09-11f.

LSC Use Only No: LSC Action-Date:	UWUCC USE Only No. Date: ~~08-74f.~~	UWUCC Action-Date: AP-11/10/09	Senate Action App 1/26/10

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person **A. J. Haija**	Email Address **haija@iup.edu**
Proposing Department/Unit **Physics Department**	Phone **7 - 4589**

Check all appropriate lines and complete information as requested. Use a separate cover sheet for each course proposal and for each program proposal.

1. Course Proposals (check all that apply)

_____ New Course _____ Course Prefix Change _____ Course Deletion

_X_ Course Revision _X_ Course Number and/or Title Change _X_ Catalog Description Change

PHYS 473/561 Quantum Mechanics I	**PHYS 461/561 Quantum Mechanics I**
***Current* Course prefix, number and full title**	***Proposed* course prefix, number and full title, if changing**

2. Additional Course Designations: check if appropriate

_____ This course is also proposed as a Liberal Studies Course.
_____ This course is also proposed as an Honors College Course.
_______ Other: (e.g., Women's Studies, Pan-African)

3. Program Proposals

_____ Catalog Description Change _____ Program Revision
____ New Degree Program ______ Program Title Change ______ Other
____ New Minor Program ______ New Track

Current program name	*Proposed program name, if changing*

4. Approvals

		Date
Department Curriculum Committee Chair(s)	[signature]	4/6/09
Department Chair(s)	[signature]	4/6/09
College Curriculum Committee Chair	[signature]	04/06/09
College Dean	John D. Eck	04/06/09
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate: (include title)		
UWUCC Co-Chairs	Gail S Sechrist	11-10-09

* where applicable

Part II: SYLLABUS OF RECORD

PHYS 461/561 – Quantum Mechanics I

I. Catalog Description

PHYS 473: Quantum Mechanics I 3c-01-3cr
Prerequisite: PHYS 331 and MATH 241

Quantum mechanics following methods of Schrodinger and Heisenberg; application to harmonic oscillator; three dimensional Schrodinger equation; hydrogen atom; electron in a magnetic field – normal and anomalous Zeeman effect; Spin.

II. Course Outcomes

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

1. Describe what the Schrodinger wave equation is and how it can be solved for simple cases (e.g., a particle moving under no external influence (zero-potential) and particle moving under external influence).
2. Explain the basic properties of the sets of wave-functions (ψ_n) belonging to the eigen-states (E_n) (e.g., normalization, orthogonality, expectation values, completeness, etc.)
3. Apply Schrodinger equation to solve one dimensional quantum mechanical problems (e.g., step potential, finite potential barrier; square well in one dimension, etc.)
4. Solve the harmonic oscillator problem using the polynomial and operator methods
5. Apply Schrodinger equation to solve quantum mechanical problems in three-dimensional systems with non-zero potential (using rectangular and spherical coordinates).
6. Describe the quantum mechanical operators for the components of the angular momentum in spherical polar coordinates and in matrix form
7. Apply Schrodinger equation to solve the allowed electron energies and wave functions in hydrogenic atoms.
8. Determine the Zeeman splitting of energy levels in a uniform and non uniform magnetic fields.

III. Detailed Course Outline

1. Review of pre-quantum mechanics (3 academic hours)
   - Planck's radiation law
   - deBroglie duality principle
   - Wave nature of particles and particle's nature of waves.
   - Bohr's atomic Model

2. Schrodinger Equation (4 academic hours)
   - Wave function and its properties.
   - Principles of quantum mechanics.
   - Quantum mechanics Operators and properties of operators.
   - Physical observables and linear operators
   - Hermitian operators

3. One dimensional Quantum Mechanical Systems (7 academic hours)
   - Infinite square well.
   - Finite square well
   - Step potential

4. Harmonic Oscillator (8 academic hours)

- Schrodinger equation for a harmonic oscillator
- Solution of Schrodinger equation using polynomial method.
- Solution of Schrodinger equation using the operator method

5. Schrodinger Equation in Three Dimensions- Spherical Polar coordinates (8 academic hours)
    - Separation of variables method
    - Angular momentum and its components in differential forms.
    - Angular momentum and its components in operator forms.
    - Angular momentum matrices.

