CURRICULUM PROPOSAL COVER SHEET
University-Wide Undergraduate Curriculum Committee

25

LSC Use Only	
Number	
Action	
Date	

UWUCC Use Only	
Number	[redacted]
Action	
Date	

I. TITLE/AUTHOR OF CHANGE

COURSE/PROGRAM TITLE BACHELOR OF SCIENCE IN APPLIED PHYSICS
DEPARTMENT PHYSICS
CONTACT PERSON DR. J. N. FOX / DR. W. L. FREEMAN

II. THIS COURSE IS BEING PROPOSED FOR:

X Course Approval Only
___ Course Approval and Liberal Studies Approval
___ Liberal Studies Approval only (course previously has been approved by the University Senate)

III. APPROVALS

Richard D. Roberts
Department Curriculum Committee

John N. Fox
Department Chairperson

College Curriculum Committee

College Dean*

Director of Liberal Studies
(where applicable)

Provost
(where applicable)

*College Dean must consult with Provost before approving curriculum changes. Approval by College Dean indicates that the proposed change is consistent with long range planning documents, that all requests for resources made as part of the proposal can be met, and that the proposal has the support of the university administration.

IV. TIMETABLE

Date Submitted
to LSC ______
to UWUCC ______

Semester/Year to be implemented ______

Date to be published in Catalog ______

Revised 5/88

[Attach remaining parts of proposal to this form.]

TABLE OF CONTENTS

THE APPLIED PHYSICS PROGRAM

The attached program was proposed by the Department of Physics and approved unanimously on February 26, 1988 by the Dean's Advisory Committee for the College of Natural Sciences and Mathematics.

Over a period of three years, the program calls for an outlay of $40,000 for equipment and supplies, one additional faculty member and one additional laboratory space. The Committee believes that this program will be extremely valuable to the University Community as well as the Commonwealth, but wishes to emphasize that resources for this program should be considered as additional resources for a new initiative and not drawn from the current programs of the University. The Advisory Committee and the Physics Department itself, urge our Administration to present The Applied Physics Program to SSHE as a new and innovative curriculum worthy of additional support by the Commonwealth.

Resources

Chairperson, Dean's Advisory Committee

CATALOG DESCRIPTION

The Applied Physics major is designed to provide students with many interdisciplinary career options in science and technology.

The program consists of a core of courses from the liberal studies curriculum and the College of Natural Sciences and Mathematics. In addition, there is the option of five possible tracks:

1. Solid State Electronics
2. Computer Science
3. Chemistry
4. Biology
5. Geology

The complete course requirements are provided below.

This program will allow students to (1) enter directly into the industrial marketplace with confidence that their background will enable them to adapt with relative ease to the ever-changing challenges of high-technology; or (2) enter directly into graduate school in their chosen field of study with a minimum of preparatory study during their first year of graduate school.

Rationale for Program:

Technology has been producing changes in the nature of and divisions between academic fields. Traditionally, physics has been concerned with the study of basic principles at their most fundamental level. While the scientific instruments and devices of any period are certainly the products of these fundamental principles, physics is not device-specific, nor is it tied to particular applications. By concentrating on broad general topics, physicists have greater versatility and their knowledge has a much longer lifespan without obsolescence than professionals in engineering fields. This generality is purchased at the price of study in great depth and sophistication of the techniques of analysis. According to statistics of the American Institute of Physics , 50% of B.S. graduates in physics go on to graduate school in either physics or some related field. This simple fact, more than any other, conditions and standardizes undergraduate physics curricula. At IUP, a substantial majority of our graduates continue their studies in graduate schools.

By contrast, engineering studies are highly specific and product-oriented, always couching the general in terms of the specific, the materials available, the techniques and devices at hand, etc. As a result, the knowledge gained in an engineering program becomes obsolete rapidly and is discarded by industry after a short but useful work life. As a result, the fields of engineering send some of the lowest percentages of graduates to further graduate study, since the emphasis is on using immediately what the student has learned before it becomes outdated. The polarity between the physicist and the engineer has introduced a void in the middle which industry has tried to fill by using teams of physicists and engineers in collaborative work.

Recent trends have produced an unprecedented crush in enrollment applications for engineering schools. The four highest paid starting salaries for college graduates in 1986 were all in subfields of engineering. The message inherent in such numbers is not lost on prospective students. Because of (1) the inability of graduate schools to attract engineers that hold the Ph.D. and (2) the high cost of expanding the faculties required for engineering programs, engineering schools are frequently unwilling or unable to expand to meet the surge in enrollment demand. This leaves many highly qualified students unable to obtain admission to engineering schools.

Even more disturbing for the engineering schools is the substantial shifts of demand within the subfields of engineering. For example, the ever expanding demand for electrical or electronic engineers at one school of international prominence has produced an 80 to one student-faculty ratio in electrical engineering, while other departments enjoy ratios as low as two to one. The simple fact that so few engineers go on to graduate school eliminates the possibility of rapid expansion of faculty at such schools, even if the desire to do so were there. Thus, substantial numbers of qualified students will be turned away by engineering schools for the forseeable future. These students are generally attracted by the prospect of doing something useful at the forefront of technology for high pay. Their orientation is mainly that of engineering - hard work and study followed by early entry into the job market at a good salary - rather than the more contemplative investigation of the nature of fundamental ideas traditional to physics.

A common ground between these positions is in the B.S. in Applied Physics program as presented in this proposal. By applied physics we mean physics with an emphasis on devices, technology, laboratory work and/or application of the techniques of physics to the problems in other fields of science. The Applied Physics curricula are NOT less rigorous than the traditional study of physics. In fact, in some institutions it is more rigorous. These applied physics curricula differs from traditional physics in its more immediate and specific application potential. The physics department has been investigating the development of an applied physics program for some time. In the fall of 1982 a formal survey of over 140 items completed by alumni of the physics department, disclosed the unanimous opinion that we should proceed toward establishing such a program. During the evaluation of our department in 1983 the external evaluators listed as a separate point in their final report:

> "2. We recommend the establishment of a B.S. degree in Applied Physics. The university offers a pre-engineering curriculum but no engineering program. It offers a popular computer science program which appears to stress the use of computers rather than the science of computers. At present, there appears to be a great opportunity for graduates having a pre-industry education in physics. This would be very similar to the present physics major but without the intensive mathematical skills (e.g., boundary value problems and partial differential equations) which are needed for quantum mechanics and graduate study in physics. Such a program would have time for a dash of computer science, a dash of electronics and perhaps some broad exposure to other sciences (chemistry, biology, geology). We believe there is a pool of students to which such a program would appeal. If

so, this would swell enrollments in many of the upper division courses. The very solid work in electronics, digital and integrated circuitry introduced by Dr. Berry and strengthened by Dr. Whitson provides a real nucleus on which to build. Several other members are well qualified to broaden the thrust of such a program by work in solid state, magnetism, nuclear physics, etc."

