OFFICIAL UNDERGRADUATE COURSE OUTLINE (page 1)

COURSE IMPLEMENTATION DATE:	January 1995
COURSE REVISED IMPLEMENTATION DATE:	May 2014
COURSE TO BE REVIEWED:	May 2020
(six years after UEC approval)	*(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 402	Faculty of Science / Physics	3
COURSE NAME/NUMBER	FACULTY/DEPARTMENT	UFV CREDITS

Advanced Optics
COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

Overview of geometric and physical optics, Fermat's principle of least time, index of refraction, dispersion, Snell's law, and the reflection and refraction of light from arbitrary shaped surfaces; lenses and mirrors, magnifiers, microscopes and telescopes, the human eye and corrective lenses; Maxwell's equations and the wave nature of light, interference and diffraction, Fourier optics, polarization, and the Jones calculus.

Note: Students with credit for PHYS 302 cannot take this course for further credit.

PREREQUISITES:	(PHYS 222) or (PHYS 105, 112, and 221). Note: As of May 2015, prerequisites will change to the following: PHYS 225 and PHYS 312.
COREQUISITES:	
PRE or COREQUISITES:	PHYS 351 recommended.

SYNONYMOUS COURSE(S):

(a) Replaces: **PHYS 302**
(b) Cross-listed with:
(c) Cannot take: **PHYS 302** for further credit.

SERVICE COURSE TO: *(department/program)*

TOTAL HOURS PER TERM: **75**

STRUCTURE OF HOURS:

Lectures:	**75**	Hrs
Seminar:		Hrs
Laboratory:		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: Every 2 years
(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):	**R. Woodside; revised P. Mulhern 2013 - Revised by Jeff Chizma**		
Department Head:	**Derek Harnett**	Date approved:	**August 26, 2013**
Campus-Wide Consultation (CWC)		Date of meeting:	**September 27, 2013**
Curriculum Committee chair:	**David Fenske**	Date approved:	**October 18, 2013**
Dean/Associate VP:	**Lucy Lee**	Date approved:	**October 18, 2013**
Undergraduate Education Committee (UEC) approval		Date of meeting:	**January 31, 2014**

LEARNING OUTCOMES:

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

- State Fermat's principle of least time, and apply it using the Calculus of Variations
- Derive the laws of reflection and refraction using: ray optics, Huygens principle, Quantum theory, and boundary conditions on Maxwell's equations
- Apply Snell's law and the law of reflection to arbitrary shaped surfaces
- Use simple ray tracing to describe the concept of dispersion from a prism
- Derive the equations relating objects and images for spherical lenses and mirrors in the paraxial approximation, as well as understand the limitation of these equations and potential issues like spherical aberration
- Solve problems involving multiple optical elements, and be able to correct for chromatic aberration of lenses
- Understand the physics of the eye, and be able to make basic corrections using eyeglasses
- Solve Maxwell's equations for both plane and spherical waves, describe evanescent waves, and derive the Fresnel equations to understand Brewster's angle
- Use the Jones calculus to describe polarization, and apply it to optical systems (quarter wave plate, polarizer)
- Describe the basics of coherence and interference, and understand the operation of interferometers
- Know the difference between Fraunhofer and Fresnel diffraction, and be able to apply scalar diffraction theory to various aperture shapes
- Understand the basic operation of a laser, and be familiar with the Einstein A and B coefficients
- Explain how laser beams and interference are used in holography

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

The course will be taught using lectures, demonstrations, and computer simulations. Problems will be assigned and marked on a regular basis.

METHODS OF OBTAINING PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):

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

☒ Other (specify): Please see the Physics PLAR policy on the department's webpage.

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

TEXTBOOKS, REFERENCES, MATERIALS:

[Textbook selection varies by instructor. An example of texts might be:]

Optics, 4th ed.; E. Hecht; Addison Wesley (2001)

SUPPLIES / MATERIALS:

STUDENT EVALUATION:

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

Assignments:	30%
Term test:	20%
Project or presentation:	10%
Final exam:	40%

COURSE CONTENT:

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

1. **Overview of the Propagation of light**
   - Wave, particle, and ray descriptions of light, derivations of the laws of reflection and refraction (Snell's law), total internal reflection, critical angle, Fermat's principle of least time, index of refraction, dispersion, Huygen's principle, plane and spherical waves

2. **Geometrical Optics**
   - Application of Snell's law to reflection and refraction from plane and spherical surfaces, paraxial approximation and thin lenses, ray tracing, multiple lens systems, reflection and refraction from arbitrary shaped surfaces, magnification, simple optical systems (eye, telescopes, microscopes, eye glasses).

Course Content continued:

3. Vector Nature of Light and Polarization

- The electromagnetic description of light, Brewster's angle, Fresnel equations, evanescent waves, frustrated total internal reflection, linear polarization, circular and elliptical polarizations, polarizers, Jones calculus

4. Coherence and Interference

- Coherence time and length, visibility of fringes and partial coherence, linear superposition, Young's experiment, interferometers (Michelson, Fabry-Perot), diffraction gratings, multiple beam interference with applications to holography

5. Diffraction and Fourier Optics

- Theory of scalar diffraction: Fresnel (near field) diffraction, Fraunhofer (far field) diffraction patterns and Fourier transforms, apodization and spatial filtering

6. Lasers

- Derivation of the Einstein A and B coefficients, population inversions, types of lasers (pulsed and continuous), solid state lasers, gas lasers, dye lasers