CGS Agenda Item:18-01
Effective Fall 2019

Eastern Illinois University
New Course Proposal
PHY 4855, Quantum Mechanics

Banner/Catalog Information (Coversheet)

1. **_x New Course or_____Revision of Existing Course**
2. **Course prefix and number:**_____PHY 4855_____
3. **Short title:**_____Quantum Mechanics_____
4. **Long title:**_____Quantum Mechanics_____
5. **Hours per week:** _3_ Class 0_ Lab _3_ Credit
6. **Terms:** _X Odd years___Fall ____Spring ____Summer ____On demand
7. **Initial term**: X_ Fall ____Spring ____Summer Year: _2019_____
8. **Catalog course description:** _ Wave functions, probabilities, spin, the uncertainty principle, and the exclusion principle will be discussed. The mathematical formalisms of Quantum Mechanics will be developed. The Schrödinger equation will be applied to one-, two-, and three-dimensional problems including the square well, the harmonic oscillator, and the hydrogen atom.
9. **Course attributes: N/A**

   General education component: _____

   ____Cultural diversity____Honors_____Writing centered ____Writing intensive____Writing active

10. **Instructional delivery**
    Type of Course:

    _X_ Lecture ____Lab ____Lecture/lab combined ____Independent study/research

    ____Internship ____Performance ____Practicum/clinical____Other, specify: _____

    Mode(s) of Delivery:

    _X_ Face to Face ____Online ____Study Abroad

    ____Hybrid, specify approximate amount of on-line and face-to-face instruction_____

11. Course(s) to be deleted from the catalog once this course is approved. PHY 4850_____
12. **Equivalent course(s):**_____No equivalent courses_____

    a. **Are students allowed to take equivalent course(s) for credit?**_____Yes ____No

13. **Prerequisite(s):** PHY 1371, PHY 2450, and MAT 2443 Also MAT 3501 should be prerequisite or concurrent

    a. **Can prerequisite be taken concurrently?** _MAT 3501_ Yes _PHY 1371, PHY 2450, and MAT 2443_ No

    b. **Minimum grade required for the prerequisite course(s)? _C_**

c. Use Banner coding to enforce prerequisite course(s)? _X__Yes ___No

d. Who may waive prerequisite(s)?

___No one _X_ Chair ___Instructor ___Advisor ___Other (specify)

14. Co-requisite(s): _____

15. Enrollment restrictions N/A

a. Degrees, colleges, majors, levels, classes which may take the course: _____

b. Degrees, colleges, majors, levels, classes which may not take the course: _____

16. Repeat status: _X_ May not be repeated ___May be repeated once with credit

17. Enter the limit, if any, on hours which may be applied to a major or minor: _N/A___

18. Grading methods: _X_ Standard ___CR/NC __Audit ___ABC/NC

19. Special grading provisions:

___Grade for course will not count in a student's grade point average.

___Grade for course will not count in hours toward graduation.

___Grade for course will be removed from GPA if student already has credit for or is registered in: _____

___Credit hours for course will be removed from student's hours toward graduation if student already has credit for or is registered in: _____

20. Additional costs to students:
Supplemental Materials or Software_____N/A_____

Course Fee _X_No___Yes, Explain if yes_____

21. Community college transfer:

___A community college course may be judged equivalent.

_X_ A community college may not be judged equivalent.

Note: Upper division credit (3000+) will not be granted for a community college course, even if the content is judged to be equivalent.

Rationale, Justifications, and Assurances (Part I)

1. _X_Course is required for the major(s) of Physics, Computational Physics, Astronomy
   ___Course is required for the minor(s) of _____
   ___Course is required for the certificate program(s) of _____
   _X_ Course is used as an elective for Engineering Physics, Teacher Certification in Physical Sciences,
2. **Rationale for proposal**: During total redesign of the Physics Major this course is seen as critical to the subject. However, it must be reworked to accommodate the removal of PHY 3080 (a prerequisite for the previous Quantum Mechanics course) while maintaining the quality and integrity of the Physics curriculum.
3. **Justifications for (answer N/A if not applicable)**
   Similarity to other courses: N/A
   Prerequisites: To ensure that the students have the appropriate conceptual knowledge base prior to entry into the course. Also to ensure that the students have the appropriate mathematical skills to handle the mathematical rigor of the course.
   Co-requisites: N/A
   Enrollment restrictions: N/A
   Writing active, intensive, centered: N/A
4. **General education assurances (answer N/A if not applicable)**
   General education component: N/A
   Curriculum: N/A
   Instruction: N/A
   Assessment: N/A
5. **Online/Hybrid delivery justification & assurances (answer N/A if not applicable)**
   Online or hybrid delivery justification: N/A
   Instruction: N/A
   Integrity: N/A
   Interaction: N/A

Model Syllabus (Part II)

Please include the following information:

1. Course number and title **Quantum Mechanics**, Phys. 4855
2. Catalog description
   Catalog course description: Wave functions, probabilities, spin, the uncertainty principle, and the exclusion principle will be discussed. The mathematical formalisms of Quantum Mechanics will be developed. The Schrödinger equation will be applied to

one-, two-, and three-dimensional problems including the square well, the harmonic oscillator, and the hydrogen atom.

