Course Description

PHY3504C| Thermodynamics & Waves| 4.00 Credits

This course is an introduction to mechanical waves and classical thermodynamics. The student will learn the physics of oscillations and mechanical waves and the postulates and results of the kinetic theory of gases, the laws of thermodynamics and their applications to heat engines.

Course Competencies:

Competency 1: The student will demonstrate knowledge, comprehension, and application of ideal and real gases by:

1. Describing and applying pressure, temperature, and volume.
2. Stating and applying the ideal gas law.
3. Stating and applying the van der Waals equation of state and the virial equation of state.
4. Stating and applying Dalton's law of partial pressure and Graham's law of diffusion.

Competency 2: The student will demonstrate knowledge, comprehension, analysis, and application of the kinetic molecular theory of gases by:

1. Stating the assumptions of the model.
2. Deriving an expression for the pressure and temperature of an ideal gas in terms of molecular velocities and kinetic energy, as well as for the collision frequency and mean free path of ideal gas molecules.
3. Stating and applying the Maxwell Boltzmann distribution law.

Competency 3. The student will demonstrate knowledge, comprehension, analysis, and application of fundamental thermodynamic concepts by:

1. Stating and applying heat, heat transfer, work, internal energy, temperature, and heat capacity.
2. Describing and applying pressure-volume diagrams
3. Stating and applying the concepts of state functions with particular emphasis on entropy.
4. Describing and applying the concepts of processes and cycles, reversibility, heat engines and refrigerators, efficiency and coefficient of performance.

Competency 4. The student will demonstrate knowledge, comprehension, analysis and application of the laws of thermodynamics by:

1. Stating and applying all four laws
2. Applying the laws to different thermodynamic processes.
3. Applying the laws to different heat engine cycles, with particular attention to the Carnot cycle.
4. Calculation of entropy changes in reversible, irreversible, and spontaneous processes. E) examining the wide-ranging consequences of the concept of entropy.
5. Deriving and applying the statistical interpretation of entropy.

Competency 5. The student will demonstrate knowledge, comprehension, analysis, and application of the fundamental ideas of statistical mechanics by:

1. Describing phase space.
2. Calculating probability distributions.
3. Deriving the Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.
4. Applying the above statistics to the derivation of the Maxwell-Boltzmann distribution law, Planck's radiation law, and the behavior of an electron gas in metals.

Competency 6. The student will demonstrate knowledge, comprehension, analysis, and application of the dynamics of the simple harmonic oscillator by:

1. Analyzing simple harmonic motion applying Newton's laws.
2. Analyzing simple harmonic motion by applying energy methods.
3. Describing and applying the concepts of amplitude, period, frequency, and phase.
4. Solving the differential equations for damped, undamped, forced, and unforced oscillations.
5. Deriving the conditions and results of resonance for a simple harmonic oscillator.

Competency 7. The student will demonstrate knowledge, comprehension, analysis, and application of the dynamics of transverse waves on a string by:

1. Stating and applying the concepts of wave speed, wavelength, and frequency.
2. Deriving the wave speed in terms of properties of the string.
3. Analyzing the reflection and transmission properties at different types of boundaries. D) deriving the conditions and characteristics for standing wave patterns produced under different boundary conditions.
4. Stating and applying the concepts of nodes and antinodes as they relate to standing waves.
5. Stating and applying the concept of wave interference and its relationship to standing wave patterns.
6. Applying Fourier analysis to interpret complex vibration patterns as a superposition of simpler sinusoidal patterns.

Competency 8. The student will demonstrate knowledge, comprehension, analysis and application the dynamics of sound waves by:

1. Deriving the speed of sound in terms of the properties of the medium
2. Relating sound intensity to perception.
3. Describing and applying the concepts of interference and diffraction
4. Explaining beats applying interference.
5. Describing the Doppler effect and relating it to the speeds of the medium, source, and observer
6. Describing sonic booms and shock waves and relating them to the speed of sound.

Competency 9: The student will demonstrate knowledge, comprehension, analysis, and application of the dynamics of sound waves in cylindrical columns by:

1. Describing and deriving the reflection and transmission properties at different types of boundaries.
2. Deriving the conditions and characteristics for standing wave patterns produced under different boundary conditions.
3. Describing and applying the concepts of nodes and antinodes as they relate to standing waves.
4. Describing and applying the concept of wave interference and its relationship to standing wave patterns.
5. Relating standing waves to the musical sounds produced by musical instruments.
6. Relating harmonics and overtones.
7. Applying Fourier analysis to interpret complex musical sounds as a superposition of simpler standing wave patterns.

Competency 10. The student will demonstrate knowledge, comprehension, and analysis of the selected concepts in thermodynamics and waves by:

1. Performing experiments consistent with an understanding of the underlying concepts.
2. Writing lab reports which show evidence that the underlying concepts are well understood.
3. Designing an experiment that tests a selected thermodynamics or wave concept.

Competency 11. The student will demonstrate knowledge and comprehension and application of laboratory techniques by:

1. Handling laboratory equipment according to operating instructions and safety guidelines.
2. Recording data in a laboratory notebook in a clear organized manner, following accepted guidelines.

3. Recording data with the proper number of significant figures.
4. Obtaining results with precision and accuracy is appropriate for the specific activity and offering careful explanations when they are not.
5. Reporting experimental results following accepted guidelines.

Learning Outcomes:

1. Computer / Technology Usage
2. Critical thinking
3. Information Literacy