6. The hydrogen Atom (7 academic hours)
    - Solution of Schrodinger equation for the hydrogen atom.
    - Derivation of azimuthal, polar, and radial wave functions.
    - Principal, angular momentum, and magnetic quantum numbers.
    - Energy schematics of the hydrogen atom.
    - Normal Zeeman effect.

7. Anomalous Zeeman effect (3 academic hours)
    - Spin – concept and quantization
    - Magnetic spin quantum number.
    - Energy splitting in a non uniform magnetic field
    - Pauli exclusion principle.

Two Class Tests (2 academic hours)

Final exam (during final exam week)

IV. Grading Scale

The standard grading scale will be followed

A: (90 – 100)%; B: (80 – 89)% ; C: (70 – 79)%; D: (60 – 69)%; F: below 60%

V. Evaluation Methods

Class Activity - Homework	(20 %)
Two exams	(50 %)
Final exam	(30 %)

VI. Required Textbooks

Potential Textbooks include but are not limited to:

1. Quantum Mechanics– Concepts and Applications, By Nouredine Zettili, John Wiley, New York, 2005.
2. Quantum Mechanics By Amit Goswami, 2nd ed, Waveland Press, Inc, Long Grove, Illinois, 2003.
3. Introduction to Quntum Mechanics, 2nd edition,, by David Griffiths, Pearson/Prentice Hall, NJ 2005.

VII. Attendance Policy

The attendance policy will conform to IUP's undergraduate course attendance policy.

VIII. Special Resource Requirements

None

IX. Bibliography

1. Quantum Theory, David Bohm, Prentice-Hall, Inc., New York, 1951
2. Quantum Mechanics By John Powell and Bernd Crasemann, Addison Wesley Publishing Company, Reading, Massachusetts, 1961
3. Introduction to the Quantum Theory. David Park, McGraw Hill, 1964
4. Modern Physics & Quantum Mechanics, Elmer Anderson, W. B. Saunders Co., 1971.
5. Lectures on Quantum Mechanics By Gordon Baim, The Benjamin/Cummings Publishing Co, Reading, Massachusetts, 1978.
6. An Introduction to Quantum Physics By A. P French, W. W. Norton & Company, Inc, 1978
7. Understanding Quantum Physics By Michael Morrison, Prentice Hall, NJ, 1990
8. Quantum Mechanics By Amit Goswami, 2nd ed, Waveland Press, Inc, Long Grove, Illinois, 2003.
9. Quantum Physics 3rd edition By Stephen Gasiorowicz, John Wiley, 2003.
10. Introduction to Quntum Mechanics, 2nd edition,, by David Griffiths, Pearson/Prentice Hall, NJ 2005.
11. Fundamentals of Quantum Mechanics By Sakir Erkoc, Taylor & Francis, New York, 2007.
12. Quantum Mechanics By Bruce Cameron Reed, Jones and Barlett, Boston, 2008.

1. SUMMARY OF PROPOSED REVISIONS

(i) Course description as well as course number were changed. The course number was changed so the undergraduate and dual level graduate numbers match.
(ii) Number of credit hours is being reduced from 4 to 3,
(iii) Course objectives phrased in a student centered way.

2. Justification/Rationale for Revision:

As part of the revision in the Physics program all majors courses were kept at 3 credit – to facilitate scheduling and timely graduation of students. Many courses will be offered in alternate years following a course sequence sheet that makes class size large enough for the size of our program.

3. The Old Syllabus of Record:

The Old Syllabus of record could not be found in the department archives. In its place, we have the classroom syllabus from the instructor who most recently taught the class.

1. An Introduction Into The Schrodinger Equation
   - 1.1 Modern Physics As a prelude to Quantum Mechanics
   - 1.2 Bohr's Atom
   - 1.3 The Correspondence Principle
   - 1.4 The Uncertainty Principle
   - 1.5 The probability Interpretation
   - 1.6 Particle In a Box
   - 1.7 The probability Current

2. Wave Packets

2.1 Gaussian Wave Packets
2.2 Application of The Uncertainty Principle To Gaussian Wave Packets
2.3 Group And Phase Velocities

