C086

UNIVERSITY OF KENTUCKY
APPLICATION FOR NEW COURSE

1. Submitted by: **College of Arts and Sciences** October 6, 2003

   Department/Division offering course: **Physics & Astronomy**

2. Proposed designation and Bulletin description of this course:

   (a) Prefix and Number **PHY 616** (b) Title **Quantum Field Theory I**
   *NOTE: If the title is longer than 24 characters (including spaces), write a sensible title (not exceeding 24 characters) for use in transcripts:

   (c) Lecture/Discussion hours per week **3** (d) Laboratory hours per week

   (e) Studio hours per week (f) Credits **3**

   (g) Course description: **An introduction to field theory and many-body theory. Topics include path integral quantization,second quantization, relativistic field theory of bosons and fermions, Green's function and perturbation theory, field theories on the lattice, renormalization of scalar fields and applications to critical phenomena.**

   (h) Prerequisites (if any): **PHY 615, PHY 632**

   (i) May be repeated to a maximum of credits. (if applicable)

4. To be cross-listed as:
   Prefix & No. Signature, Chairman, cross-listing department

5. Effective Date: **Fall 2004** (semester and year)

6. Course to be offered (a) Fall **X** (b) Spring (c) Summer

7. Will the course be offered each year? (a) **Yes**
   (Explain if not annually):

8. Why is this course needed: **This course provides essential theoretical background for advanced graduate students in particle physics, nuclear physics and condensed matter physics. We offer a number of advanced level courses on the individual research specialties of the department. Often we do not have sufficient enrollment to justify offering these courses on a regular basis. Therefore, we have decided to drop four such courses (PHY 625, 629, 640, 756) and establish new courses meeting the needs of multiple research specialties in the department. PHY 616 (previously taught on an experimental basis as PHY 600) is such a course.**

9. (a) By whom will the course be taught? **Selected faculty in theoretical physics**

   (b) Are facilities for teaching the course now available? (a) **Yes**
   If not, what plans have been made for providing them?

ORIGINAL

10. What enrollment may be reasonably anticipated? **10**

11. Will this course serve students in the Department primarily? (a) **Yes** (b) No

Will it be of service to a significant number of students outside the Department? (a) Yes (b) **No**
If so, explain

Will the course serve as a University Studies Program course? (a) Yes (b) **No**

If yes, under what Area?

12. Check the category most applicable to this course:

_____ traditional; offered in corresponding departments elsewhere;

___**X**___ relatively new, now being widely established

_____ not yet to be found in many (or any) other universities

13. Is this course applicable to the requirements for at leas one degree or certificate at the University of Kentucky? (a) **Yes** (b) No

14. Is this course part of a proposed new program? (a) Yes (b) **No**
If yes, which?

15. Will adding this course change the degree requirements in one or more programs?* (a) Yes (b) **No**
If yes, explain the change(s) below:

16. Attach a list of the major teaching objectives of the proposed course, outline and/or reference list to be used.

17. If the course is a 100-200 level course, please submit evidence (e.g., correspondence) that the Community College System has been consulted.

18. Within the Department, who should be contacted for further information about the proposed course?
Name/e-mail: **Thomas H. Troland** Phone Extension: **7-8620**

*NOTE: Approval of this course will constitute approval of the program change unless other program modifications are proposed.

Signatures of Approval:

Department Chair	10-7-03 Date
Dean of the College	DEC 09 2003 Date
	NOV 21 2003 Date of Notice to the Faculty
*Undergraduate Council	Date
*University Studies	Date
*Graduate Council	3-19-04 Date
*Academic Council for the Medical Center	Date
*Senate Council (Chair)	Date of Notice to Univ. Senate

*If applicable, as provided by the Rules of the University Senate

ACTION OTHER THAN APPROVAL:

PHY 616 - Learning Objectives

1. Students will master topics in advanced quantum mechanics that are relevant to current research in theoretical particle physics, nuclear physics and condensed matter physics.
2. Students will understand the many-body Schrodinger equation and the concepts of second quantization of bosons and fermions.
3. Students will become acquainted with topics in special relativity that are applicable to quantum field theory.
4. Students will become acquainted with and be capable of explaining the Klein-Gordon equation, the Dirac equation, and discrete symmetries of Dirac theory.
5. Students will become familiar with perturbation theory and Feynman diagrams and be able to explain their applications to modern quantum theory.

PHY 616 - Course outline

Please see Course Syllabus (attached).

PHY 616 – List of references

Please see Course Syllabus (attached), section on textbooks.

