OFFICIAL UNDERGRADUATE COURSE OUTLINE (page 1)

COURSE IMPLEMENTATION DATE:	January 2013
COURSE REVISED IMPLEMENTATION DATE:	
COURSE TO BE REVIEWED: *(six years after UEC approval)*	June 2018 *(month, year)*

OFFICIAL UNDERGRADUATE COURSE OUTLINE INFORMATION

Students are advised to keep course outlines in personal files for future use.

Shaded headings are subject to change at the discretion of the department – see course syllabus available from instructor

PHYS 225	Science/Physics	3
COURSE NAME/NUMBER	FACULTY/DEPARTMENT	UFV CREDITS

Waves and Introductory Optics

COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

This course builds upon the foundations of mechanics presented in PHYS 221 by extending oscillatory motion from single point masses to continuous bodies. In particular, the course will introduce students to both longitudinal and transverse waves via the *wave equation*, and describe how energy can be transported through distortions of a continuous medium (like sound waves in air). Properties specific to waves like superposition and interference will also be investigated, and will see application in effects like wave diffraction. As light can be considered to be an electromagnetic wave, students will be able to apply these concepts to the study of Optics (Huygens Principle), and look at simple optical processes like reflection, and refraction from mirrors and lenses. Lastly, the concept of matter waves and quantum theory using the de Broglie hypothesis will be introduced, which will set the stage for the study of Quantum Mechanics in PHYS 351. A small number of experiments will be performed in order to quantify many of the concepts studied.

PREREQUISITES:	PHYS 221
COREQUISITES:	PHYS 381 recommended
PRE or COREQUISITES:	

SYNONYMOUS COURSE(S):

(a) Replaces:

(b) Cross-listed with:

(c) Cannot take: for further credit.

SERVICE COURSE TO: *(department/program)*

TOTAL HOURS PER TERM: 75

STRUCTURE OF HOURS:

Lectures:	60	Hrs
Seminar:		Hrs
Laboratory:	15	Hrs
Field experience:		Hrs
Student directed learning:		Hrs
Other (specify):		Hrs

TRAINING DAY-BASED INSTRUCTION:

Length of course:

Hours per day:

OTHER:

Maximum enrolment: **24**

Expected frequency of course offerings: annually

(every semester, annually, every other year, etc.)

WILL TRANSFER CREDIT BE REQUESTED? (lower-level courses only)	☒ Yes	☐ No
WILL TRANSFER CREDIT BE REQUESTED? (upper-level requested by department)	☐ Yes	☐ No
TRANSFER CREDIT EXISTS IN BCCAT TRANSFER GUIDE:	☐ Yes	☐ No

Course designer(s):	**Jeff Chizma, Carmen Herman**		
Department Head:	**Norm Taylor (2011) Derek Harnett (2012)**	Date approved:	**December 6, 2011**
Supporting area consultation (Pre-UEC)		Date of meeting:	**February 17, 2012**
Curriculum Committee chair:	**David Fenske**	Date approved:	**May 18, 2012**
Dean/Associate VP:	**Ora Steyn**	Date approved:	**June 1, 2012**
Undergraduate Education Committee (UEC) approval		Date of meeting:	**June 22, 2012**

LEARNING OUTCOMES:

Upon successful completion of this course, students will be able to:

- apply the relationship between frequency, velocity, and wavelength of waves to various situations
- solve the wave equation for various boundary conditions in one dimension
- distinguish the difference between standing and traveling waves
- derive both plane wave and spherical wave solutions from the wave equation, and apply them to diffraction
- describe the difference between transverse and longitudinal waves, and identify examples of both
- utilize the concepts of interference and superposition of waves to perform specific calculations
- perform calculations involving the relationship between power and intensity of sound waves
- demonstrate a knowledge of Huygens principle, and be able to apply it to simple situations
- perform basic calculations for simple optical systems involving the reflection, refraction and diffraction of light
- understand that a wave equation can be derived from Maxwell's equations in free space
- apply de Broglie's hypothesis to understand the basic implications of matter waves

METHODS: *(Guest lecturers, presentations, online instruction, field trips, etc.)*

This course is primarily lecture-based, but laboratory experiments will be performed on a bi-weekly basis in order to both help students understand the lecture material, and gain a better insight into the physical processes involved.

METHODS OF OBTAINING PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):

☒ Examination(s) ☐ Portfolio assessment ☐ Interview(s)

☒ Other (specify): Evidence of industrial or related experience with sufficient overlap to the course material.

☐ PLAR cannot be awarded for this course for the following reason(s):

TEXTBOOKS, REFERENCES, MATERIALS: *[Textbook selection varies by instructor. Examples for this course might be:]*

Waves and Oscillations: A Prelude to Quantum Mechanics, Walter Fox Smith, Oxford University Press (2010)
Vibrations and Waves, A.P. French, W. W Norton & Company (1971)

SUPPLIES / MATERIALS:

STUDENT EVALUATION: *[An example of student evaluation for this course might be:]*

Assignments	30%
Laboratory Experiments	10%
Term Test	20%
Final Exam	40%

COURSE CONTENT: *[Course content varies by instructor. An example of course content might be:]*

1. Review and Extension of Harmonic Motion
   - Basic equation of SHM with real and complex solutions, mass on a spring, simple pendulum, physical pendulum, torsion oscillators, buoyant oscillations (cork bobbing in water), coupled oscillators
2. Continuous Media
   - Stress and strain, elastic deformations and Young's modulus, derivation of the wave equation for a 1 dimensional string, relationship between frequency, velocity and wavelength, energy carried by a wave
3. Solutions to the 1 D Wave Equation
   - Boundary conditions for standing waves and the quantization of frequency, boundary conditions for traveling waves between different media, reflection and transmission coefficients, superposition and interference, beats, wave packets and Fourier series, group and phase velocities
4. Sound
   - Sound as a 3D longitudinal pressure wave, bulk modulus and the velocity of sound, simple musical instruments, beats, Doppler shift, power and intensity of sound waves, sonar, noise cancellation
5. More Properties of Waves
   - Huygens principle, reflection and refraction, diffraction from: single slit, double slit and multiple slits

6. Wave Optics
   - 3D wave equation from Maxwell's equations, polarization, law of reflection, index of refraction, Snell's law, total internal reflection, dispersion, presentation of lens and mirror equations, real and virtual images, magnification, examples of simple optical systems, Doppler shift of light
7. Matter Waves
   - Planck and de Broglie's hypotheses, energy and momentum quantization, quantum theory and the simplified hydrogen atom, Balmer series, derivation of the Schrödinger equation and the introduction of the wavefunction

LABORATORY EXPERIMENTS: *(an example of possible experiments to be performed are as follows)*

1. Periodic Motion
2. Resonance in an Air Column
3. Standing Waves
4. Interference of Sound and Light
5. Geometric Optics and the Thin Lens Equation
6. Diffraction of Light

Spectral Analysis