LSC Use Only No:	LSC Action-Date:	UWUCC USE Only No.	UWUCC Action-Date:	Senate Action Date:
		06-16a	App. 3-6-07	App-4/20/10

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

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

***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 ___x___Program Revision

_____New Degree Program _____Program Title Change _____Other

_____New Minor Program _____New Track

	Bachelor os Science – Applied Physics/Nanomanufacturing Technology (NMT) Track
***Current* program name**	***Proposed* program name, if changing**

4. Approvals		**Date**
Department Curriculum Committee Chair(s)	Kenneth E Hershman	9/13/06
Department Chair(s)	Kenneth E Hershman	9/13/06
College Curriculum Committee Chair		9/18/06
College Dean		10/5/06
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate: (include title)		
UWUCC Co-Chairs	Gail S Eichhorst	3-6-07

Received OCT - 6 2006 Liberal Studies

Received FEB - 9 2007 Liberal Studies

Received NOV 28 2006 Liberal Studies

* where applicable

Dr. Gail Sechrist, Chair UWUCC,

We have addressed all of your concerns and made appropriate changes (brown color) in this revised draft of the course proposals for the Applied Physics/Nanomanufacturing Technology Track.

On Page 5

(i) We have made the changes in the Liberal Studies section and converted the list of **Old** courses and credits to a side by-side with the new calculus courses included on the **New** courses list:

(ii) Changed the order of the PHYS 345
(iii) Correct the title of the NMTT 314 course

On Page 3

(i) We have corrected the name of the college in the first paragraph of the Rationale/Justification section.

On Page 4

(i) Also made changes in the last paragraph of the Rationale/Justification by adding couple of lines. We have also added lines at the end of that section indicating that this NMT Track was already approved and the Senate is asked to reaffirm its approval.

I hope the present version will be acceptable to you and the UWUCC.

Thanks for all the help that you and your committee provided to us.

With kind regards

Devki N. Talwar, Ph.D.
Professor of Physics

Feb. 9th, 2007

Part II. Description of Curriculum Change

1. Complete Catalog Description For Revised Track. This includes both the description about track and the list of courses and credits for the new track.

Catalog description

The Bachelor of Science Degree in Applied Physics with Nanomanufacturing Technology (NMT) Track will help IUP students to take one semester of experiential learning in the high-tech field of semiconductor device manufacturing at the state-of-the-art facility at Penn State - University Park Campus. Nanofabrication industries using this technology are rapidly growing from biomedical applications to microelectronics. Graduates of the Applied Physics/NMT Track may enter careers in industry and education.

The students enrolled in Applied Physics/NMT Track will spend one semester (16 weeks) (18 cr Capstone) in their Junior/Senior year at Penn State (in the Fall, Spring or Summer (12 weeks)) for hands-on experience in high-tech semiconductor device manufacturing field. Students must earn a GPA of at least 3.0 in the required Science and Mathematics courses to be considered for admission into the Capstone semester at Penn State.

2. Detailed Description For The Track

A. Rationale/Justification

The program leading to the Bachelor of Science – Applied Physics/Nanomanufacturing Technology (NMT) Track in the College of Natural Sciences and Mathematics proposes a revised academic track with emphasis in the high-tech semiconductor device manufacturing field. This will provide knowledge base necessary for the manufacture of any micro- and nano-scale product. The goal is to prepare our Applied Physics undergraduate students for a career in industry or academia using nanotechnology. The student will derive this valuable knowledge base from a program composed of safety training, lectures, software based training, fabrication experiments, tool training, processing training, product cost evaluation, independent research, and process integration projects. To facilitate the process integration goal, the student will be required to work on a micro- or nano-scale structure at the end of the semester as a group project.

The Physics of Semiconductor has played a major role in the development of modern micro (micro means a millionth 10^{-6}) technology, especially microelectronics, and solid state devices. Since the dimensions of new microelectronic components, e.g., computer chips are reaching to a nanometer range (nano means a billionth 10^{-9}), the research and development in semiconductor physics has been steadily moving from micro-technology to nanotechnology. Nanofabrication is the technology that grew out of making semiconductor chips. Everybody wanted faster computers and faster access to the Internet, which resulted in transistors getting smaller. Things have gotten so tiny now that this technology has become "machining at the atomic level" and it has spread from being used to make chips to being used to make a variety of technological innovations, including, for example, artificial organs, tiny valves, and flat, picture-like televisions. An understanding of the semiconductor physics involved in this new technology would be advantageous to every student majoring in Natural Sciences (Physics, Chemistry, Biology, Geoscience and Computer Science) and/or Engineering.