Similarly, following our program evaluation, local administrative review produced the "Proposed Action Plan" for the Physics Department, which listed this program among its objectives:

"9. The Department of Physics is urged to begin the development of an "applied physics" curriculum or concentration, and to determine the modifications and/or additional resources necessary to implement this program."

REQUIREMENTS

BACHELOR OF SCIENCE IN APPLIED PHYSICS

Liberal Studies: As outlined in Liberal Studies section with the specifications:	55 sh	
Mathematics: MA 123		4 sh
Natural Science: +CH 111, +CH 112		8 sh
Liberal Studies Electives: CO 110, Foreign Language III & IV		9 sh
English Composition I & II		7 sh
Fine Arts		3 sh
Health & Wellness		3 sh
Humanities		9 sh
*Social Sciences		9 sh
Synthesis		3 sh

+Replaced by CH 113 & 114 for Chemistry track
*3 sh must be devoted to study of a non-Western culture or civilization.
**If ROTC is taken decrease the number of free electives by 1 sh.

Major:		28 sh	
Required courses:			
PY 131/141 - 132/142	Physics IC & IIC Lect. & Labs		8 sh
PY 150	Computer Applications to Physics Laboratories		3 sh
PY 222	Mechanics I		2 sh
PY 231	Electronics		4 sh
PY 242	Optics		3 sh
PY 322	Electricity and Magnetism I		2 sh
PY 331	Modern Physics		3 sh
PY 352	Applied Physics Laboratory		3 sh
Other requirements:		10 sh	
MA 124	Calculus II for Physics and Chemistry		4 sh
MA 241	Differential Equations		3 sh
CO 250	Introduction to Numerical Methods		3 sh

****TRACKS****

Solid State Electronics Track:

Requirements: 31 sh

CO 300	Assembly Language Programming	3 sh
MA 342	Advanced Calculus for Applications	4 sh
PY 323	Electricity and Magnetism II	2 sh
PY 342	Thermal and Statistical Physics	3 sh
PY 353	Solid State Electronics Laboratory	3 sh
PY 432	Advanced Electronics	3 sh
PY 475	Physics of Semiconductor Devices I	3 sh
PY 476	Physics of Semiconductor Devices II	3 sh
	Free Electives	7 sh

Total Requirements 124 sh

Tracks have between 4-8 hrs of free electives

Computer Science Track:

Requirements: 31 sh

PY 342	Thermal and Statistical Physics	3 sh
PY 353	Solid State Electronics Laboratory	3 sh
PY 432	Advanced Electronics	3 sh
PY 475	Physics of Semiconductor Devices I	3 sh
PY 476	Physics of Semiconductor Devices II	3 sh
CO 300	Assembly Language Programming	3 sh
CO 310	Data Structures	3 sh
CO 410	Computer Architecture and Microprogramming	3 sh
CO 450	Numerical Methods	3 sh
	Free Elective (consider PY 323)	4 sh

Total Requirements - 124 sh

Chemistry Track:

Requirements:		31 sh
MA 342	Advanced Calculus for Applications	4 sh
CH 231	Organic Chemistry I	4 sh
CH 232	Organic Chemistry II	4 sh
*CH 323	Analytical Methods	4 sh
CH 341	Physical Chemistry I	4 sh
CH 342	Physical Chemistry II	3 sh
CH 343	Physical Chemistry Laboratory I	1 sh
Free Electives (consider CH 411, PY 342)		7 sh

Total Requirements - 124 sh

*CH 321 and CH 322 may be taken instead of CH 323 if a BA in Chemistry is also desired.

Biology Track:

Requirements:		31 sh
BI 105	Cell Biology	4 sh
CH 231	Organic Chemistry I	4 sh
BI 120	Animal Biology	5 sh
CH 323	Analytical Methods	4 sh
CH 351	Biochemistry	4 sh
BI	Two Biology Electives from the following: BI 263 Genetics, BI 361 Microbiology, BI 472 Radiation Biology, BI 352 Comparative Animal Physiology, BI 350 Cell Physiology, BI 401 Laboratory Methods in Biology & Biotechnology	6 sh
	Free Elective (consider a third biology elective from the above list, or PY 342)	4 sh

Total Requirements - 124 sh

Geology Track:

Requirements:		31 sh	
GS 121	General Geology I		3 sh
GS 122	General Geology I Laboratory		1 sh
GS 131	General Geology II		3 sh
GS 132	General Geology II Laboratory		1 sh
GS	Five Geoscience electives from the following: GS 321 Mineralogy, GS 325 Structural Field Geology I, GS 326 Structural Field Geology II, GS 440 Subsurface Geology, GS 362 Plate Tectonics, GS 412 Stratigraphy, GS 481 Special Topics: Geochemistry; GS 481 Special Topics: Applied Geophysics		15 sh
	Free Electives (consider PY 342)		8 sh

Total Requirements - 124 sh

REQUIREMENTS FOR B.S. IN APPLIED PHYSICS
SOLID STATE ELECTRONICS TRACK

First Semester

	English Compos. I	4
MA 123	Calc I for Phys.	4
PY 131	Physics IC Lec.	3
PY 141	Physics IC Lab	1
	Liberal Studies	3
	ROTC	0-2
		15-17

Second Semester

	Liberal Studies	3
MA 124	Calc II for Phys.	4
PY 132	Physics IIC Lec.	3
PY 142	Physics IIC Lab	1
CO 110	Intro Comp. Sci.	3
	ROTC or Liberal Studies	2-3
		16-17

