Never sent to Senate because of objections from state APSCUF

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		06-16e	App 11-28-06	

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person	Email Address
Dr. Devki N. Talwar	talwar@iup.edu
Proposing Department/Unit	Phone
Physics/NSM	7-2190

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)

_____New Course _____Course Prefix Change _____Course Deletion

__X__Course Revision _____Course Number and/or Title Change _____Catalog Description Change

	NMTT 314 *Lithography and Patterning Techniques*
***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)	Kenneth E Hrehman	9/13/06
Department Chair(s)	Kenneth E. Hrehman	9/13/06
College Curriculum Committee Chair		09/19/06
College Dean	Gerard m O'Brien	10/5/06
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate:		
(include title)		
UWUCC Co-Chairs	Gail S Sechrist	11-28-06

Received
OCT - 6 2006
Liberal Studies

Received
NOV 28 2006
Liberal Studies

* *where applicable*

4. NMTT 314: Lithography and Patterning Techniques

I. Catalog Description

NMTT 314 Lithography and Patterning Techniques 3c-2l-3cr
Corequisite: Admission to NMT track

Provides knowledge and hands-on treatment to all aspects of advanced lithography and pattern generation processes covering topics from substrate preparation to exposure using pattern transfer equipment such as stamping and embossing; ion and e-beam; and optical contact and stepper systems.

II. Course objectives

Students will be able to

A. Demonstrate an understanding of 'lithography'; identify different processes and steps used for transfer of patterns on photosensitive materials by selective exposure to radiation; describe the nature and behavior of photosensitive materials (such as benzocyclobutene (BCB)) used in micro and nanofabrication technology.
B. Identify and operate different equipment used in photolithography:
    a. Karl Suss MJB3 contact aligner, lithography station (photoresist application)
C. Discuss the design and the use of e-beam tools; explain mask layout and fabrication processes for photolithography using an e-beam tool; operate the Lieca EBPG-5R tool in the class 10 cleanroom.
D. Perform the process steps necessary to produce a photolithographic pattern from a 'mask' to the 'silicon' wafer using positive, negative, and chemically amplified 'photoresists'.
E. Identify lithographic issues in nanofabrication:
    a. Dehydration bake, soft bake, hard bake, resist spin/spray, alignment, etc.
    b. Underexposure, overexposure, under-development, over-development.
    c. Resist removal using wet chemistry and ashing.
F. Describe and perform alignment and registration in photolithography.
    a. Examine and contrast stepper based systems.
    b. Examine underexposure, overexposure, underdeveloped, overdeveloped profiles in the cleanroom.
G. Modify profiles in photoresist for liftoff applications
    a. Liftoff lab using chlorobenzine.
H. Describe the process of 'embossing lithography' with knowledge of its applications and limitations.
    a. Use embosser for pattern transfer.
I. Describe the process of 'stamp lithography' with knowledge of application and limitations.
    a. Use stamp for pattern transfer.
J. Describe the process of 'probe lithography' and systems with knowledge of application and limitations.
    a. Use probe lithography for pattern transfer.

III. Course outline

Patterning materials on the nanoscale is a challenging aspect of the Nanofabrication. The selection of tools and techniques is the key to creating products in the competitive modern workplace. This course addresses these issues and provides in-depth knowledge to students about the tools and techniques including state-of-the-art lithography equipment used in the Nanofabrication facility cleanrooms. The course is designed to give students experience in novel

lithography techniques including embossing litho, stamp litho, probe litho and self assembly lithography.

Lectures are generally presented for 3 hours for 4 days/week and lab sessions for 3 hours for 3 or 4 days/week in the fall and spring semester. During summers, lectures and labs are held for 5 days/week.

Part A: Lecture, group project (30 hours)

In this course the students learn in details about contact printing with emphasis on chemistry; advanced lithography systems and techniques including embossing, stamping; e-beam, steppers; production yield and economics; and group project presentation etc.

The course is divided into five major sections. The first section is an overview of all pattern generation processes covering aspects from substrate preparation to exposure tool operation. The second section concentrates on photolithography and examines such topics as mask generation, and phase shifting masks. Chemical makeup of resists will be discussed including polymers, solvents, sensitizers, and additives. The role or dyes and antireflective coatings will be discussed. In addition, critical dimension (CD) control and profile control of resists will be investigated. The third section will discuss the particle beam lithographic techniques of e-beam and ion beam lithography. The forth section covers probe pattern generation and the fifth section (see Part B: Lab) explores hands on exercises on embossing lithography, stamp lithography, and self assembled lithography.

Part B: Lab (18 hours)

In the labs students are involved in hands-on treatment of all aspects of the advanced pattern transfer and pattern transfer equipment including probe techniques; stamping and embossing using ion and e-beam, optical contact and stepper systems, etc.

IV. Evaluation method

The final grade will be determined as follows

Mid-term exam (500 points)
Quizzes (usually 3 quizzes each of 100 points = 300 points)
Lab + homework (400 points)
Independent reports and simulation (250 points)
Final presentation (300 points)
Final Exam (500 points optional)

V. Example Grading Scale

The final grade will be determined by the following percent scale.

