CGS Agenda Item: 18-02
Effective Spring 2020

Eastern Illinois University
New Course Proposal
PHY 4865, Advanced Quantum Mechanics

Banner/Catalog Information (Coversheet)

1. **_x New Course or_____Revision of Existing Course**
2. **Course prefix and number:**_____PHY 4865_____
3. **Short title:**_____Advanced Quantum Mechanics_____
4. **Long title:**_____Advanced Quantum Mechanics_____
5. **Hours per week:** _3_ Class 0_ Lab _3_ Credit
6. **Terms:**___Fall _X_ Even years___Spring ____Summer ____On demand
7. **Initial term**:___Fall _X_ Spring ____Summer Year: _2020_____
8. **Catalog course description:** _ Advanced topics in Quantum Mechanics will be discussed. Applications of Quantum Mechanics are used as examples. Coupled angular momentum, time dependence, and perturbations are some of the topics covered.
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 4860_____
12. **Equivalent course(s):**_____No equivalent courses_____

    a. Are students allowed to take equivalent course(s) for credit?_____Yes ____No
13. **Prerequisite(s):** PHY 4855 and MAT 3501

    a. Can prerequisite be taken concurrently? No

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

    c. Use Banner coding to enforce prerequisite course(s)?_____Yes X_ No

d. Who may waive prerequisite(s)?

___No one _X_ Chair ___Instructor ___Advisor ___Other (specify)

14. Co-requisite(s): _____N/A_____

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: N/A

___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. ___Course is required for the major(s) of ___

   ___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, Physics, Computational Physics, and Astronomy options.

2. **Rationale for proposal**: During total redesign of the Physics Major this course is seen as important to the subject. However, it must be reworked to accommodate the other changes in the curriculum. This course will be offered on alternate years as the only elective available in a given semester. It will be the only pure elective for the entire cadre of concentrations in Physics. It is important for students considering graduate school.

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 **Advanced Quantum Mechanics**, Phys. 4865
2. Catalog description

Catalog course description: _ Advanced topics in Quantum Mechanics will be discussed. Applications of Quantum Mechanics are used as examples. Coupled angular momentum, time dependence, and perturbations are some of the topics covered.

3. Learning objectives.

Course Learning Objective	University Learning Goals
A. Students will be able 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
B. Students will be able to apply appropriate theoretical physical models to angular momentum states and solve related mathematical equations.	UG: CT-2, 3, QR-1, 2, RC-4 Grad: 1,2
C. Students will be able to identify appropriate approximation methods to solve complex Quantum Mechanical problems	UG: CT-2, 3, 4, QR-1, 2, CR-4 Grad: 1,2

4. Course materials.
We will cover various applications & approximations to the theory you learned in 4855, including time independent & dependent perturbation theory, the variational principle, the fine structure of hydrogen, the ground state of helium, & electromagnetic interactions. We will briefly discuss the Einstein-Podolsky-Rosen (EPR) & Schrödinger's cat paradoxes.
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 to and Review of Angular Momentum
Week 2: The Vector Model for Combining Angular Momentum
Week 3: Selection Rules
Week 4: Lande g Factor and the Zeeman Effect
Week 5: Clebsch-Gordon Coefficients
Week 6: Introduction to Approximation Methods
Week 7: Stationary State Perturbation Theory
Week 8: Applications of Perturbation Theory
Week 9: Time Dependent Perturbation Theory
Week 10: Hydrogen and Helium Atoms
Week 11: The Hydrogen Molecule
Week 12: Electromagnetic Interactions
Week 13: Partial Wave Approach to Scattering
Week 14: Scattering of Electrons by Atoms
Week 15: Einstein-Podolsky-Rosen (EPR) Paradox
Week 16: Final Exam

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

Grading:

lowest of 3 hour exams	12%
other 2 hour exams	48% (24% each)
final exam	25%
homework	15%
	100%

Homework: There will be 7 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. 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 elsewhere, but the work must ultimately be yours. It is highly recommended to take the time to really understand the homework problems; otherwise you won't do very well on 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 10%**	**Exam 1 20%**	**Exam 2 20%**	**Exam 3 20%**	**Final 30%**
Students will critically evaluate Quantum Mechanical word problems and write complete solutions to those problems	X	X	X	X	X
Students will apply appropriate theoretical physical models to angular momentum states and solve related mathematical equations.	X	X			X
Identify appropriate approximation methods to solve complex Quantum Mechanical problems.	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:**