Third Semester

MA 241	Diff. Equations	3
PY 231	Electronics	4
CH 111	Gen. Chemistry I	4
CO 250	Intro to Num. Meth.	3
	Liberal Studies	3
		17

Fourth Semester

	Liberal Studies	3
PY 432	Advanced Electronics	3
CH 112	Gen. Chemistry II	4
PY 222	Mechanics I	2
MA 342	Advanced Calculus for Applications	4
		16

Fifth Semester

PY 331	Modern Physics	3
PY 342	Thermal Physics	3
CO 300	Ass. Lang. Prog.	3
	Foreign Lang. III	3
PY 150	Computer Appl. to Physics Labs	3
		15

Sixth Semester

PY 322	Elec & Mag I	2
PY 352	Appl. Physics Lab	3
PY 475	Phys. of Semiconductor Dev. I	3
	Foreign Lang. IV	3
	Liberal Studies	3
		14

Seventh Semester

PY 323	Elec. & Mag. II	2
PY 353	Solid State Electronics Lab	3
PY 476	Phys of Semi Dev. II	3
	Free Elective	3
	Liberal Studies	3
		14

Eighth Semester

PY 242	Optics	3
	Free Elective	4
	Liberal Studies	9
		16

Liberal Studies Courses		30 sh
Fine Arts	3 sh	
Health & Wellness	3 sh	
English Composition II	3 sh	
Humanities	9 sh	
Social Sciences	9 sh	
Synthesis	3 sh	

REQUIREMENTS FOR B.S. IN APPLIED PHYSICS
COMPUTER SCIENCE TRACK

First Semester

	English Composition I	4
MA 123	Calculus I for Physics	4
PY 131	Physics IC Lecture	3
PY 141	Physics IC Laboratory	1
	Liberal Studies	3
	ROTC	0-2
		15-17

Second Semester

	Liberal Studies	3
MA 124	Calculus II for Physics	4
PY 132	Physics IIC Lecture	3
PY 142	Physics IIC Laboratory	1
CO 110	Intro to Computer Sci.	3
	ROTC or Liberal Studies	2-3
		16-17

Third Semester

MA 241	Differential Equations	3
PY 231	Electronics	4
CH 111	General Chemistry I	4
CO 250	Intro to Numerical Methods	3
	Liberal Studies	3
		17

Fourth Semester

	Liberal Studies	3
PY 242	Optics	3
CH 112	General Chemistry II	4
PY 222	Mechanics I	2
PY 432	Advanced Electronics	3
		15

Fifth Semester

PY 331	Modern Physics	3
PY 342	Thermal & Statistical Phys	3
CO 300	Assembly Language Prog.	3
PY 150	Computer Appl. to Physics Labs	3
	Foreign Language III	3
		15

Sixth Semester

PY 322	Electricity & Magn. I	2
PY 352	Applied Physics Lab	3
PY 475	Phys. of Semiconductor Devices I	3
	Foreign Language IV	3
	Liberal Studies	3
		14

Seventh Semester

	Liberal Studies	6
PY 353	Solid State Elec. Lab	3
CO 310	Data Structures	3
PY 476	Physics of Semiconductor Devices II	3
		15

Eighth Semester

CO 410	Computer Architecture	3
	Free Elective	4
CO 450	Numerical Methods	3
	Liberal Studies	6
		16

REQUIREMENTS FOR B.S. IN APPLIED PHYSICS
CHEMISTRY TRACK

First Semester

	English Composition I	4
MA 123	Calculus I for Phys.	4
PY 131	Physics IC Lecture	3
PY 141	Physics IC Laboratory	1
	Liberal Studies	3
	ROTC	0-2
		15-17

Second Semester

	Liberal Studies	3
MA 124	Calculus II for Phys.	4
PY 132	Physics IIC Lecture	3
PY 142	Physics IIC Laboratory	1
CO 110	Intro to Computer Sci.	3
	ROTC or Liberal Studies	2-3
		16

Third Semester

MA 241	Differential Equations	3
PY 231	Electronics	4
CH 113	General Chemistry I	4
	Liberal Studies	3
		14

Fourth Semester

	Liberal Studies	6
MA 342	Advanced Calc. for Appl.	4
CH 114	General Chemistry II	4
PY 222	Mechanics I	2
		16

Fifth Semester

	Liberal Studies	3
PY 331	Modern Physics	3
	Foreign Language III	3
CH 231	Organic Chemistry I	4
PY 150	Computer Appl. to Physics Labs	3
		16

Sixth Semester

PY 322	Electricity & Magn. I	2
PY 352	Applied Physics Lab	3
CH 232	Organic Chemistry II	4
	Foreign Language IV	3
CH 323	Analytical Methods	4
		16

Seventh Semester

	Free Elective	4
CO 250	Numerical Methods	3
CH 341	Physical Chemistry I	4
	Liberal Studies	3
		14

Eighth Semester

PY 242	Optics	3
CH 342	Physical Chemistry II	3
CH 343	Physical Chemistry I Lab	1
	Free Elective	3
	Liberal Studies	6
		16

REQUIREMENTS FOR B.S. IN APPLIED PHYSICS
BIOLOGY TRACK

First Semester

	English Composition I	4
MA 123	Calculus for Phys. & Chem	4
PY 131	Physics IC Lecture	3
PY 141	Physics IC Laboratory	1
	Liberal Studies	3
	ROTC	0-2
		15-17

Second Semester

	Liberal Studies	3
MA 124	Calculus II for Phys.	4
CO 110	Intro to Comp. Science	3
PY 132	Physics IIC Lecture	3
PY 142	Physics IIC Laboratory	1
	ROTC or Liberal Studies	2-3
		16-17

Third Semester

MA 241	Differential Equations	3
PY 231	Electronics	4
CH 111	General Chemistry I	4
	Liberal Studies	3
	Foreign Language III	3
		17

Fourth Semester

	Liberal Studies	3
PY 242	Optics	3
CH 112	General Chemistry II	4
PY 222	Mechanics I	2
	Foreign Language IV	3
		15

Fifth Semester

PY 150	Comp. Appl. to Phys Labs	3
PY 331	Modern Physics	3
BI 105	Cell Biology	4
CH 231	Organic Chemistry I	4
		14

Sixth Semester

PY 322	Electricity & Magnetism I	2
PY 352	Applied Physics Lab	3
BI 120	Animal Biology	5
	Liberal Studies	6
		16

Seventh Semester

CO 250	Numerical Methods	3
CH 351	Biochemistry	4
	Liberal Studies	6
BI	Biology Elective*	3
		16

Eighth Semester

	Free Elective	4
CH 323	Analytical Methods Bio.	4
BI	Biology Elective*	3
	Liberal Studies	3
		14

*Must be chosen from the following: BI 361 Microbiology; BI 472 Radiation Biology; BI 352 Comparative Animal Physiology; BI 350 Cell Physiology; BI 401 Laboratory Methods in Biology and Biotechnology; BI 263 Genetics.

REQUIREMENTS FOR B.S. IN APPLIED PHYSICS
GEOLOGY TRACK

First Semester

	English Composition I	4
MA 123	Calculus I for Phys.	4
PY 131	Physics IC Lecture	3
PY 141	Physics IC Laboratory	1
	Liberal Studies	3
	ROTC	0-2
		15-17

Second Semester

	Liberal Studies	3
MA 124	Calculus II for Phys.	4
PY 132	Physics IIC Lecture	3
PY 142	Physics IIC Laboratory	1
CO 110	Intro to Computer Sci.	3
	ROTC or Liberal Studies	2-3
		16-17

Third Semester

MA 241	Differential Equations	3
PY 231	Electronics	4
CH 111	General Chemistry I	4
GS 121	General Geology I	3
GS 122	General Geology I Lab	1
		15

Fourth Semester

	Liberal Studies	3
PY 222	Mechanics I	2
PY 242	Optics	3
CH 112	General Chemistry II	4
GS 131	General Geology II	3
GS 132	General Geology II Lab	1
		16

Fifth Semester

PY 331	Modern Physics	3
	Liberal Studies	3
GS	Geoscience Elective*	3
PY 150	Computer Appl. to Physics Labs	3
	Foreign Language III	3
		15

Sixth Semester

PY 322	Electricity & Magn. I	2
PY 352	Applied Physics Lab	3
GS	Geoscience Elective*	3
	Liberal Studies	3
	Foreign Language IV	3
		14

Seventh Semester

	Free Elective	4
CO 250	Numerical Methods	3
	Liberal Studies	6
GS	Geoscience Elective*	3
		16

Eighth Semester

GS	Geoscience Electives*	6
	Free Elective	4
	Liberal Studies	6
		16

*Must be chosen from the following courses (15 s.h. total):
GS 321 Mineralogy; GS 325 Structural Field Geology I; GS 326 Structural Field Geology II; GS 412 Stratigraphy; GS 440 Subsurface Geology; GS 362 Plate Tectonics; GS 481 Special Topics: Geochemistry; GS 481 Special Topics: Introduction to Geophysics.

PY 352 Applied Physics Laboratory OC-6L-3sh
Prerequisites: PY 231, PY 150 or permission of instructor.

In this laboratory the student is introduced to much of the fundamental equipment used in industry. The student is trained in the operation and proper use of this equipment through a series of experiments that teaches him/her signal detection and analysis including data acquisition by computer. The student will receive instruction on the proper methods to be used for various oral and written presentations.

COURSE SYLLABUS

I. CATALOG DESCRIPTION

PY 352 Applied Physics Laboratory OC-6L-3sh
Prerequisites: PY 231, PY 150 or permission of instructor.

In this laboratory the student is introduced to much of the fundamental equipment used in industry. The student is trained in the operation and proper use of this equipment through a series of experiments that teaches him/her signal detection and analysis including data acquisition by computer. The student will receive instruction on the proper methods to be used for various oral and written presentations.

II. COURSE OBJECTIVES

This is a laboratory course whose purpose is to train students how to use correctly modern instrumentation. Electronic, optical and thermal systems will be studied by the student to obtain an appreciation for the errors that can be encountered and the interconnection of these systems.

(1) The students will perform experiments and keep a log of all work performed in the laboratory.

(2) The students will also be taught how to give oral presentations and written reports in technical areas.

(3) Grades are to be based upon written reports and progress made by the student in obtaining the required skills for good laboratory work.

III. DETAILED COURSE OUTLINE

A. Error Analysis

B. Cables, connectors, and impedance matching

C. Grounding and noise reduction

D. Data acquisition by computer: RS-232 and IEEE-488 interfaces

E. Digital meters

F. Time, frequency, and waveform analysis

G. AC and DC signal sources

H. Electrical transducers

I. Advanced oscilloscopes

The laboratory sessions will be conducted twice a week for three hours during each period. The laboratory will be conducted during a period of 13 to 14 weeks. Each of the above topics will be covered in 1 to 2 week periods. The beginning of each period will be devoted to an oral presentation by a student on some aspect of his current work. The students will be expected to have read required materials before coming to lab and immediately start to work on their laboratory experiment. Periodically throughout the semester, written reports of a formal nature will be required of the students.

IV. EVALUATION METHODS

Students will be graded on the basis of their written laboratory reports (50%), oral presentations (25%), and an assessment of the progress made by the student in the laboratory (25%).

V. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

A proposed text is: Guide to Electronic Measurements and Laboratory Practice by Stanley Wolf, Prentice Hall. Additional materials will be supplied to the students as is deemed necessary by the instructor.

VI. SPECIAL RESOURCE REQUIREMENTS

Each student is expected to buy a packet of linear graph paper. No lab fee is associated with this course.

VII. BIBLIOGRAPHY

Seitz, Frederick and Turnbull, David (Editors), Solid State Physics and articles from the American Journal of Physics.

COURSE ANALYSIS QUESTIONNAIRE

A. DETAILS OF THE COURSE

A1. This course addresses the academic needs of those students who wish to learn the proper use of sophisticated electronic equipment in the collection of meaningful data in the modern scientific laboratory.

This course fits into the program of the Physics Department because applied physics and science students in general must be prepared to develop and use sophisticated techniques for the collection of data under exacting conditions.

The clientele for this course will be Physics, Applied Physics, and other science students.

All students majoring in applied physics must take this course.

Students with other majors may take this course with the approval of the instructor.

This course is NOT for the Liberal Studies course list at this time. In the future it will be proposed as a Writing Intensive course.

A2. This course does not require changes in the content of existing courses.

