
   Mass center / Lineal momentum / Angular momentum / Energy of a particle system / Reduced mass / Frontal and oblique shock / Motion of a variable mass body.

6. **MOTION IN NON-INERTIAL SYSTEMS**
   Translation and rotation of a non-inertial system / Fictitious forces: Coriolis, centrifugal and transversal / Effect of Earth rotation / Focault pendulum.

7. **RIGID BODY DYNAMICS**
   Rotation respect to an axis and a point / Inertia tensor and inertia moment / Eigenvalues and main axis / Euler equations / Free rotation / Rotation in a gravitational field / Gyroscope.

8. **COUPLED OSCILLATIONS. VIBRATING STRING. FLUIDS**
   Normal modes / Normal coordinates / Vibration of a particles system / Vibrating string / Wave equation.

9. **WAVE EQUATION**
   Phase velocity / Superposition / Wave packet / Dispersion / Attenuation / Reflection / Refraction.

V. METHODOLOGY

The course consists of theory, practice and laboratory sessions. The instructor presents the concepts and physical laws using applets, videos and formulating equations using differential and integral expressions. Problems related to engineering are solved with active student participation. Students present reports on physics-based engineering problems, summarizing main results, analysis and conclusions. Student active participation is promoted.

VI. GRADING SYSTEM

The Final Grade (FG) is calculated with the following formula:

FG = (EP + EF + PP) / 3

EP: Mid-term exam EF: Final exam PP: Average of quizzes

VII. BIBLIOGRAPHY

1. K.R. Symon
   Mechanics
   Addison Wesley, 2001

2. W. Hauser
   Introduction to Mechanics Principles
   Prentice Hall, Mexico, 2010