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

VI. Attendance Policy

Attendance is mandatory. Make up time is required for any absence that extends beyond two days. The student must give a written explanation for absences. An attendance sheet is attached to the classroom door, and the missed time must be documented before re admittance to the class. Failure to make up lab time results in an F grade.

VII. Required Textbook(s), Supplemental Books and Readings

1 *Semiconductor Manufacturing Technology* by Michael Quirk and Julian Serda (2001) [Prentice-Hall : ISBN 0-13-081520-9].
2 *Nanotechnology A gentle introduction to the next big Idea* by Mark Ratner, Daniel Ratne (2003) [Prentice Hall : ISBN 0-13-101400-5]
3. Nanofab Safety Manual
4. Class notes in printed form
5. Notes issued during class
6. Equipment training notes
7. Lab experiment notes

VIII. Special Resources Requirements

There is no special resource requirements for this course

IX. Bibliography

Books

1. *Nanotechnology: A Gentle Introduction to the Next Big Idea*, by Mark A Ratner *et al.* (Pearson, Education, Inc. 2003).
2. *The Next Big Thing Is Really Small: How Nanotechnology Will Change the Future of Your Business* by Jack Uldrich (Crown Business, 2003).
3. *Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform Our World* by Douglas Mulhall (Prometheus 2002).
4. *Understanding Nanotechnology* by editors at The Scientific American (2002).
5. *Introduction to Nanotechnology*, by Charles P. Poole, Frank J. Owens (Wiley 2003).
6. *Nanotechnology: Basic Science and Emerging Technologies* Edited by Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons (Chapman and Hall 2002)
7. *Engines of Creation : The Coming Era of Nanotechnology*, by Eric Drexler (Anchor 1990).

Popular Articles

It's a Small World After All by Lawrence D. Maloney, Design News Sep 26, 2005
Nanotech could put a new spin on sports by Kevin Maney, USA Today, Nov 17 2004.
Nanomechanical memory demoed by Eric Smalley TRN, Nov 15, 2004

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? (majors, students in other majors, liberal studies). Explain why this content cannot be incorporated into an existing course.*

The course will extend knowledge learned in other departmental courses to areas that are currently the subjects of cutting-edge research and technology. The course is designed for the Applied Physics majors who have been admitted to NMT track. This content cannot be incorporated into an existing course because the department currently does not have necessary equipment and facility. Also, the content covers a broad range of topics in physics chemistry and interface areas such as biology, biochemistry, material science, and forensics. There are no physics courses in which all of these topics could be included.

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.*

The course **does not** require changes in the content of existing courses or requirements.

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 course has **never been offered** on a trial basis.

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

No, it is not dual-level.

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?*

The course is not variable credit.

A6 *Do other higher education institutions currently offer this course? If so, please list examples (institution, course title).*

Yes, similar courses are being taught at several other PASSHE universities including Lock Haven, Shippensburg, California, Millersville, Clarion, etc.

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

Section B: Interdisciplinary Implications

B1 *Will this course be taught by instructors from more than one department? If so, explain the teaching plan, its rationale, and how the team will adhere to the syllabus of record.*

This course will be taught only at the Penn State's NMT facility.

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).*

The content of this course is not related to courses given in other departments.

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.*

The course will not be cross-listed with other departments.

Section C: Implementation

C1 *How will the proposed new track affect students already in the existing program?*

The essence of the Applied Physics/NMT track is to help students in their Junior/Senior year to gain valuable experience (18 cr. Capstone 16 weeks (Fall or Spring) or 12 weeks (Summer)) in nanofabrication manufacturing technology at the Penn State' Nanofabrication Facility while enrolled for the BS degree in Applied Physics at Indiana University of Pennsylvania. Students taking the capstone experience at Penn State will pay tuition for the 18 credits at IUP at the prevailing rate while Penn State will provide, through agreement with the State of Pennsylvania, the necessary boarding and lodging. The 18 credits earned by the students at Penn State will be transferred to IUP in compliance with the agreement between Penn State and PASSHE. Other students in the IUP physics program will not be affected at all.

C2 *Are faculty resources adequate? If you are not requesting or have not been authorized to hire additional faculty, demonstrate how these courses will fit into the schedule(s) of current faculty. What will be taught less frequently or in fewer sections to make this possible?*

Since capstone experience in nanofabrication manufacturing technology will take place at the Penn State' Nanofabrication Facility, no new faculty at IUP will be needed to offer this new track and no change in other courses or programs in the physics department is foreseen.

C3 *Are other resources adequate? (Space, equipment, supplies, travel funds)*

(a) No additional space is necessary to offer this new track
(b) No additional supplies are necessary for this new track
(c) No additional equipment is needed for this new track
(d) Available library materials are adequate for this new track.
(e) No travel funds are needed.

C4 *Do you expect an increase or decrease in the number of students as a result of these revisions? If so, how will the department adjust?*

Although the number of students in this track might not significantly increase the total number of students in the Applied Physics Program, it is expected that the NMT track may help attract highly motivated undergraduates into our program.

C5 *Intended implementation date (semester and year)*

The new track is expected to start as soon as it is approved. Intended implementation date is Fall 2006. Students in the Applied Physics Program with NMT track will be advised in a manner consistent with university procedures for phasing in of the 120 curricula.

Section D: Miscellaneous

D1 Include any additional information valuable to those reviewing this new course proposal.

N/A