National University of Engineering (UNI)
School of Civil Engineering
Syllabus 2027-I

1. COURSE

BFI101. General Physics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	BFI101. General Physics
2.2 Semester	:	2nd Semester.
2.3 Credits	:	5
2.4 Hours	:	3 HT; 4 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	MA111. Calculus I. (1st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Physics I introduces the foundations of classical mechanics as a mathematical and experimental discipline. Through the study of kinematics, Newtonian dynamics, conservation principles, rotational motion, elasticity, fluid mechanics, vibrations and waves, and an introduction to transport phenomena, students acquire the analytical tools needed to model and solve problems of the physical world. This course provides the indispensable foundation for the study of oscillatory, wave, and electromagnetic phenomena addressed in subsequent courses.

5. GOALS

- Describe the motion of particles in different coordinate systems and formulate the equations of motion from Newton's laws.
- Apply the principles of work, potential energy, and conservation of mechanical energy to systems with conservative and non-conservative forces.
- Solve particle-system dynamics problems using conservation of linear momentum and collision analysis.
- Analyze rotational motion and angular momentum dynamics in systems of particles and extended bodies.
- Apply elastic moduli and Hooke's law to relate stress and strain in solids.
- Apply the principles of hydrostatics and hydrodynamics, including the continuity and Bernoulli equations, to fluid flow problems.
- Analyze simple harmonic motion and mechanical wave propagation, including superposition and resonance phenomena.
- Apply Fourier's and Fick's laws to describe basic heat conduction and mass diffusion processes.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: Kinematics and Dynamics of Particles (22 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Vector description of position, velocity, and acceleration in Cartesian, polar, and spherical coordinates • Newton's three laws of motion and inertial reference frames • Formulation and solution of equations of motion for constant and variable forces • Static and kinetic friction forces, including angle of repose • Numerical integration of equations of motion for engineering dynamics problems	• Formulate the equations of motion for a particle in one, two, and three dimensions given a force law [Usage] • Identify all forces acting on a particle and draw a correct free-body diagram [Familiarity] • Calculate the terminal velocity of an object falling through a fluid with drag resistance [Assessment] • Implement a numerical algorithm to simulate the dynamics of an engineering mechanical system [Usage] • Construct and interpret phase space diagrams for simple engineering oscillatory systems [Assessment]
Readings : [**Serway2018**], [**Young2015**]	

Unit 2: Work, Energy, and Conservative Forces (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of work as a line integral $W = \int \vec{F} \cdot d\vec{r}$ • Work-energy theorem: $W_{total} = \Delta K$ • Potential energy function and the force relation $\vec{F} = -\nabla U$ • Conservation of total mechanical energy $E = K + U$ • Energy diagrams, turning points, and equilibrium stability • Work done by non-conservative forces and energy dissipation in engineering systems	• Calculate the work done by a force along a specified engineering path [Usage] • Apply conservation of mechanical energy to solve for speeds and positions in engineering dynamics [Usage] • Analyze an energy diagram to identify equilibrium positions and stability [Assessment] • Estimate energy dissipated by friction and damping forces in mechanical engineering systems [Assessment]
Readings : [**Serway2018**], [**Tipler2010**]	

Unit 3: Systems of Particles and Linear Momentum (8 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition and computation of center of mass for particle systems and distributed bodies • Linear momentum of a particle and system: $\vec{P} = M\vec{V}_{CM}$ • Conservation of linear momentum for isolated engineering systems • Two-body collisions: elastic, inelastic, and the coefficient of restitution • Variable mass systems such as rockets and conveyor belts	• Locate the center of mass for discrete particle systems and distributed engineering objects [Usage] • Apply conservation of linear momentum to analyze impact and collision problems [Usage] • Classify collisions as elastic or inelastic and determine energy loss [Familiarity] • Solve variable-mass system equations to determine velocity gain in propulsion problems [Usage]
Readings : [**Young2015**], [**Tipler2010**]	

Unit 4: Rotational Motion and Angular Momentum (12 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Rotational kinematics: angular displacement, velocity, and acceleration • Torque: $\vec{\tau} = \vec{r} \times \vec{F}$ and its computation • Moment of inertia $I = \sum m_i r_i^2$ and the parallel axis theorem • Rotational kinetic energy: $K_{rot} = \frac{1}{2} I \omega^2$ • Conservation of angular momentum in engineering machines and rotating structures • Rolling without slipping dynamics and applications to wheels and shafts	• Calculate torque about a given axis for an engineering power transmission system [Usage] • Determine the moment of inertia for machine components such as rods, disks, and shafts [Usage] • Apply conservation of angular momentum to analyze speed changes in rotating engineering systems [Assessment] • Analyze combined translational and rotational motion in wheeled engineering systems [Assessment]
Readings : [**Serway2018**], [**Kleppner2013**]	

