California State University Channel Islands

NEW COURSE PROPOSAL

Courses must be submitted by October 15, 2012, and finalized by the end of that fall semester for the next catalog production.

Use YELLOWED areas to enter data.

DATE (*Change if modified and redate file with current date)*) OCTOBER13, 2012; REV 10.31.12

PROGRAM AREA(S) MATH AND APPLIED PHYSICS

1. Course Information. *[Follow accepted catalog format.]*

Prefix(es) (Add additional prefixes if cross-listed) **and Course No. PHYS 400**

Title: QUANTUM PHYSICS Units: 3

☑ Prerequisites Phys 306 for Applied Physics majors

☐ Corequisites

☑ Consent of Instructor Required for Enrollment for other majors

Catalog Description (Do not use any symbols): **Course overs the physical principles, mathematical techniques and interpretation of quantum theory. It takes an innovative approach to quantum physics by combining the essential elements of the theory with the practical applications. Applications include Raman spectroscopy, scanning tunnelling microscopy, quantum optics, quantum cryptography and quantum computing.**

Grading Scheme:

☑A-F Grades

☐ Credit/No Credit

☐ Optional (Student Choice)

Repeatability:

☐ Repeatable for a maximum of ☐ units

Total Completions Allowed ☐

☐ Multiple Enrollment in Same Semester

Course Level Information:

☑ Undergraduate

☐ Post-Baccalaureate/Credential

☐ Graduate

Mode of Instruction/Components (*Hours per Unit are defaulted*).

	Units	Hours per Unit	Benchmark Enrollment	Graded Component	CS & HEGIS # (Filled in by the Dean)
Lecture	3	1	25	X	
Seminar		1			
Laboratory		3			
Activity		2			
Field Studies					
Indep Study					
Other Blank					

Leave the following hours per week areas blank. The hours per week will be filled out for you.

3 hours lecture per week

hours blank per week

Is this course always delivered online? Yes_____ No_☑___

2. Course Attributes:

☐ **General Education Categories**: All courses with GE category notations (including deletions) must be submitted to the GE website: http://summit.csuci.edu/geapproval. Upon completion, the GE Committee will forward your documents to the Curriculum Committee for further processing.

A (English Language, Communication, Critical Thinking)

☐ A-1 Oral Communication

☐ A-2 English Writing

☐ A-3 Critical Thinking

B (Mathematics, Sciences & Technology)

☐ B-1 Physical Sciences

☐ B-2 Life Sciences – Biology

B-3 Mathematics – Mathematics and Applications
B-4 Computers and Information Technology

C (Fine Arts, Literature, Languages & Cultures)

C-1 Art
C-2 Literature Courses
C-3a Language
C-3b Multicultural

D (Social Perspectives)
E (Human Psychological and Physiological Perspectives)
UDIGE/INTD Interdisciplinary
Meets University Writing Requirement
Meets University Language Requirement

American Institutions, Title V Section 40404: Government US Constitution US History
Refer to website, Exec Order 405, for more information: http://senate.csuci.edu/comm/curriculum/resources.htm
Service Learning Course (Approval from the Center for Community Engagement must be received before you can request this course attribute).

3. Justification and Requirements for the Course. (Make a brief statement to justify the need for the course)

A. Justification: This course will become a requirement for the revised Applied Physics major (Technology emphasis). It can be also used an elective for the Math major. The course increases coverage of the applications of quantum theory at 400 level.

B. Degree Requirement:
☑ Requirement for the Major/Minor
Elective for the Major/Minor
Free Elective

Note: Submit Program Modification if this course changes your program.

4. Student Learning Outcomes. List in numerical order. Please refer to the Curriculum Committee's "Learning Outcomes" guideline for measurable outcomes that reflect elements of Bloom's Taxonomy: *http://senate.csuci.edu/comm/curriculum/resources.htm*. The committee recommends 4 to 8 student learning outcomes, unless governed by an external agency (e.g., Nursing).
Upon completion of the course, the student will be able to:

- interpret experiments displaying the wavelike behavior of matter, and explain how this motivates the need to replace classical mechanics by a wave equation of motion for matter
- compute probabilities, expectation values, uncertainties and time evolution using the Schrödinger equation
- explain the Zeeman affect and spin orbit coupling
- compute scattering cross sections using perturbation theory
- analyse the rotation-vibration spectrum or Raman spectrum of a diatomic molecule
- evaluate experimental results in terms of quantum physics
- demonstrate the role of quantum physics in laser physics, computer science and emerging technologies
- apply problem-solving skills to practical problems in quantum physics

5. Course Content in Outline Form. *[Be as brief as possible, but use as much space as necessary]*

The course begins with a wide-ranging introduction to the quantum revolution. It then develops Schrödinger's equation, together with the concepts of wave functions, expectation values and uncertainties. The equation can be used in various applications including quantum dots and vibrating molecules. The concept of a wavepacket is used to describe the classical limit of quantum mechanics. The quantum processes of tunneling, barrier penetration and reflection are discussed, together with their application to nuclear fusion, alpha decay, and the scanning tunneling microscope.