The current widespread interest in nanotechnology dates back to the years 1996 to 1998 when a panel under the auspices of the World Technology Evaluation Center (WTEC) funded by the National Science Foundation (NSF) and other federal agencies undertook a world-wide study of research and development in the area of nanotechnology innovation. The WTEC study concluded that nanotechnology has enormous potential to contribute to significant advances over a wide and diverse range of technological areas ranging from producing stronger and lighter materials to shortening the delivery time of nano-structured pharmaceuticals to the body's circulatory system,

increasing the storage capacity of magnetic tapes, and providing faster switches for computers. Recommendations made by WTEC and subsequent panels have led to the appropriation of very large levels of funding. This resulted in the establishments of five 'National Nanofabrication User Networks' (NNUN) all over the country with a funding of more than $100 million dollars from the NSF. One of such networks is at the Research Park of Penn State (see: www.nnun.org).

The 23 million dollar Penn State Nanofabrication Facility is meant for the sharing of a Pennsylvania resource by educational institutions across the Commonwealth. The access of this significant resource has given opportunities to students across the state - from the PASSHE universities to the community colleges - to get 18 credits of capstone experience in nanofabrication manufacturing technology (NMT). This program will be extremely valuable for our students to earn BS degree (Applied Physics/NMT track) by taking appropriate courses (described in 1) from IUP and taking one-semester (18 cr) of capstone, hands-on experience in their junior/senior year at Penn State's Nanofabrication Facility. In compliance with the agreement between Penn State and PASSHE, the grades earned by students for the courses will be entered by the program coordinator at IUP in consultation with the instructor(s) at Penn State. The coordinator in consultation with the Penn State instructor(s) will also address any grade related issues raised by the students.

It is worth mentioning that Bachelor of Science –Applied Physics/Naomanufacturing Technology Track was approved earlier and the Senate is asked to reaffirm it.

What is the outlook for industries using nanofabrication?

Every year some industries spurt ahead and some slow down. That is the way the world economy is. However, the ones that do more spurting ahead are the high-tech industries like optoelectronics (fiber-optic communications for the Internet), displays (flat TVs, computer screens, etc.), sensors (pollution, food bacteria detection, etc.), pharmaceuticals (DNA immobilization, "lab-on-a-chip"), and microelectronics. These industries use nanofabrication technology now and will use nanofabrication even more in the future.

What are the opportunities for a graduate of this program?

The spectrum of industries using nanofabrication technology is broad - from pharmaceuticals to opto-electronics and microelectronics. A person with a nanofabrication technology skill can work in any of these industries, all of which continue to grow. The federal government, in stressing the unprecedented spread of nanotechnology, has stated that it "...is likely to change the way almost everything - from vaccines to computers to automobile tires to objects not yet imaginable - is designed and made."

The industries using nanotechnology are growing from biomedical applications to microelectronics. As the worldwide nanofabrication industries continue to grow, graduates of the NMT partnership program will become an even more valuable resource. As the international use of nanofabrication manufacturing (i.e., semiconductor manufacturing-based) technologies increases across high-tech industries, individuals with this training will have an ever-growing list of companies in a variety of fields to choose from in selecting job opportunities:

- Micro- and nano- electronics
- Information Storage
- Optoelectronics
- Bio-Medical
- Chemical

B. List of courses and credits for the Bachelor of Science – Applied Physics/Nanomanufacturing Technology (NMT) Track

Current

Bachelor of Science—Applied Physics/Nanomanufacturing Technology Track **Liberal Studies:** As outlined in the Liberal Studies section with the following specifications: **Mathematics:** MATH 123 **Natural Science:** CHEM 111-112 **Liberal Studies Electives:** 4cr, MATH 124, no courses with PHYS prefix		**50**
Major:		**28**
Required Courses:		
PHYS 131	Physics I-C Lecture	3cr
PHYS 132	Physics II-C Lecture	3cr
PHYS 141	Physics I-C Lab	1cr
PHYS 142	Physics II-C Lab	1cr
PHYS 222	Mechanics I	2cr
PHYS 231	Electronics	4cr
PHYS 322	Electricity and Magnetism I	3cr
PHYS 331	Modern Physics	2cr
PHYS 345	Optics	3cr
PHYS 352	Applied Physics Laboratory	3cr
PHYS 355	Computer Interfacing	3cr
Controlled Electives: **Nanomanufacturing Technology Track** (18cr PSU Capstone)		**24**
NMTT 311	Materials, Safety and Equipment Overview for Nanofabrication	3cr
NMTT 312	Basic Nanofabrication Process	3cr
NMTT 313	Thin Films in Nanofabrication	3cr
NMTT 314	Advanced Lithography and Dielectrics for Nanofabrication	3cr
NMTT 315	Materials Modification in Nanofabrication	3cr
NMTT 316	Characterization, Packaging, and Testing of Nanofabrication Structures	3cr
PHYS 475	Physics of Semiconductor Devices I	3cr
PHYS 476	Physics of Semiconductor Devices II	3cr
Other Requirements:		**9-15**
COSC 110	Problem Solving and Structured Programming	3cr
COSC 250	Introduction to Numerical Methods	3cr
MATH 241	Differential Equations	3cr
Foreign Language Intermediate Level		0-6cr
Free Electives:		**3-9**
Total Degree Requirements:		**120**

Proposed

Bachelor of Science—Applied Physics/Nanomanufacturing Technology (NMT) Track **Liberal Studies:** As outlined in the Liberal Studies section with the following specifications: **Mathematics:** MATH 125, MATH 126 **Natural Science:** CHEM 111-112 **Liberal Studies Electives:** 3cr, MATH 225, no courses with PHYS prefix		**51**
Major:		**28**
Required Courses:		
PHYS 131	Physics I-C Lecture	3cr
PHYS 132	Physics II-C Lecture	3cr
PHYS 141	Physics I-C Lab	1cr
PHYS 142	Physics II-C Lab	1cr
PHYS 222	Mechanics I	2cr
PHYS 231	Electronics	4cr
PHYS 322	Electricity and Magnetism I	2cr
PHYS 331	Modern Physics	3cr
PHYS 345	Optics	3cr
PHYS 352	Applied Physics Laboratory	3cr
PHYS 355	Computer Interfacing	3cr
Controlled Electives: **Nanomanufacturing Technology (NMT) Track**		**24**
NMTT 311*	Materials, Safety and Equipment Overview for Nanofabrication	3cr
NMTT 312*	Basic Nanofabrication Process	3cr
NMTT 313*	Thin Films in Nanofabrication	3cr
NMTT 314*	Lithography and Patterning Techniques	3cr
NMTT 315*	Materials Modification in Nanofabrication	3cr
NMTT 316*	Characterization, Packaging, and Testing of Nanofabrication Structures	3cr
PHYS 475	Physics of Semiconductor Devices I	3cr
PHYS 476	Physics of Semiconductor Devices II	3cr
Other Requirements:		**9-15**
COSC 110	Problem Solving and Structured Programming	3cr
COSC 250	Introduction to Numerical Methods	3cr
MATH 241	Differential Equations	3cr
Foreign Language Intermediate Level (1)		0-6cr
Free Electives: (2)		**2-8**
Total Degree Requirements:		**120**

(*) These six courses are part of the PSU capstone experience and are taken concurrently by the student at the Penn State Campus.

(1) Intermediate-level Foreign Language may be included in Liberal Studies electives.

(2) Student is to work with his/her advisor to select appropriate free electives. It is possible in some cases that additional courses in Physics may be recommended.

Part III. Periodic Assessment

Include information about the Department's plan for program evaluation

There are several components proposed for the periodic assessment of this track. One is a survey of the senior students completing the track. Another is a five-year re-evaluation of the program by the departmental curriculum committee.

1. *Describe the evaluation plan. Include evaluation criteria. Specify how the input from students will be incorporated into the evaluation process*

   To ensure that the proposed BS Applied Physics/NMT track is meeting the IUP standards of education in providing a high quality program to our undergraduates, this program will be evaluated every year.

