Course Number and Title: PHY 284 Oscillation and Waves

Campus Location:
Georgetown, Dover, Stanton, Wilmington

Effective Date:
2020-51

Prerequisite:
(MAT 281 or MAT 282 or MAT 283), PHY 281

Co-Requisites:
None

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course builds on the concepts introduced in PHY 281 (Physics I with Calculus) with strong emphasis on oscillation and waves. Continuum physics, with elements of elasticity theory and fluid mechanics along with oscillations and resonance phenomena in both mechanical systems and electrical circuits is introduced. Wave propagation, interference, diffraction, and dispersion are covered in depth. Advanced labs accompany the curriculum throughout the course.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Analyze simple harmonic motion (SHM) using mechanics concepts and techniques. (CCC 2, 6)
2. Analyze damped and forced oscillations in mechanical and electrical systems. (CCC 2, 6)
3. Analyze coupled oscillators and models of physical system using coupled oscillators. (CCC 2, 6)
4. Compare and contrast the mechanics of traveling and standing waves. (CCC 2, 6)
5. Differentiate interference and diffraction of waves. (CCC 2, 6)
6. Analyze the physical properties of dispersive waves. (CCC 2, 6)
7. Analyze waves and oscillation principles using experimental techniques. (CCC 1, 2, 3, 6)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Analyze simple harmonic motion (SHM) using mechanics concepts and techniques.
    1. Describe the physical requirements for systems that exhibit simple harmonic motion.
    2. Solve for unknown variables in problems involving oscillations in mass on spring, simple, physical pendulum, and LC circuits.
    3. Interpret and create motion and energy graphs of simple harmonic oscillators from information provided.
    4. Employ the physics of small vibrations to model physical systems where oscillations occur.
    5. Construct harmonic solutions to pendulums using the small angle approximation.
    6. Construct the numerical solution of a pendulum to illustrate the effect of the small angle approximation.
    7. Contrast the SHM oscillations in an LC circuit with those found in mechanical systems.
2. Analyze damped and forced oscillations in mechanical and electrical systems.
    1. Construct and graph the solutions to different degrees of damping in physical and electrical systems.
    2. Calculate and assess energy loss and quality factor in different systems.
    3. Determine and compare the solutions for forced oscillations of undamped and damped systems.
    4. Calculate power transfer, and compare its relationship to quality factor.
    5. Compare and contrast the transient behavior of forced oscillators to the steady state solution.
3. Analyze coupled oscillators and models of physical system using coupled oscillators.
    1. Construct the normal modes of mass(es) connected via springs.
    2. Employ the superposition of normal modes to construct oscillation of mass(es) connected to springs.
    3. Employ the method of normal coordinates to solve for forced coupled oscillators.
    4. Create solution to transverse oscillations using appropriate techniques.
    5. Apply techniques of coupled oscillators to electrical and solid state systems.
4. Compare and contrast the mechanics of traveling and standing waves.
    1. Recall the derivation of the linear traveling wave equation and associated sinusoidal solutions.
    2. Recall the derivation of the wave on a string equation and associated sinusoidal solutions.
    3. Compute the energy and energy transfer of travelling waves.
    4. Apply boundary conditions to determine reflection and transmittance coefficients of travelling waves.
    5. Employ boundary condition and superposition to construct solution for standing string on a string.
    6. Apply Fourier analysis to determine normal modes of vibrating string.
    7. Determine the energy stored in a vibrating string.
5. Differentiate interference and diffraction of waves.
    1. Apply Huygen's principle to the propagation of waves.
    2. Employ Huygen's principle and superposition to explain Young's double slit experiment.
    3. Construct the wave amplitude and intensity after diffraction from a single slit.
    4. Use diffraction to explain Rayleigh criterion.
    5. Determine wave amplitude and intensity after diffraction from double slits of finite width.
6. Analyze the physical properties of dispersive waves.
    1. Construct the superposition of waves in non-dispersive media to understand beats and amplitude modulation.
    2. Compare and contrast the phase velocity with group velocity of dispersive waves.
    3. Use the dispersion relation to determine group and phase velocity of different waves.
    4. Employ dispersion to explain the formation and properties of wavepackets.
7. Analyze waves and oscillation principles using experimental techniques.
    1. Examine the motion graphs and period versus amplitude relationship for a pendulum.
    2. Examine the resonance curves for a driven oscillator, and determine the resonant frequency for each oscillation.
    3. Construct the phase space and the Poincaré plot for a nonlinear oscillator.
    4. Construct LRC circuits to create resonance curves, and determine the phase difference versus driving frequency relationship.
    5. Examine normal and coupled modes of harmonic oscillators made of carts and springs.
    6. Examine standing waves in mechanical and acoustical systems.
    7. Verify the transmittance and reflection coefficient of light waves at different boundaries.
    8. Use the diffraction patterns from single and double slits to calculate the wavelength of a laser beam.
    9. Determine the wavelength of a laser by using a Michelson interferometer.
    10. Examine non-dispersive and dispersive media using wave packet propagation.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the [Student Handbook - https://www.dtcc.edu/handbook](https://www.dtcc.edu/handbook) for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Final Course Grade:
Calculated using the following weighted average

Evaluation Measure	Percentage of final grade
3 Unit Tests * (summative) (equally weighted)	45%
Final Exam** (summative)	25%
Labs (summative) (equally weighted)	20%
Other – Homework, Quiz, Projects (formative)	10%
TOTAL	100%

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):
None

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.