3. Eigen Value Eigen Function Equation
3.1 Postulates of Quantum Mechanics
3.2 Linear Operators
3.3 Commuting operators
3.4 Hermitian Operators
3.5 The Momentum, The Kinetic Energy, and Position Operators
3.6 Measurement And Expectation Values

4. One Dimensional Quantum Mechanical Systems
4.1. Rigid Box Revisited
4.2 Finite square Potential Well
4.3 Square Barrier
4.4 Step potential

5. The Harmonic Oscillator
5.1 Solution of The Harmonic Oscillator Using The Polynomial Method
5.2 Dirac Bra and Ket notation
5.3 Position Representation
5.4 Solution of The Harmonic Oscillator Using Dirac's Notation

6. The Angular Momentum
6.1 The Eigenvalue Problem
6.2 Coordinate Transformation
6.3 Spherical Harmonics
6.4 The Operator Method
6.5 Angular Momentum Matrices
6.6 Raising And Lowering Angular Momentum Matrices

7. Central Potentials
7.1 Reduction of Two-Body to One-Body Problem
7.2 Separation of Variables
7.3 Solution of the Radial andAngular Equations

8. The Hydrogen Atom
8.1 Solution Of The Radial Equation for The Coulomb Field
8.2 Associated Laguerre Polynomials
8.3 Legendre Polynomials

9. Approximation Methods For Stationary States
9.1 Timer Independent Perturbation Theory
9.2 The Anharmonic Oscillator
9.3 Stark Effect

10. Zeeman Effect
10.1 Normal Zeeman Effect
10.2 Anomalous Zeeman Effect

Appendix for Graduate Course

I. Catalog Description

PHYS 561 Quantum Mechanics 3c-01-3cr
Prerequisite: permission of the Physics Department

Quantum mechanics following methods of Schrodinger and Heisenberg; application to harmonic oscillator; three dimensional Schrodinger equation; hydrogen atom; electron in a magnetic field – normal and anomalous Zeeman effect; Spin.

II. Course Outcomes

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

1. Use the Schrodinger wave equation so solve for simple Quantum mechanical systems.
2. Explain the basic properties of the sets of wave-functions (ψ_n) belonging to the eigen-states E_n
3. Use the Schrodinger equation to solve one dimensional quantum mechanical problems
4. Solve the harmonic oscillator problem using the polynomial and operator methods
5. Apply Schrodinger equation to solve quantum mechanical problems in three-dimensional systems with non-zero potential (using rectangular and spherical coordinates).
6. Describe the quantum mechanical operators for the components of the angular momentum in spherical polar coordinates and in matrix form
7. Apply Schrodinger equation to solve the allowed electron energies and wave functions in hydrogenic atoms.
8. Determine the Zeeman splitting of energy levels in a uniform and non-uniform magnetic fields.
9. Apply the theory used and discussed in this class to current research topics in physics.

III. Additional Material for Graduate students

Although graduate students receive the same number of credits as undergraduates additional work is required of all graduate students. The extra work may take the form of (i) additional assignments of more challenging problems, (ii) extra readings of original works of scholarship, (iii) extra computer-based problems (iv) a term paper on one or more of the significant themes of Quantum Mechanics (e.g., fundamental postulates of Quantum Mechanics or linear operators in Quantum Mechanics).

Graduate students will be required to show a greater degree of analysis, synthesis and evaluation of knowledge as well as, in presenting their results, greater independence than undergraduates. The instructor will make final judgment on the quality of their work.

IV. Evaluation Methods

Class Activity and homework - Graduate students will be assigned extra problems above the undergraduate level	20 %
Two exams - Graduate students will be given an extra problem or problems above the undergraduate level	50%
Final exam - Graduate students will be assigned an extra problem above the undergraduate level.	30%

V. Example Grading Scale

The standard grading scale will be followed

A: (90 – 100)%; B: (80 – 89)% ; C: (70 – 79)%; F: below 60%

Letter from registrar stating that PHYS 461 has not been used before.

Friday, April 3, 2009 1:22 PM
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Subject: PHYS 461
Date: Wednesday, April 1, 2009 1:11 PM
From: Marcy Rearick <MREARICK@iup.edu>
To: Stanley Sobolewski <sobolews@iup.edu>

Stan,
PHYS 461 is an available number.
Thanks for inquiring.

Marcy