09-11i

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Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person W. Larry Freeman	Email Address wlf@iup.edu
Proposing Department/Unit Department of Physics	Phone 724-357-2370

Check all appropriate lines and complete information as requested. Use a separate cover sheet for each course proposal and for each program proposal.

1. Course Proposals (check all that apply)

__X__ New Course _____ Course Prefix Change _____ Course Deletion

_____ Course Revision _____ Course Number and/or Title Change _____ Catalog Description Change

	PHYS 401/501 Theoretical Physics
Current Course prefix, number and full title	*Proposed course prefix, number and full title, if changing*

2. Additional Course Designations: check if appropriate

_____ This course is also proposed as a Liberal Studies Course.

_____ This course is also proposed as an Honors College Course.

_____ Other: (e.g., Women's Studies, Pan-African)

3. Program Proposals

_____ Catalog Description Change _____ Program Revision

_____ New Degree Program _____ Program Title Change _____ Other

_____ New Minor Program _____ New Track

Current program name	*Proposed program name, if changing*

4. Approvals

		Date
Department Curriculum Committee Chair(s)	[signature]	4/6/09
Department Chair(s)	[signature]	4/6/09
College Curriculum Committee Chair	[signature]	04/06/09
College Dean	[signature]	04/07/09
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate: (include title)		
UWUCC Co-Chairs	Gail S Sechrist	11/18/09

• where applicable

II. SYLLABUS OF RECORD

PHYS 401/501 Theoretical Physics

I. Catalog Description

PHYS 401 Theoretical Physics 3c-01-3cr

Prerequisites: PHYS 131, 132: MATH 125, 126

Prerequisite or co-requisite: MATH 241, or permission of the physics department

Explores the applied mathematics necessary to solve ordinary and partial differential equations in closed and series forms for boundary value problems in intermediate and advanced physics. Coordinate transformations, tensor analysis, special functions and series involving complex variables and integral transforms are also considered.

II. Course Outcomes

Upon successful completion of this course students should be able to:

1. Apply intermediate (e.g., determinants, vector and tensor analysis) and advanced level of mathematical methods (e.g., Fourier analysis and differential equations) to solve problems of advanced physics.
2. Perform integral transforms to explain (i) the current-time variation in RLC circuit, and (ii) the normal modes of vibrations in coupled oscillators.
3. Apply complex variables to derive Kramers - Kronig dispersion relation used in Optics and Solid State Physics – relating the refractive part and the absorptive part of the refractive index at different frequencies.
4. Demonstrate the use of vectors and matrices to solve Eigen-value problems in one – and two – dimensional spring-mass systems (e.g., linear mono and diatomic chains; molecular vibrations of three mass-spring coupled system).

III. Detailed Course Outline

1. Coordinate Systems (9 academic hours)
   - A. Coordinate transformations
     1) Scalar and vector fields
     2) Properties of rotation matrices
     3) Matrix operations
     4) Cartesian tensors
     5) Applications in electrostatics
   - B. Tensor and Vector analysis
     1) Scalar product
     2) Vector product
     3) Unit (basis) vectors
     4) Tensor operations
     5) Applications in mechanics and modern physics
2. Complex Variables (6 academic hours)
   - A. Analytic functions
   - B. Laurent Series
   - C. The residue Theorem
   - D. Applications in electronics and fluid flow

Exam (1 academic hour)

3. Fourier Series (6 academic hours)
   1) General and sinusoidal functions
   2) Transient effects
   3) Applications in electric circuits and wave motion

4. Differential Equations (9 academic hours)
   A. Ordinary first and second order differential equations
   B. Partial first and second order differential equations
   C. Separation of variables
   D. Singular Points
   E. Series Solutions
      1) Frobenius method
      2) Legendre polynomial
      3) Hermite polynomials
      4) completeness
      5) eigen-values, eigen-functions
   F. Applications in mechanics, electronics, wave motion

Exam (1 academic hour)

5. Special Functions (6 academic hours)
   A. Gamma function
   B. Dirac delta function
   C. Error functions
   D. Applications in electrostatics and modern physics

6. Integral Transforms and Their Inverse (4 academic hours)
   A. Fourier transform
   B. Laplace transform
   C. Applications in diffusion, wave motion, electrostatics

Final Exam (2 hours)

IV. Evaluation Methods

The final grades for the course will be based upon the following:

50% Exams. A minimum of two fifty minute in-class examinations consisting of problem solutions or essay exercises.
20% One two hour final examination
30% Homework and class participation. Students are expected to participate in the classroom discussions.