A3. This course differs from the usual course offering in that it is directed toward students who plan to enter some area of applied physics.

A4. This course has not been offered on a trial basis at IUP.

A5. This course is not intended to be dual level.

A6. This course is not to be taken for variable credit.

A7. This course is somewhat similar to laboratory programs offered by other colleges and universities that offer applied physics or engineering programs. Pitt and Penn State both offer engineering programs. Cornell offers an extensive degree program in applied or engineering physics.

A8. Neither the American Physical Society nor the American Association of Physics Teachers recommends nor requires any specific course for an Applied Physics program.

B. <u>INTERDISCIPLINARY IMPLICATIONS</u>

B1. The course will be taught by a single instructor or shared on a half-time basis by two instructors.

B2. Solid State Electronics Laboratory, the second semester of this course, is also being proposed.

B3. This course in no way impacts or affects other departments.

B4. Seats in this course will be available to all students who have appropriate physics background. This includes Continuing Education students.

C. <u>IMPLEMENTATION</u>

C1. a) One new faculty position is required because this course is one of four new courses that are part of a proposed Applied Physics program. The four new courses require 18 hours of new faculty complement.

b) This laboratory will share some facilities with the current PY 350, Intermediate Experimental Physics I. The remainder of the laboratory will be taught in the same laboratory space as the off-semester PY 353, Solid State Electronics Laboratory, which is being proposed.

c) The department budget is sufficient to purchase the additional equipment needed for the course.

d) Laboratory supply needs will be covered by the present physics budget.

e) Library holdings are adequate.

f) Current travel funds are adequate.

C2. No grant funds are associated with this course.

C3. The course will be offered yearly in the spring semester.

C4. One section of the course will be offered each spring.

C5. Sixteen students can be accommodated in this laboratory. The nature of the laboratory activities and room size restricts enrollment to this number.

C6. None of the appropriate professional societies recommend limits or parameters for a course of this nature.

C7. This course is required in all of the tracks of the proposed Applied Physics program. This course requirement does not necessitate having a program requirement of greater than 124 credits.

D. <u>MISCELLANEOUS</u>

This course proposal is part of a proposed Applied Physics program.

PY 353 Solid State Electronics Laboratory OC-6L-3sh

Prerequisite: PY 352 or permission of instructor.

In this laboratory the student will encounter a number of areas of current interest in semiconductor technology. The student will perform experiments and learn skills in such areas as device process simulation, device simulation, measurements of semiconductor materials, and measurement of device parameters. The student will also be instructed in the proper presentation of written and oral reports.

COURSE SYLLABUS

I. GATALOG DESCRIPTION

PY 353 Solid State Electronics Laboratory OC-6L-3sh
Prerequisite: PY 352 or permission of instructor.

In this laboratory the student will encounter a number of areas of current interest in semiconductor technology. The student will perform experiments and learn skills in such areas as device process simulation, device simulation, measurements of semiconductor materials, and measurement of device parameters. The student will also be instructed in the proper presentation of written and oral reports.

II. COURSE OBJECTIVES

This is a laboratory program intended to introduce students to a variety of areas of current technical interest in the semiconductor industry.

(1) The students will perform experiments and keep a log of all work performed in the laboratory.

(2) The students will also be taught how to give oral presentations and written reports in technical areas.

(3) Grades are to be based upon written reports and progress made by the student in obtaining the required skills for good laboratory work.

III. DETAILED COURSE OUTLINE

A. Device Process Simulation

1. SUPREM III

a. One dimensional doping profile
Multiple impurity doping involving current doping schemes, i.e. ion implantations and diffusion

b. Multiple-level oxidation of Silicon, Polysilicon and Silicon Nitride

c. Epitaxial growth of silicon starting with an appropriate substrate

2. SUPRA (Two dimensional version of SUPREM)

B. Measurement of Semiconductor Material

1. Hall Effect Measurements

a. Mobility measurement

b. Carrier concentration

c. Resistivity

d. Hall coefficient

2. Lifetime Measurements

a. OCD - open circuit decay

b. Zerbst analysis, C-t

3. Capacitance - voltage measurements

a. MOS properties

b. Surface states

4. Optical transmission effects

5. Ellipsometry - thickness of thin films

6. Thermal conductivities

C. Measurement of device parameters

1. I-V of P-N junction as a function of temperature

2. MOS parameters as a function of gate length, etc.

3. Measurement of mobility for n and p channel devices in the linear region

4. C-V of P-N junction to determine nature of junction, step-like, graded, etc.

D. Device Simulation using PISCES

1. Two dimensional simulation of MOSFET, trench isolation of CMOS, and Bipolar devices.

2. Output includes hole and electron current densities and potentials.

The laboratory sessions will be conducted twice a week for three hours during each period. The laboratory will be conducted during a period of 13 to 14 weeks. The goal is to study several aspects of each of the four major topics. A two to four week period will be spent on each of the major topics. The experimental problems associated with getting some of these experiments working could easily affect the time allotted to each area. The beginning of each period will be devoted to an oral presentation by a student on some aspect of his current work. The students will be expected to have read required materials before coming to lab and immediately start to work on their project. Periodically throughout the semester, written reports of a formal nature will be required of the students.

IV. EVALUATION METHODS

Students will be graded on the basis of their written laboratory reports (50%), oral presentations (25%), and an assessment of the progress made by the students in the laboratory (25%).

V. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

No text?

Materials will be developed and supplied to the students as is deemed necessary by the instructor.

Lab course - will make manual specific to course.

VI. SPECIAL RESOURCE REQUIREMENTS

Each student is expected to buy a packet of linear graph paper.

VII. BIBLIOGRAPHY

L. Solymar & D. Walsh, Lectures on the Electrical Properties of Materials
B. Streetman, Solid State Electronic Devices
S. M. Sze, Physics of Semiconductor Devices
F. Seitz & D. Turnbull (Editors), Solid State Physics
American Journal of Physics articles
Physical Review articles

COURSE ANALAYSIS QUESTIONNAIRE

A. DETAILS OF THE COURSE

A1. This course addresses the academic needs of those students who wish to develop skills in the areas of device process simulation, device performance simulation, measurements of semiconductor materials, and device parameters.
This course fits into the program of the Physics Department because students in the solid state electronics and computer science tracks of the applied physics program must be prepared to use these skills in the modern semiconductor industry.
The clientele for this course will be Physics, Applied Physics, and other science students.
All students majoring in the solid state electronics and computer science tracks of Applied Physics must take this course.
Students with other majors may take this course with the approval of the instructor.
This course is NOT for the liberal studies list.