Unit 5: Elasticity (2 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Definition of stress (force/area) and strain ($\Delta L/L$) • Young's modulus and Hooke's law for longitudinal strain: $\sigma = E\epsilon$ • Shear modulus (rigidity) and shear strain • Bulk modulus (compressibility) and volumetric strain • Elastic limit, plastic region, and fracture point on the stress-strain diagram • Elastic energy stored in a deformed material	• Apply the scalar Hooke's law to calculate the deformation of a rod under axial load [Usage] • Calculate Young's, shear, or bulk modulus from experimental stress-strain data [Usage] • Identify the elastic region, elastic limit, and fracture point on a stress-strain curve [Familiarity] • Calculate the elastic potential energy stored in a deformed spring or rod [Usage]
Readings : [**Serway2018**], [**Young2015**]	

Unit 6: Fluids: Hydrostatics, Hydrodynamics, and Viscosity (10 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Density, pressure, and its variation with depth in a fluid at rest: $p = p_0 + \rho g h$ • Pascal's principle and its applications (hydraulic press) • Archimedes' principle, buoyant force, and flotation • Pressure measurement with manometers and barometers • Continuity equation for incompressible flow: $A_1 v_1 = A_2 v_2$ • Bernoulli's equation and energy conservation in ideal flow • Applications: Venturi tube, Torricelli's theorem, Pitot tube • Viscosity and Poiseuille's law for laminar flow in pipes • Reynolds number and the transition to turbulent flow • Stokes' law for the drag force on a sphere in a viscous fluid	• Calculate the pressure at a point in a fluid at rest given depth and density [Usage] • Apply Archimedes' principle to determine whether an object floats, sinks, or remains in equilibrium [Usage] • Apply the continuity and Bernoulli equations to solve flow problems in pipes of varying cross-section [Usage] • Interpret manometer and barometer readings to determine absolute and gauge pressures [Assessment] • Apply Poiseuille's law to calculate the flow rate of a viscous fluid in a cylindrical tube [Usage] • Estimate the Reynolds number of a flow and predict whether it is laminar or turbulent [Assessment]
Readings : [**Serway2018**], [**Young2015**]	

Unit 7: Vibrations and Waves (14 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Simple harmonic motion (SHM): equation of motion, position, velocity, and acceleration • Oscillating systems: spring-mass and simple/physical pendulum • Energy in simple harmonic motion • Damped and forced oscillations; introduction to resonance • Transverse and longitudinal waves; propagation speed • Wave equation and speed of a wave on a taut string: $v = \sqrt{T/\mu}$ • Superposition principle and standing waves • Sound waves, intensity, and sound intensity level (decibels) • Doppler effect for sound waves • Beats and interference of waves of nearby frequencies	• Derive the equation of motion and the period of a spring-mass system and a simple pendulum [Usage] • Calculate the kinetic, potential, and total energy of a simple harmonic oscillator at any instant [Usage] • Analyze the amplitude response of a forced oscillator near the resonance frequency [Assessment] • Calculate the propagation speed of a wave on a string from the tension and linear density [Usage] • Determine the frequencies and wavelengths of the normal modes of a standing wave on a fixed string [Usage] • Calculate the sound intensity level in decibels from the intensity of a sound wave [Usage] • Apply the Doppler effect formula for a moving source and/or observer [Usage]
Readings : [**Serway2018**], [**Young2015**]	

Unit 8: Transport Phenomena (4 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Heat conduction and Fourier's law: $\vec{q} = -k\nabla T$ • Thermal conductivity of materials and thermal resistance in composite walls • Molecular diffusion and Fick's first law: $\vec{J} = -D\nabla C$ • Analogy between heat, mass, and momentum transport (Prandtl and Schmidt numbers)	• Apply Fourier's law to calculate the heat flux through a plane or composite wall [Usage] • Apply Fick's first law to calculate the diffusive flux of a species in a concentration gradient [Usage] • Identify mathematical analogies between heat, mass, and momentum transport processes [Familiarity]
Readings : [**Serway2018**], [**Tipler2010**]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY