OFFICIAL UNDERGRADUATE COURSE OUTLINE (page 1)

COURSE IMPLEMENTATION DATE:	September 1992
COURSE REVISED IMPLEMENTATION DATE:	May 2014
COURSE TO BE REVIEWED: *(six years after UEC approval)*	May 2020 *(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 351	Faculty of Science/Physics	3
COURSE NAME/NUMBER	FACULTY/DEPARTMENT	UFV CREDITS

Quantum Mechanics

COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

Quantum theory and the Planck-deBroglie hypotheses, wave-particle duality, uncertainty principle; operators and the Schrödinger equation, statistical interpretation of the wavefunction, solutions for simple one dimensional potentials; position, momentum and energy representations, Dirac Bra-Ket notation, Hilbert space; Coulomb potential and the hydrogen atom, angular momentum and spin.

PREREQUISITES:	PHYS 252. Note: As of May 2015, prerequisites will change to the following: PHYS 225.
COREQUISITES:	
PRE or COREQUISITES:	PHYS 381, PHYS 382, or 383 (20th Century Physics Group of experiments) strongly recommended. Note: As of May 2015, pre or corequisites will change to the following: PHYS 381

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:	**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: Once 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):	**Tim Cooper; revised Derek Harnett;** 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 the origins and implications of the wave-particle duality
- Explain the statistical interpretation of quantum mechanics and the origin of the Schrödinger equation
- Solve the 1 dimensional Schrödinger equation for various potentials
- Evaluate expectation values of various quantities using normalized solutions
- Provide interpretations of statistical results as related to positions and momenta
- Work with the Dirac notation and demonstrate a knowledge of Hilbert space
- Utilize the uncertainty principle to make estimates of energy, lifetimes etc.
- Write out the Schrödinger equation as well as basic energy relations for well-known potentials
- Set up and solve the Schrödinger equation for the Hydrogen atom
- Demonstrate a knowledge of angular momentum and spin as related to particles
- Show how the periodic table of the elements can be explained via the Pauli principle
- Discern the difference between Bosons and Fermions and their properties

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

This course will be taught using lectures, demonstrations, seminars, and student projects. 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 for this course might be:]

Texts:
David J. Griffiths, Introduction to Quantum Mechanics (Ed. 2), Addison-Wesley

Optional texts:
Quantum Mechanics with Basic Field Theory. Desai, Bipin; Cambrige (2010)
Albert Messiah, Quantum Mechanics, Dover Publications

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. **Review of Waves and Quantum Theory**
    - Wave equations, standing and traveling wave solutions, interference, DeBroglie and Planck hypotheses, wave-particle duality, Bohr atom
2. **Basic Concepts of Probability and Statistics**
    - Mean/ averages, standard deviation and variance, statistical distributions, normalization

Course Content continued:

3. **Schrödinger Equation and the Wavefunction**
   - Motivation for the Schrödinger equation, interpretation of the wavefunction, position, momentum and energy operators, expectation values, uncertainty principle
4. **Time Independent One Dimensional Schrödinger Equation**
   - Stationary solutions and the separation of variables, potential barrier, infinite and finite potential wells, energy quantization, harmonic potential, Hermite polynomials, free particle solutions, Dirac delta function, wave packets and superposition
5. **Hilbert Space and Quantum Formalism**
   - Finite and infinite vector spaces, orthonomality, inner product, Dirac notation, Hermitian and Unitary operators, observables, wave packets, uncertainty principle, commutators, raising and lowering operators, eigenvalues and eigenstates
6. **Time Independent Schrödinger Equation in Three Dimensions**
   - Separation of variables, Cartesian equations, radial and angular equations, angular momentum, Legendre polynomials and the spherical harmonics, spherical well, Hydrogen atom and Laguerre polynomials, energy levels
7. **Spin and Identical Particles**
   - Spin and fundamental angular momentum, Stern-Gerlach experiment, magnetic dipole moment, Pauli matrices, commutation relations, spin addition, identical particles, Fermions, Bosons, exchange force, Pauli exclusion principle, simple explanation of the periodic table