A2. This course does not require changes in the content of existing courses.

A3. This course differs from the usual course offerings in that it is directed more toward students who plan to enter the semiconductor industry.

A4. This course has not been offered on a trial basis at IUP.

A5. This course is not intended to be dual level.

A6. This course is not to be taken for variable credit.

A7. This course is somewhat similar to laboratory programs offered by other colleges and universities that offer applied physics or engineering programs. Pitt and Penn State both offer engineering programs. Cornell offers an extensive degree program in applied or engineering physics.

A8. Neither the American Physical Society nor the American Association of Physics Teachers recommends nor requires any specific course for an Applied Physics program.

B. <u>INTERDISCIPLINARY IMPLICATIONS</u>

B1. The course will be taught by a single instructor or shared on a half time basis by two instructors.

B2. Applied Physics Laboratory, the first semester of this course, is also being proposed.

B3. This course in no way affects other departments.

B4. Seats in this course will be available to all students who have appropriate physics background. This includes Continuing Education students.

C. <u>IMPLEMENTATION</u>

C1. a) One new faculty position is required because this course is one of four new courses that are part of a proposed Applied Physics program. The four new courses require 18 hours of new faculty complement.

b) This laboratory will be housed in room 331 Weyandt. Plans have been made to convert this space into a laboratory space. Work orders have been submitted for 110 and 208 electrical power lines and for water supplies for the room. This work will be completed by IUP's maintenance staff when the program is approved. The necessary laboratory furniture is already in the department. The furniture was obtained through the campus inventory department.

c) Some specialized equipment items will be required for this program if it is to meet its potential to fully prepare students for the high-technology semiconductor field. Below is a time prioritized listing of essential equipment.

First year:

1) Sample Storage Containers	1,500
2) Drying Oven	900
3) OCD Lifetime Measurement	4,700
	7,100

Second year:

1) 4-point Resistivity Probe	8,250
2) Hot Chuck System	6,650
	14,900

Third year:

1) Interference Contrast Microscope	12,000
Total	$34,000

d) Laboratory supplies. Main item will be the acquisition of a set of wafers that will have the necessary test devices fabricated on them. Possibly $6,000. 6,000

e) Library holdings are adequate.

f) Current travel funds are adequate.

C2. No grant funds are associated with this course.

C3. The course will be offered yearly.

C4. One section of the course will be offered each fall.

C5. Sixteen students can be accommodated in this laboratory. The nature of the laboratory activities and laboratory space restricts enrollment to this number.

C6. None of the appropriate professional societies recommend limits or parameters for a course of this nature.

C7. This course is required in the solid state electronics and computer science tracks of the proposed Applied Physics program. This course requirement does not necessitate having a program requirement of greater than 124 credits.

D. MISCELLANEOUS

This course proposal is part of a proposed Applied Physics program.

PY 475 Physics of Semiconductor Devices I 3c-0L-3sh

Prerequisites: PY 231, PY 242, PY 342 or permission of instructor.

This course develops the basic foundation for a study of the theory of semiconductors. Elementary quantum concepts, the band theory of solids, electrical properties of solids, growth of semiconductor materials, and principles of semiconductor devices are discussed.

COURSE SYLLABUS

I. CATALOG DESCRIPTION

PY 475 Physics of Semiconductor Devices I 3c - OL - 3sh

Prerequisites: PY 231, PY 242, PY 342 or permission of instructor.

This course develops the basic foundation for a study of the theory of semiconductors. Elementary quantum concepts, the band theory of solids, electrical properties of solids, growth of semiconductor materials, and principles of semiconductor devices are discussed.

II. COURSE OBJECTIVES

This course presents the theory of solids for students in the applied physics program. These students must be introduced to quantum physics as applied to solids and to the general behavior of electrical conductors and semiconductors. The student will be brought to the point where simple junction devices and their operation can be discussed.

(1) The students will receive lectures on the properties of materials, etc. three times a week during the semester.

(2) Problems and outside readings will be assigned.

(3) Grades will be based upon written exams and homework solutions.

III. DETAILED COURSE OUTLINE

A. INTRODUCTION TO SEMICONDUCTOR PHYSICS AND DEVICES

1. The band theory of solids

   a. Quantum Mechanics

      (1) The Schroedinger View

      (2) The Heisenberg Uncertainty Principle

      (3) The Pauli Exclusion Principle

      (4) The Importance of Symmetry

      (5) Bloch Functions and Perturbations

   b. Holes and Electrons

   c. Nearly Free Electron Model

      (1) Density of States

      (2) Physical Results of the Model

d. Tight Binding Model

(1) Density of States

(2) Physical Results

e. Fermi-Dirac Statistics

f. Conductors, Semiconductors, and Insulators

g. The Transport of Electrons and Holes in Solids

(1) Energy and Symmetry Considerations

(2) The Effective Mass Approximation

h. Semiconductors

(1) Intrinsic and Extrinsic

(2) Doping (Ion Implantation and Diffusion)

(3) Compensation

(4) Carrier Concentration

(5) Mobility and Conductivity

(6) Carrier Lifetimes

(7) Thermal and Magnetic Effects

(8) Optical Properties

2. Non-Equilibrium Considerations

a. Carrier Injection Processes

b. Recombination Kinetics of Injected Carriers

c. Recombination Lifetime

d. Surface Effects and Recombination

e. Origin of Recombination-Generation Centers

3. P-N Junctions

a. Electrostatics in Junction Formation

b. Step Junctions

c. Linearly Graded Junctions

d. Capacitance-Voltage Characteristics

e. Current-Voltage Characteristics

f. Junction Breakdown and other Transient Behavior

B. SOLID STATE TECHNOLOGY

1. Bulk and epitaxial techniques for semiconductor growth
2. The kinetics of growth
3. Mass-transfer in the gas-phase as an illustrative mechanism
4. Properties of gases as applied to solid state physics
5. Oxidation and the kinetics of oxide growth
6. Space-charge effects on oxidation and oxide layers
7. The concept of flux
8. Diffusion and the development of the transport equation
9. A study of diffused layers by application of transport theory
10. Extension of the diffusion-transport concept
11. Impurity redistribution during thermal oxidation
12. Oxide masking in silicon (diffusion through SiO_2 layers)
13. Impurity redistribution during epitaxy

Seventy-five percent of the time will be spent on an Introduction to Semiconductor Physics and Devices and 25% of the time will be spent on Solid State Technology. The purpose of this course is to ensure that all the students obtain a firm theoretical foundation upon which to discuss the applications introduced in the second semester. Classes will consist of lectures based upon the material described in the topical outline. Problems will be assigned on a periodic basis. Exams will be given throughout the semester.