PHY 600 : QUANTUM FIELD THEORY

Timings : Tuesdays and Thursdays 5:00 PM - 6:15 PM
Location: CP 297

Instructor : Sumit R. Das
Office : CP 377
Phone : 257-4686
E-Mail : das@pa.uky.edu

Office Hour : Fridays 2:00 - 3:00 PM

Exams

There will be no in-class exam. Grades will be decided on the basis of homework assigments and oral exams. In the oral exams, the student will be asked to work out and explain some of the home work problems and some related questions will be asked. This will be done twice, once during the week beginning October 20, and once during the week beginning December 15. These oral exams will last for about an hour each and may be arranged during mutually convenient times.

Course Syllabus

1. Phonons and field theory.
2. Many body Schodinger equation. Second quantization of bosons and fermions
3. Application to degenerate electron gas
4. Review of Special Relativity
5. Klein-Gordon equation. Necessity for field description. Quantization of free scalar field theory
6. Dirac equation. Quantization of free Dirac field. Discrete symmetries of Dirac theory.
7. Interactions. Correlation functions, S-matrix and cross sections
8. Perturbation theory and Feynman diagrams.
9. Elementary processes in Quantum electodynamics from Feynman diagrams.

Textbooks

Primary Textbook : M. Peskin and D. Schroeder, "An Introduction to Quantum Field Theory" (Perseus Books, 1995). This is an excellent introduction to methods in field theory with general applicability but with a slant towards applications in particle physics.

For students with a more condensed matter inclination the book by J.M. Ziman, "Elements of Advanced Quantum Theory" is an excellent introduction. This book also contains applications to nuclear physics.

- For part 2 I will use Fetter and Walecka, "Quantum Theory of Many Particle Systems"
- For a review of special relativity choose your favorite book,e.g. the chapter on Special Relativity in Jackson "Classical Electrodynamics".
- For parts 4-9 I will primarily use Chapters 2-5 of Peskin and Schroeder.

UNIVERSITY OF KENTUCKY

October 6, 2003

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To Whom it may concern:

The attached course applications are the product of many discussions in the Physics & Astronomy Department. These discussions concerned our offerings of advanced level graduate courses in the research specialties of our department.

A careful audit of enrollments in these courses over the last 15 years demonstrated that we offer more of them than our student population permits. Therefore, more than a year ago, we began to consider how these advanced courses might be consolidated, which courses might be dropped, and which had outdated course descriptions or prerequisites. As a result of these discussions, we decided to drop four existing courses (PHY 625, 629, 640, 756), create a new interdisciplinary physics course (PHY 616) and make a major change in another course (PHY 716) so it will become a sequel to PHY 616. Also, we decided to update the course descriptions and/or prerequisites to six existing courses (PHY 525, 591, 592, 600, 624, 632).

As the appropriate committees review these course applications, I ask them to bear in mind the following considerations:

- All courses included in this submission are graduate courses in advanced research topics. Changes in these courses do not affect our graduate core course requirements in fundamental physics, nor any other course requirements in our department nor any students outside our department.
- Apart from PHY 616 and 716, all proposed changes in course descriptions or prerequisites are minor in the sense that they will not affect the ways in which the courses are currently taught. Our goal with these minor changes is to update the course descriptions to reflect the evolution that has occurred in advanced subject matter over the course of a decade or more.

Sincerely,

T. Troland
Director of Graduate Studies
troland@pa.uky.edu

ARTS AND SCIENCES COLLEGE COUNCIL/CURRICULUM COMMITTEE

INVESTIGATOR REPORT

INVESTIGATING BODY **Nat. & Math Sci.** (Area) COURSE, MAJOR, DEGREE or PROGRAM PHY 6166 (department or college)

DATE FOR COUNCIL REVIEW **Dec. 9, 2003** CATEGORY: (NEW) CHANGE, DROP

INSTRUCTIONS: This completed form will accompany the course application to the Graduate/Undergraduate Council(s) in order to avoid needless repetition of investigation. The following questions are included as an outline only. Be as specific and as brief as possible. If the investigation was routine, please indicate this. The term "course" is used to indicate one course, a series of courses or a program, whichever is in order. Return the form to **David Leep Associate Dean, 231 Patterson Office Tower** for forwarding to the Council(s). ATTACH SUPPLEMENT IF NEEDED.

1. List any modifications made in the course proposal as submitted originally and why.

   None

2. If no modifications were made, review considerations that arose during the investigation and the resolutions.

   None

3. List contacts with program units on the proposal and the considerations discussed therein.

   None

4. Additional information as needed.

5. A&S **Area** A **Curriculum Committee** Recommendation:

   (APPROVE) APPROVE WITH RESERVATION, OR DISAPPROVE

6. A&S **Council** Recommendation:

   APPROVE, APPROVE WITH RESERVATION, OR DISAPPROVE

7. _____ Date: 09-DEC-03

   A&S Council Investigator, Tom Troland

File: \InvestigatorRpt