Rowan College of New Jersey Senate Curriculum Committee

Approval Form

Proposal Title: Quantum Mechanics 702-389

Sponsor(s) Hong Yuan Liu Dept.: Chemistry and Physics Ext. [illegible]

[illegible]

Check one: ☒ Course ☐ Specialization ☐ Concentration ☐ Minor ☐ Achievement Certificate

☐ Certification Program ☐ Major Program ☐ Minor Change _____ (Please name deletion or credit/title/catalog change)

☐ Undergraduate ☐ Graduate ____ Credit Hours

Step 1 (Department)

☐ Approved _____ Date

☐ Not Approved

_____ Dept. CC Chairperson

☐ Reviewed _____ Date

_____ Dept. Chairperson

Step 2 (Receipt)

☒ SCC# [illegible]

Proposal Received _____ Date

_____ SCC Chairperson

Step 3 (School CC)

Reviewed 2-22-93

☒ Approved

☐ Not Approved

Comments:
Change "grant" to "project" on p1
Is course title "Quantum Physics" or "Quantum Mechanics"?

_____ School Curr. Comm. Chairperson

Step 4 (Academic Dean)

☒ Recommend

☐ Not Recommend

☐ Conditionally Recommend (see comments)

Reviewed _____ Date

Comments:

_____ Signature, Dean of School

Step 5 (SCC)

Open Hearing 4/2/93 Date ☐ Approved by Senate Curriculum Committee _____ Date

☐ Returned to sponsor(s) for the following reasons:

Step 6 (Senate)

Presented to Senate 4/30/93 Date ☐ Approved ☐ Not Approved

Notification to Executive Vice-President/Provost 4/30/93 Date

_____ Signature, SCC Chairperson

Step 7 (Executive V.P./Provost)

Received _____

Approved Yes / No

If no, reasons are as follows

Student credit hours 4

Faculty load hours _____

Equalized credit hours _____

Official copy and approval sheet filed 5/25/93
Date

Signature [illegible]

Registrar

Approved course description received 2 June 93
Date

Hegis Taxonomy and Course Number assigned 1902.389

B Z Kelsey
Signature Registrar

2 June 93
Date

Notification forwarded:

- ☐ Senate Curriculum Committee Chairperson
- ☐ Department Chairperson(s)
- ☐ Academic Dean(s)
- ☐ Registrar
- ☐ Sponsor(s)

Rev. 8-88 8007

Quantum Physics

1. Details:

Course Title:	Quantum Physics
Sponsors:	Hong Yuan Ling, Karen Magee-Sauer, Department of Chemistry and Physics
Credit Hours:	4 sh
Course Level:	Undergraduate: Junior/Senior
Curricular Effect:	Elective
Prerequisites:	1902.200 (or 1902.202), 1902.201 (or 1902.203), 1902.300 and 1701.131
Time of Implementation:	Fall 94
Adequacy of Resources:	Present faculty, facilities and library holdings are adequate.

2. Rationale:

The study of physics is a logical progression. The required curriculum is remarkably uniform from program to program not only on a national level, but on a international level as well. Students begin their study with introductory courses in Mechanics, Heat, Waves and Optics, Electricity and Magnetism, and Quantum Physics. They then take intermediate/advanced courses in these same five areas to complete the "core" of their program. The core of the program is usually covered by advanced courses in Mechanics, Electricity and Magnetism, Quantum Physics, and Statistical Physics. Upper level electives complement and expand on these five basic areas as well.

Our physics program at Rowan is part of a Physical Science degree with a Physics concentration. The selection of courses presently being taught and in the catalog are courses that the previous faculty (now retired) wanted to teach. Courses in Quantum Physics and Statistical Physics are not present in our current curriculum. As part of our commitment to the "Revising the Major" project (Association of American Colleges), we are trying to develop our Physics program into a program which has a logical progression of courses with milestones and a capstone. Presently our intermediate course offerings are a piecemeal of courses. We need to establish a solid core of intermediate/advanced level courses. We currently offer Mechanics and Electricity & Magnetism. We are developing new courses in Quantum Physics and Statistical Physics. In the future a capstone

experience will be submitted.

Quantum Physics solves the problems in physics where Newtonian (classical) physics fails. Quantum Physics is extremely successful in describing the behavior of matter on a microscopic scale. Its importance to our society has become even more evident since most new technology developed is based on the principles of Quantum Physics. A few examples of recent technology whose foundation is based on the laws of Quantum Physics are:

- Charged Coupled Device (CCD) which allows an image to be mapped into the memory of a computer
- Scanning Tunneling Microscope which maps the image atoms
- Lasers whose application ranges from printing to guided missiles

Quantum Physics is an integral part of the undergraduate curriculum in the study of physics. Since Quantum Physics is truly a core course for any physics program, we decided to require our majors to take Physical Chemistry (offered by the Chemistry faculty) until a Quantum Physics course was in place. This option is a "stopgap" measure. Physical Chemistry is the closest related course to Quantum Physics.

This course will introduce students to the study of Quantum Physics from three different perspectives: pure physics, solid state engineering, and physical chemistry. The students will learn concepts that revolutionized our view of the subatomic world. The student will also be introduced to the approaches and techniques relevant to the fundamental problems of Quantum Physics.

Thus, a course in Quantum Physics is not only interesting but necessary for a better understanding of the atomic, molecular, and nuclear systems. Majors and non-majors who take this course will benefit from such a study. This course is a required part of any physics program.

Quantum Physics will be offered as a physics elective. Majors will be strongly advised to take the course. In the future, when we have established the necessary courses to achieve our goals of "Revising the Major", we will require Quantum Physics as part of our intermediate milestone experience.

3. Essence of the course:

(a) Objectives:

After taking this course the student will be able to:

- Understand the foundation of the Quantum Physics and its necessity.

- Solve problems such as the finite square well, simple harmonic oscillator, and other simple potential energy functions.
- State and understand the implications of the Uncertainty Principle.
- Utilize the Schrodinger equation and understand eigenvalues and wavefunctions.
- Solve the hydrogen atom problem and its related quantum numbers, and extend these concepts to more complicated atoms.
- Use perturbation theory to solve problems, such as the probability of the atom making a transition from a high to low energy level.

(b) Topical Outline:
Possible text: Principles of Quantum Physics by Hans C. Ohanian.
The course will include the following selected topics:

1. The Origin of Quantum Physics
   Early Quantum Theory, Wave and Matrix Mechanics, Wave particle duality
2. The Free Particle in Wave Mechanics
   Wave Equation: Solution to the Free-Particle Wave Equation, Expectation Values, Momentum and Position as Operators, Measurement in Quantum Physics
3. Particles in Potentials
   Schrodinger equation with potential:Stationary states, The infinite and finite square well, the energy representation, barrier penetration
4. Axiomatic Formulation of Quantum Physics
   Operators, Eigenvectors, Compatible observables
5. Particles in three dimensions and angular momentum
   Free Particle, Harmonic Oscillator, The Hydrogen Atom
6. Spin and the exclusion principle
   Spin of the Electron, Magnetic Moment, Addition of Angular Momentum, Fermions and Bosons, Exclusion Principle, and the Periodic Table
7. Perturbation theory
   Time - independent Perturbations, Degenerate Perturbations, Time-dependent perturbations
8. Scattering and Resonance
   Elastic scattering in One Dimension, Scattering by a Square Well, Resonance

(c) Evaluation Procedures:
Students will be evaluated by homework, exams, class participation, and a final.

(d) Course Evaluations:

The departmental course evaluation form will be used at the end of the course.

4. Consultations

Consultation letters were sent to

Robert Newland, Chairman, Department of Chemistry and Physics

Pearl Bartelt, Dean, SLAS

Gary Itzkowitz, Chairman, Department of Mathematics

Catalog Description:

Quantum Physics 4 s.h

(Prerequisite: 1902.200 (or 1902.202), 1902.201 (or 1902.203), 1902.300 and 1701.131)

This course will serve as an intermediate course in Quantum Physics. Students will learn basic concepts in Quantum Physics as well as the approaches to problems that require the use of Quantum Physics. Topics selected for study include: Origin of Quantum Physics, Wave Mechanics, Axioms of Quantum Physics, Schrodinger Equation, Particles in Potentials, Spin and the Exclusion Principle, Angular Momentum, and Scattering.

Rowan College *of* New Jersey
Glassboro, New Jersey 08028-1701

MEMORANDUM

TO: Hong Yuan Ling, Ph.D.
Physical Sciences

FROM: Pearl W. Bartelt, Acting Dean
School of Liberal Arts & Sciences

DATE: February 22, 1993

SUBJECT: Quantum Mechanics

I am happy to endorse the proposal for the new course Quantum Mechanics. As one of the designated programs within the Association of American Colleges Projects on Reforming the Majors, I am very please that you are adding courses to allow students to go through a logical development of progression in the study of Physics.

Quantum Mechanics will also be important in the new Physics minor.

PWB/dts
c. R. Newland
M. Putman