IV. EVALUATION METHODS

As a guideline it is suggested that the final grade be determined according to the following:

A. Two or three hourly exams
B. Homework problems, the total of which will be equivalent to one hourly exam.
C. Final exam equivalent to two hourly exams.

V. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

Textbook: Physics of Semiconductor Devices by S. M. Sze., John Wiley.

VI. SPECIAL RESOURCE REQUIREMENTS

The student is not expected to buy any materials or equipment for this course.

VII. BIBLIOGRAPHY

L. Solymar & D. Walsh, Lectures on the Electrical Properties of Materials
B. Streetman, Solid State Electronic Devices
F. Seite & D. Turnbull (Editors), Solid State Physics
American Journal of Physics Articles
Physical Review Articles

COURSE ANALYSIS QUESTIONNAIRE

A. DETAILS OF THE COURSE

A1. This course addresses the academic needs of those students who wish to develop an understanding of the fundamental physical concepts underlying the operation of semiconductor devices.
This course fits into the program of the Physics Department because students in the solid state electronics and computer science tracks of the applied physics program must be able to apply these concepts to understanding the operation of real devices.
The clientele for this course will be Physics, Applied Physics, and other science students.
All students majoring in the solid state electronics and computer science tracks of applied physics must take this course.
Students with other majors may take this course with the approval of the instructor.
This course is NOT for the liberal studies course list.

A2. This course does not require changes in the content of existing courses.

A3. This course differs from the usual course offering in that it is directed more towards students who plan to enter the high-tech semiconductor industry.

A4. This course has not been offered on a trial basis at IUP.

A5. This course is not currently being considered for dual level status.

A6. This course is not to be taken for variable credit.

A7. This course is similar to courses offered by other colleges and universities that offer applied physics or engineering programs. Pitt and Penn State both offer engineering programs. Cornell offers an extensive degree program in applied or engineering physics.

A8. Neither the American Physical Society nor the American Association of Physics Teachers recommends nor requires any specific course for an Applied Physics program.

B. INTERDISCIPLINARY IMPLICATIONS

B1. The course will be taught by a single instructor.

B2. Physics of Semiconductor Devices II the second semester of this course, will also be introduced.

B3. This course in no way impacts or affects other departments.

B4. Seats in this course will be available to all students who have appropriate physics background. This includes Continuing Education students.

C. IMPLEMENTATION

C1. a) One new faculty position is required because this course is one of four new courses that are part of a proposed Applied Physics program. The four new courses require 18 hours of new faculty compliment.

b) Current space allocations are adequate to offer this course.

c) No additional equipment is needed to teach this course.

d) No additional laboratory supplies or other consumable goods are needed to teach this course.

e) Library holdings are adequate.

f) Current travel funds are adequate.

C2. No grant funds are associated with this course.

C3. This course will be offered yearly in the spring semester.

C4. One section of the course will be offered each spring.

C5. Due to the nature and level of this course, enrollments larger than fifteen are not anticipated.

C6. None of the appropriate professional societies recommend limits or parameters for a course of this nature.

C7. This course is required in the solid state electronics and computer science tracks of the proposed Applied Physics program. This course requirement does not necessitate having a program requirement of greater than 124 credits.

D. MISCELLANEOUS

This course proposal is part of a proposed Applied Physics program.

PY 476 Physics of Semiconductor Devices II 3c-01-3sh
Prerequisites: PY 475 or permission of instructor

This course discusses the physics and operation of a number of discrete devices. These include bipolar transistors, MOSFETS, JFETS, CCDs, various diode technologies, photovoltaic and photoconductive devices, solid state lasers, and light emitting diodes.

COURSE SYLLABUS

I. CATALOG DESCRIPTION

PY 476 Physics of Semiconductor Devices II 3c-01-3sh
Prerequisites: PY 475 or permission of instructor
This course discusses the physics and operation of a number of discrete devices. These include bipolar transistors, MOSFETS, JFETS, CCDs, various diode technologies, photovoltaic and photoconductive devices, solid state lasers, and light emitting diodes.

II. COURSE OBJECTIVES

This course is a continuation of PY 475. Once a foundation in the theory of semiconductors has been established in PY 475, a number of applications can be explored. These applications will range from the well established pn junction diode and bipolar transistor to lasers and photoresponsive systems.

(1) The students will receive lectures on the properties of materials three times a week during the semester.

(2) Problems and outside readings will be assigned.

(3) Grades will be based upon written exams and homework solutions.

Topical Course Syllabus:

III. DETAILED COURSE OUTLINE

A. Bipolar transistor

1. The fundamentals of transistor action
   a. current gain
   b. limitations of the simple theory
   c. base resistance
   d. minimum and maximum voltage limitations
   e. thermal limitations

2. Applications
   a. small signal
   b. power handling
   c. switching capabilities

3. Fabrication
   a. planar structures
   b. mesa structures

B. Junction field effect transistors (JFET)

1. Fundamentals of operation
   a. the "channel" concept in terms of the simple theory
   b. power gain
   c. characteristics of the JFET

d. limitations of the simple theory
e. parametric limitations

2. Applications of JFETS
   a. small signal behavior
   b. power handling
   c. switching

3. Fabrication technology

C. Metal Oxide Semiconductor Field Effect Transistors (MOSFET)

1. Fundamentals of operation
   a. distinguish from JFET
   b. simple theory
   c. power gain
   d. characteristics of the MOSFET
   e. channel effects