V. Example Grading Scale

A	90%-100%
B	80%-89%
C	70%-79%
D	60%-69%
F	less than 60%

VI. Required Textbooks

Potential textbooks include but are not limited to:

Mathematical Methods for Physicists, H. Weber, and G. B. Arfken, Elsevier Academic Press, Amsterdam, 2005

Mathematical Methods for Physics and Engineering, K.F. Riley, M.P. Hobson, and S.J. Bence, Cambridge University Press, 2003

Mathematical Methods in the Physical Sciences 2nd ed., M. L. Boas, John Wiley & Sons, New York, 1983

VII. Attendance Policy

Attendance and enforcement thereof shall be in accord with the general guidelines provided in the official university "Undergraduate Course Attendance Policy".

VIII. Special Resource Requirements

Scientific calculator, Textbook, Notebook, paper, pen or pencil. No laboratory fee.

IX. Bibliography

NOTE: Even though these references have very old copyright dates, they are appropriate and suitable for this class.

1. Mathematical Physics, S. Hassani, Springer-Verlag, New York, 2000
2. Complex Variables, a Physical Approach, S. Krantz, Taylor & Francis Inc., London,2007
3. The Mathematics of Physics and Chemistry, H. Margenau, G. M. Murphy, D. Van Nostrand Co., Inc., New York, 1943
4. Mathematical Physics, E. Butkov, Addison Wesley, Reading Massachusetts, 1968
5. Vector and Tensor Analysis, N. Coburn, The MacMillan Co., New York, 1955 Inc, Reading, Massachusetts,
6. Operational Mathematics, R. V. Churchill, McGraw Hill Book Co, New York, London, 1958
7. Complex Variables and Applications, R. V. Churchill, McGraw Hill Book Co. Company., New York, London, 1960

Course Analysis Questionnaire

Section A: Details of the Course

A1 How does this course fit into the programs of the department? For what students is the course designed? **This course is required by all physics majors but may be attended by anyone who meets the prerequisites.** Explain why this content cannot be incorporated into an existing course. **The proposed course is part of a major curriculum revision proposed by the Department of Physics. There is no single existing course at the undergraduate level that covers the necessary material. The individual courses in which much of the mathematical physics is covered are two-semester sequence courses in mechanics, electricity and magnetism and quantum physics. Under the program revision the latter courses will be condensed into three one-semester courses, requiring some consolidation of the content. The emphasis of this new course will be on presenting some of the advanced methods and applications useful for analyzing problems in physics (e.g., in Mechanics, Thermodynamics, Electronics and Electricity & Magnetism).**

A2 Does this course require changes in the content of existing courses or requirements for a program? If catalog descriptions of other courses or department programs must be changed as a result of the adoption of this course, please submit as separate proposals all other changes in courses and/or program requirements. **This course is part of a curriculum revision (enclosed herein).**

A3 Has this course ever been offered at IUP on a trial basis (e.g. as a special topic) If so, explain the details of the offering (semester/year and number of students). **The proposed course has never been offered.**

A4 Is this course to be a dual-level course? If so, please note that the graduate approval occurs after the undergraduate. **The proposed course will be a dual level course.**

A5 If this course may be taken for variable credit, what criteria will be used to relate the credits to the learning experience of each student? Who will make this determination and by what procedures? **This course is a fixed credit course.**

A6 Do other higher education institutions currently offer this course? If so, please list examples (institution, course title). **Most higher learning schools offer similar courses: Shippensburg University, PHY 442 Math Physics, Temple University, PHYSICS 2502 Mathematical Physics**

A7 Is the content, or are the skills, of the proposed course recommended or required by a professional society, accrediting authority, law or other external agency? If so, please provide documentation. **No, there is no accrediting agency or organization for Physicists**

Section B: Interdisciplinary Implications

B1 Will this course be taught by instructors from more than one department? **No** If so, explain the teaching plan, its rationale, and how the team will adhere to the syllabus of record.

B2 What is the relationship between the content of this course and the content of courses offered by other departments? Summarize your discussions (with other departments) concerning the proposed changes and indicate how any conflicts have been resolved. Please attach relevant memoranda from these departments that clarify their attitudes toward the proposed change(s). **Physics by its nature is very mathematical; the content of this class seems to be mathematical in nature. However, while mathematics is used in physics, mathematics is not the same as physics. It is the use and application that differentiates mathematics from physics. Attached is a letter of support from the Mathematics Department.**

B3 Will this course be cross-listed with other departments? If so, please summarize the department representatives' discussions concerning the course and indicate how consistency will be maintained across departments. **N/A**

Section C: Implementation

C1 Are faculty resources adequate? **Resources are adequate. This course is being implemented as part of the Physics department rotation scheme, to make efficient use of resources.** If you are not requesting or have not been authorized to hire additional faculty, demonstrate how this course will fit into the schedule(s) of current faculty. What will be taught less frequently or in fewer sections to make this possible? **The following existing course sequences will be consolidated into single semester courses: PHYS 322, PHYS 323 (4 credit sequence to 3 credits in one new course PHYS 451) and PHYS 222, PHYS 223 (4 credit sequence to 3 credits in one new course PHYS 441). PHYS 473 is being reduced from four to three credits.** Please specify how preparation and equated workload will be assigned for this course. **There will be no change from the current process in assignment of workloads.**