3. Learning objectives.

Course Learning Objective	University Learning Goals
A. Students will be able to construct normalized wave functions.	UG: CT-2, 3, WCR-5, QR-1, 2 Grad: 1
B. Students will be able to calculate probabilities from wave functions.	UG: CT-2, 3, QR-1, 2, RC-4 Grad: 1,2
C. Students will be able to calculate eigenvalues and eigenstates based on various potentials.	UG: CT-2, 3, 4, QR-1, 2 Grad: 1,2
D. Students will be able to mathematically manipulate wave functions and their interactions with operators.	UG: CT-2, 3, SL-7, QR-1, 2 Grad: 1,2
E. Students will be able to identify appropriate spherical harmonics, Hermite polynomials, and other solutions to the Schrödinger equation.	UG: CT-2, 3, 4, WCR-5, QR-2 Grad: 1,2
F. Students will be able to critically evaluate Quantum Mechanical word problems and write complete solutions to those problems.	UG: CT-2, 3, 4, 5, 6, WCR-1, 3, 4, QR-1, 2, RC-4 Grad: 2,3

4. Course materials.

The course begins with an introduction to the wavefunction & the Schrödinger equation which governs it. We will study solutions for a free particle & several simple 1-D potentials. We will then study Hilbert space & some other elements of the formalism of QM. Then the 3-D Schrödinger equation is developed & solved for several systems including the harmonic oscillator and the Hydrogen atom. Particle spin & the Exclusion Principle are developed.

Quantum mechanics is the most fundamental view that we have of the nature of physical reality.

Books: Introduction to Quantum Mechanics by Griffiths (2nd edition, 2005), Principles of Quantum Mechanics by Ohanian (1990), & Schaum's Outline, Quantum Mechanics. We will cover Ch. 1-5 of Griffiths & Ch. 12 of Ohanian. In every part of the course, you might want to look at the other books for alternative explanations.

5. Weekly outline of content.

Week 1: Introduction and basis for Quantum Mechanics
Week 2: Development of Wave Mechanics
Week 3: Probabilities in Wave Mechanics
Week 4: The Schrödinger Equation
Week 5: The Square Well and Step Potentials
Week 6: The Postulates of Quantum Mechanics
Week 7: Measurement Theory
Week 8: The Harmonic Oscillator
Week 9: Eigenvalues and Eigenstates

Week 10: Linear Vector Spaces – Hilbert Space
Week 11: Matrix Formalism
Week 12: The Wave Equation in 3 Dimensions
Week 13: Angular Momentum
Week 14: The Hydrogen Atom
Week 15: Spin
Week 16: Final Exam

6. Assignments and evaluation, including weights for final course grade.

Grading:

4 hour exams! 50%
final exam 25%
homework 25%
Total: 100%

Homework: There will be 10 homework assignments, due in class on the due date. Note that the due dates given on the syllabus may be only approximate; if we get behind, I'll announce new due dates in class. I will take off 25% for lateness after I have started grading that assignment, & 50% after I have finished. Homework will not be accepted after I have returned it to the class or posted the solutions. You must always show your work. At the end of the semester, I will drop your lowest homework grade.

You can get hints from classmates or from me (on Thursdays or any time), or from the physics tutors, but the work must ultimately be yours. Remember, homework is only 25% of the grade, & if you just copy down someone else's solutions, you won't be able to do the exams.

7. Grading scale.

Normally the grading scale is 90% – A, 80% – B, 70% – C, 60% – D, below 60% – F, & these boundaries will be shifted down by no more than about 1 percentage point at the end of the semester, depending on factors such as improvement & consistency. For graduate students, each exam including the final exam will contain at least one additional question of a more advanced nature.

8. Correlation of learning objectives to assignments and evaluation.

Learning Objectives	**Homework 25%**	**Exam 1 12.5%**	**Exam 2 12.5%**	**Exam 3 12.5%**	**Exam 4 12.5%**	**Final 25%**
Student will construct normalized wave functions.	X	X				X
Calculate Probabilities from Wave Functions.	X	X				X
Mathematically manipulate wave functions and their interactions with operators	X	X	X	X	X	X
Mathematically identify appropriate spherical harmonics, Hermite polynomials, and other solutions to	X		X	X	X	X

the Schrodinger equation.						
Critically evaluate Quantum Mechanical word problems and write complete solutions to those problems.	X	X	X	X	X	X

Date approved by the department or school: October 2, 2017
Date approved by the college curriculum committee: October 20, 2017
Date approved by the Honors Council ***(if this is an honors course): N/A***
Date approved by CAA: November 30, 2017 **CGS:**