   The students input will be incorporated by surveying them (after two years of graduation) and asking questions such as: (i) How the Applied Physics/NMT program at IUP has prepared them for their future work? (ii) How has their general perception of this world changed as a result of their Applied Physics/NMT studies at IUP? (iii) What skills/experience they feel they did not gain at IUP for their future academic/job related works? (iv) Why in their opinion, they were unable to acquire these skills/experience?

2. *Specify the frequency of the evaluations.*

   To ensure that the Bachelor of Science – Applied Physics/NMT program is current with the most recent advances in education and training, the program of courses will be evaluated continuously both by the IUP Physics and Penn State Nanofabrication faculty.

Part IV. Course Proposals

There are <u>six</u> new course proposals for the Bachelor of Science in Applied Physics at IUP with Nano Manufacturing technology (NMT) track. Each of these courses (already approved by the Penn State NMT program) with lectures and lab (using 23 Million Dollar Clean Room) components will be taught by the faculty members at the Penn State Nanofabrication Facility. The <u>six</u> courses of the NMT capstone experience (NMTT 311-316) presented here will be taught sequentially in three phases. The first phase covers NMTT 311 and NMTT 312, followed by NMTT 313/314, and then NMTT 315/316. Lab work and training will coincide with the lecture material. 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 16 week semester. Because of the equipment availability, labs will occasionally be required on Fridays. During summers, lectures and labs are held 5 days per week due to the shorter 12 week session.

Part V. Letters of Support

A letter of support has been requested from Terry Kuzma, Penn State NMT program coordinator.

PENNSTATE

Penn State Center for Nanotechnology Education and Utilization

College of Engineering
The Pennsylvania State University
114 Lubert Building
University Park, PA 16802-7007

Ph: 814-865-9635
Fax: 814-865-9400
www.cneu.psu.edu

November 16, 2006

IUP Undergraduate Curriculum Committee,

I am writing to you on behalf of the Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership.

The NMT Partnership is a higher education collaborative dedicated to creating and upgrading the Pennsylvania workforce by providing educational opportunities to students from community colleges, State System Universities, and other post-secondary institutions across Pennsylvania in the exciting field of nanotechnology. Indiana University of Pennsylvania (IUP) students enrolled in this collaborative program are eligible to attend the six-course 18 credit NMT capstone semester in nanofabrication conducted three times yearly at Penn State's University Park Campus. The students receive hands-on exposure to nanofabrication manufacturing technology by utilizing multi-million dollar class 10 clean room facilities and equipment at Penn State. Penn State's ability to offer this educational experience to students from IUP and the other partner institutions is contingent upon continued support for the NMT Partnership from the Commonwealth of Pennsylvania.

We strongly support IUP's Applied Physics NMT proposal. Through the NMT Partnership, more than 50 associate and baccalaureate degree programs have been established since 1999 at partner institutions across the Commonwealth. Our experience shows that this collaborative is opening the door for students to well-paying careers in a variety of industries such as pharmaceuticals, biotechnology, chemicals, opto-electronics, sensors, information storage, power electronics and, of course, microelectronics.

If you have any questions please do not hesitate to contact me.

Sincerely,

Stephen J. Fonash
Kunkle Chair Professor of Engineering Sciences
Director, Center for Nanotechnology Education & Utilization
Director, PA Nanofabrication Manufacturing Technology (NMT) Partnership

Gail Sechrist

From: "Jerry Buriok" <JBURIOK@iup.edu>
To: <talwar@iup.edu>
Cc: "Jerry Buriok" <jburiok@iup.edu>; "Allan Andrew" <atandrew@iup.edu>; "Ken Hershman" <hershman@iup.edu>
Sent: Tuesday, November 28, 2006 8:33 AM
Subject: Nanomanufacturing Technology Program

Dr. Talwar,

Since the term at Pennsylvania State University for hands-on experience in high-tech semiconductor device manufacturing is crucial to the Physics Department's Bachelor of Science - Applied Physics/Nanomanufacturing program, the College of Natural Sciences and Mathematics waives the "last 30 credits" residence requirement for students in this program. This waiver is granted with the proviso that the last 30 credits before graduating from IUP include part of all of the term completing the nanomanufacturing requirement at Penn State, and is not applicable to any other courses from Penn State or courses from any other institution of higher education.

Gerald Buriok, Interim Dean
College of Natural Sciences and Mathematics