C2 What other resources will be needed to teach this course and how adequate are the current resources? **No additional resources are required.** If not adequate, what plans exist for achieving adequacy? Reply in terms of the following:

*Space
*Equipment
*Laboratory Supplies and other Consumable Goods
*Library Materials
*Travel Funds

C3 Are any of the resources for this course funded by a grant? **No.** If so, what provisions have been made to continue support for this course once the grant has expired? (Attach letters of support from Dean, Provost, etc.)

C4 How frequently do you expect this course to be offered? **This course is expected to be offered each year.** Is this course particularly designed for or restricted to certain seasonal semesters? **Yes, because this course is required of all physics majors in a highly structured sequence where several required courses are taught every second year, it is necessary that it be taught in the Fall Semester of each year.**

C5 How many sections of this course do you anticipate offering in any single semester? **One section**

C6 How many students do you plan to accommodate in a section of this course? It is planned to accommodate 15 students. What is the justification for this planned number of students? **Physics majors will be required to take this course and since the course is dual level all incoming graduate students will also be required to take the course under a graduate course number and section identifier.**

C7 Does any professional society recommend enrollment limits or parameters for a course of this nature? **No.** If they do, please quote from the appropriate documents.

C8 If this course is a distance education course, see the Implementation of Distance Education Agreement and the Undergraduate Distance Education Review Form in Appendix D and respond to the questions listed. **N/A**

Section D: Miscellaneous

Include any additional information valuable to those reviewing this new course proposal. **N/A**

Stan,

The Mathematics Department supports the new course PHYS 401.

There is significant overlap with the course and required MATH courses for
Physics majors, but through conversations between our departments we have
worked out the details. The Mathematics Department understands that there
will be a lot of time spent on applications of the mathematics involved to
specific physics topics. This course should provide to students a
reinforcement of the interplay between mathematics and physics
concepts.

Gary Stoudt

Mathematics Department

Appendix for Graduate Course

I. Catalog Description

PHYS 501 Theoretical Physics 3c-0l-3cr

Prerequisites: permission of the physics department

Explores the applied mathematics necessary to solve ordinary and partial differential equations in closed and series forms for boundary value problems in intermediate and advanced physics. Coordinate transformations, tensor analysis, special functions and series involving complex variables and integral transforms are also considered.

II. Course Outcomes

Upon successful completion of this course students should be able to:

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3. Apply complex variables to derive Kramers - Kronig dispersion relation used in Optics and Solid State Physics – relating the refractive part and the absorptive part of the refractive index at different frequencies.
4. Demonstrate the use of vectors and matrices to solve Eigen-value problems in one – and two – dimensional spring-mass systems (e.g., linear mono and diatomic chains; molecular vibrations of three mass-spring coupled system).
5. Demonstrate the application of mathematical techniques from the course to examples in research

III. Additional Material for Graduate students

Although graduate students receive the same number of credits as undergraduates additional work is required of all graduate students. The extra work may take the form of (i) additional assignments of more challenging problems, (ii) extra readings of original works of scholarship, (iii) extra computer-based problems.

Graduate students will be required to show a greater degree of analysis, synthesis and evaluation of knowledge as well as, in presenting their results, greater independence than undergraduates. The instructor will make final judgment on the quality of their work.

IV. Evaluation Methods

The final grades for the course will be based upon the following:

50% Exams. A minimum of two fifty minute in-class examinations consisting of problem solutions or essay exercises. Graduate students will be assigned one or two additional problems at a level above that of the undergraduate students.
25% One two hour final examination
25% Homework and class participation. Students are expected to participate in the classroom discussions. Additional home work problems will be assigned to the graduate students in the class

V. Example Grading Scale

A	90%-100%
B	80%-89%
C	60%-79%
F	less than 60%

(E-mail of support from the Mathematics Department)

Friday, April 3, 2009 10:51 AM
Page 1 of 1
Subject: PHYS 401
Date: Thursday, April 2, 2009 9:22 AM
From: Gary Stoudt <Gary.Stoudt@iup.edu>
Reply□To: <Gary.Stoudt@iup.edu>
To: Stanley Sobolewski sobolews@iup.edu

Stan,
The Mathematics Department supports the new course PHYS 401.
There is significant overlap with the course and required MATH courses for Physics majors, but through conversations between our departments we have worked out the details. The Mathematics Department understands that there will be a lot of time spent on applications of the mathematics involved to specific physics topics. This course should provide to students a reinforcement of the interplay between mathematics and physics concepts.

Gary Stoudt

Mathematics Department