It shows how quantum states can be represented by vectors in a vector space, with observable quantities represented by operators acting on the vectors. This formalism is used to derive quantum mechanical conservation laws and to provide a proof of the uncertainty principle. The properties of orbital and spin angular momentum and the extraordinary properties of systems of identical particles, including Bose-Einstein condensation, are explored. The concept of quantum entanglement, and its applications to quantum information theory, quantum encryption and computing, and quantum teleportation are discussed.

Perturbation theory is developed to obtain approximate results in cases where exact calculations become difficult. The course covers multi-electron atoms and the Periodic Table, molecular binding and the behaviour of electrons in the energy bands of metals, insulators and semiconductors. It considers the interaction of matter with light, and how quantum physics can predict the lifetimes of atomic states and the brightness of spectral lines.

The mathematical techniques include complex numbers, separation of variables, integration, differential equations and eigenvalues, vector spaces, Hermitian operators and matrix algebra.

Does this course content overlap with a course offered in your academic program? **Yes** **No** ☑
If YES, what course(s) and provide a justification of the overlap.

Does this course content overlap a course offered in another academic area? **Yes** **No** ☑
If YES, what course(s) and provide a justification of the overlap.

Overlapping courses require Chairs' signatures.

6. Cross-listed Courses (*Please note each prefix in item No. 1)*

A. List Cross-listed Courses (Signature of Academic Chair(s) of the other academic area(s) is required).
List each cross-listed prefix for the course:

B. Program responsible for staffing:

7. References. *[Provide 3 - 5 references]*

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles. R. Eisberg and R. Resnick. John Wiley, 2nd ed

Quantum Mechanics: Concepts and Applications. N. Zettili, Wiley, 2009.

Quantum Physics I. MIT Open Courseware. (http://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2006/index.htm)

The Quantum World. Open University, SM 358. (http://www3.open.ac.uk/study/undergraduate/course/sm358.htm)

Modern Physics – Quantum Mechanics. Perimeter Institute.
(http://www.perimeterinstitute.ca/Outreach/Students/Modern_Physics_-_Quantum_Mechanics/)

8. Tenure Track Faculty Qualified to Teach This Course.

Dr. G. Dougherty; Dr. G. Wood

9. Requested Effective Date:
First semester offered: Fall 2014

10. New Resources Requested. Yes **No** ☑
If YES, list the resources needed.

A. Computer Needs (data processing, audio visual, broadcasting, other equipment, etc.)

B. Library Needs (streaming media, video hosting, databases, exhibit space, etc.)

C. Facility/Space/Transportation Needs

D. Lab Fee Requested (please refer to Dean's Office for additional processing) **Yes** **No**

E. Other

11. Will this new course alter any degree, credential, certificate, or minor in your program? Yes ☑ No
If, YES attach a program update or program modification form for all programs affected.
Priority deadline for New Minors and Programs: October 1, 2012 of preceding year.
Priority deadline for Course Proposals and Modifications: October 15, 2012, of preceding year.
Last day to submit forms to be considered during the current academic year: April 15th.

Dr.G. Dougherty	10/13/2012
Proposer of Course (Type in name. Signatures will be collected after Curriculum approval)	Date

Approval Sheet

Program/Course: Math and Applied Physics
If your course has a General Education Component or involves Center affiliation, the Center will also sign off during the approval process.

Multiple Chair fields are available for cross-listed courses.

The CI program review process includes a report from the respective department/program on its progress toward accessibility requirement compliance. By signing below, I acknowledge the importance of incorporating accessibility in course design.

Program Chair		
	Signature	Date
Program Chair		
	Signature	Date
Program Chair		
	Signature	Date
General Education Chair		
	Signature	Date
Center for International Affairs Director		
	Signature	Date
Center for Integrative Studies Director		
	Signature	Date
Center for Multicultural Engagement Director		
	Signature	Date
Center for Civic Engagement Director		
	Signature	Date
Curriculum Chair		
	Signature	Date
AVP		
	Signature	Date