



**NATIONAL UNIVERSITY OF ENGINEERING**  
**COLLEGE OF CIVIL ENGINEERING**  
**CIVIL ENGINEERING PROGRAM**

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**SYLLABUS - DYNAMICS**

**I. GENERAL INFORMATION**

<b>CODE</b>	: EC114 Dynamics
<b>SEMESTER</b>	: 4
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 5 (Theory – Practice)
<b>PREREQUISITES</b>	: FI204 Physics II, CB311 Mathematics III
<b>CONDITION</b>	: Compulsory
<b>DEPARTMENT</b>	: Structures

**II. COURSE DESCRIPTION**

This course provides students with the main principles of Mechanics and its applications. Its general objective is to understand and apply the concepts of particle kinematics, particle movement, relative motion, rigid body kinematics, dynamics of a particle and a system of particles, dynamics of a rigid body and vibration with one degree of freedom. Applications are related to several fields of engineering including structural engineering.

**III. COURSE OUTCOMES**

1. Interpret physic phenomena related to main principles of Mechanics.
2. Create models representing the dynamics of moving particles and bodies (longitudinal and rotational motion)
3. Physically and mathematically represent everyday problems, and problems related to engineering making their analysis and modeling.
4. Understand the importance of Mechanics for the study of practical situations related to problems of the career.

**IV. LEARNING UNITS**

**1. PARTICLE KINEMATICS. RELATIVE MOTION**

Framework of reference. Position. Trajectory parametrical equations. Velocity and acceleration. Velocity and acceleration in Cartesian coordinate system. Intrinsic components of acceleration. Applications. Particle movement in other coordinate systems. Coordinate systems that revolve with respect to a fixed coordinate system. General equation for the particle movement with respect to the moving coordinate system. Applications.

**2. KINEMATICS OF A RIGID BODY / 7 HOURS**

General equation for the movement of a rigid body. Translational motion. Rotation movement around a fixed axis. Main properties of the rigid body movement. Instantaneous axis of rotation and slipping. Movement in one plane of a rigid body. Instantaneous center of rotation. Rigid body movement with respect to a moving coordinate system. Rigid body movement with a fixed point. Euler angles. Euler velocities. General movement of a solid. Applications.

### 3. DYNAMICS

Differential equations for movement in various coordinate systems. Impulse and momentum. Conservation of momentum. Momentum and impulse theorem. Work and energy. Work-energy theorem and kinetic energy. Fields of conservative forces. Potential energy. Mechanical energy conservation. Center of mass movement. Total kinetic energy of a system of particles. Work and energy equation. Impulse and momentum. Angular momentum. Application.

### 4. RIGID BODY KINETICS AND VIBRATIONS

Angular momentum of a rigid body. Moments and products of solids inertia. Rotation of coordinate axes. Main axes. General equation of motion. Translation. Rotation around a fixed axis. Movement in one plane. Rotation around a fixed point. Work and energy equation for rigid bodies. Lagrange equation applied to solids movement. Vibration of a particle with a degree of freedom. Differential equation of shaking motion. D'Alembert's principle applied to the formulation of the differential equation for systems with a degree of freedom. Free vibrations without damping. Dynamic response. Free damped motion. Overdamped motion. Motion with critical damping. Free subdamped vibration. Logarithmic energy decrement. Energy dissipation. Forced damped vibrations. Dynamic amplification. Vibration-isolation. Duhamel's integral.

### V. METHODOLOGY

The course is carried out in theory and practice sessions using active methods in the teaching-learning process and encouraging students' participation. The instructor exposes and gives examples to complement students' activity using the available audiovisual aids. Students should solve problems applied to diverse engineering fields.

### VI. EVALUATION FORMULA

The average grade PF is calculated as follows:

$$PF = (EP + EF + PP) / 3$$

EP: Mid-Term Exam

EF: Final Exam

PP: Average of six quizzes

### VII. BIBLIOGRAPHY

1. **BEER, FERDINAND AND JOHNSTON, RUSSELL JR.**  
Newtonian Mechanics for Engineers. Dynamics  
Mc. Graw Hill Editorial, Mexico, 2015
2. **HIBBELER, R. C.**  
Mechanics And Dynamics  
Prentice Hall Hispano-American, Mexico, 2014
3. **SHAMES, IRVING**  
Mechanical Engineering  
Prentice Hall, Iberia, Madrid, 2005