2. Applications
   a. switching
   b. memory
   c. small signal
   d. power handling

3. Fabrication

D. Special Devices

1. Charge coupled devices (CCD)
2. Tunnel Diodes
3. Varactor diodes
4. Schottky diodes
5. IMPATT diodes
6. Photovoltaic devices
7. Photocondutive devices
8. Light Emitting diodes
9. Solid state lasers

E. Surface Effects

1. Surface effect theory for semiconductors
   a. surface space-charge region (equilibrium)
   b. Ideal structures MIS or MOS
   c. Effect of dissimilar work functions, charge affinities, and surface states on MOS characteristics
   d. Passivation

2. Surface effects on P-N junctions
   a. Surface space-charge region (non-equilibrium)
   b. metal semiconductor contacts
   c. gate controlled structures
   d. recombination-generation processes in the surface space-charge region

e. Field induced junction and channel currents
f. surface effects on junction breakdown

3. Surface field effect transistors
   a. theory of operation
   b. characteristics
   c. extension of the simple theory
   d. fabrication

Approximately 20% of the time will be spent on each major topic. The purpose of this course is to establish a working knowledge of the various devices that will be encountered by students entering semiconductor industry. Classes will consist of lectures based upon the material described in the topical outline. Problems will be assigned on a periodic basis. Exams will be given throughout the semester.

IV. EVALUATION METHODS

As a guideline it is suggested that the final grade be determined according to the following:

A. Two or three hourly exams
B. Homework problems, the total of which will be equivalent to one hourly exam
C. Final exam equivalent to two hourly exams

V. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

Textbook: Physics of Semiconductor Devices by S. M. Sze, John Wiley.

VI. SPECIAL RESOURCE REQUIREMENTS

The student is not expected to buy any materials or equipment for this course.

VII. BIBLIOGRAPHY

L. Solymar & D. Walsh, Lectures on the Electrical Properties of Materials
B. Streetman, Solid State Electronic Devices
F. Seitz & D. Turnbull (Editors), Solid State Physics
American Journal of Physics articles
Physical Review articles

COURSE ANALYSIS QUESTIONNAIRE

A. DETAILS OF THE COURSE

A1. This course addresses the academic needs of those students who wish to develop an understanding of the fundamental physical concepts underlying the operation of semiconductor devices.
This course fits into the program of the Physics Department because students in the solid state electronics and computer science tracks

of the applied physics program must be able to apply these concepts to understanding the operation of real devices.
The clientele for this course will be Physics, Applied Physics and other science students.
All students majoring in the solid state electronics and computer science tracks of applied physics must take this course.
Students with other majors may take this course with the approval of the instructor.
This course is NOT for the liberal studies course list.

A2. This course does not require changes in the content of existing courses.

A3. This course differs from the usual course offering in that it is directed more toward students who plan to enter the high-technology semiconductor industry.

A4. This course has not been offered on a trial basis at IUP.

A5. This course is not currently being considered for dual level status.

A6. This course is not to be taken for variable credit.

A7. This course is similar to courses offered by other colleges and universities that offer applied physics or engineering programs. Pitt and Penn State both offer engineering programs. Cornell offers an extensive degree program in applied or engineering physics.

A8. Neither the American Physical Society nor the American Association of Physics Teachers recommends nor requires any specific course for an Applied Physics program.

B. <u>INTERDISCIPLINARY IMPLICATIONS</u>

B1. The course will be taught by a single instructor.

B2. Physics of Semiconductor Devices I, the first semester of this course, is also being proposed.

B3. This course in no way impacts or affects other departments.

B4. Seats in this course will be available to all students who have appropriate physics background. This includes Continuing Education students.

C. <u>IMPLEMENTATION</u>

C1. a) One new faculty position is required because this course is one of four new courses that are part of a proposed Applied Physics program. The four new courses require 18 hours of new faculty complement.
b) Current space allocations are adequate to offer this course.
c) No additional equipment is needed to teach this course.

d) No additional laboratory supplies or other consumable goods are needed to teach this course.
e) Library holdings are adequate.
f) Current travel funds are adequate.

C2. No grant funds are associated with this course.

C3. This course will be offered yearly in the fall semester.

C4. One section of the course will be offered each fall.

C5. Due to the nature and level of this course, enrollments larger than fifteen are not anticipated.

C6. None of the appropriate professional societies recommend limits or parameters for a course of this nature.

C7. This course is required in the solid state electronics and computer science tracks of the proposed Applied Physics program. This course requirement does not necessitate having a program requirement of greater than 124 credits.

D. <u>MISCELLANEOUS</u>

This course proposal is part of a proposed Applied Physics program.

SSHE REQUIREMENTS FOR NEW PROGRAMS

1. Appropriate to Mission:

According to the University catalog, IUP's "primary concern is with the intellectual, moral, cultural, physical, social, and aesthetic development and maturation of its (our) students. To this end we are charged with providing a liberal education of both general and specialized studies which will allow our students to liberate themselves from narrow interests and prejudices, to broaden their intellectual horizons by increased cultural perspective, to develop the ability to think logically, critically, and creatively, and to communicate their judgements clearly and forcefully." The statement goes on to say that the University recognizes that such an education is only a beginning and hopes to stimulate its students to pursue continuous development and to become useful members of society by embracing careers which will touch the whole community.

Statement one of the Strategic Direction Statements of the State System of Higher Education (SSHE) states that within Pennsylvania Higher Education, the system shall maintain eight distinguishing features. The seventh feature is that "In addition to strong programs in the liberal arts and sciences, each university will offer selected professional programs for which there is sufficient need and demand, and the aggregation of system Universities will assure a range of programs preparatory for careers in such fields as education, health and human services, government, applied science and advanced technology, business, communication, and the arts.

The proposed Applied Physics program meets both objectives for today's high-technology and information based society. The program will offer the students of the Commonwealth of Pennsylvania the very best opportunity to find productive careers in a rapidly changing technological age, while still pursuing a broad liberal studies program. The Applied Physics program demands that the student obtain a solid background in fundamentals that will not change with time while still giving to the student a firm grounding in the techniques, instruments, and materials of today's technology. Students graduating from this program will be able to adapt to the future whether it be for post-undergraduate educational purposes or demands resulting from rapid changes in the industrial marketplace. It is clear that the proposed program will generate new and attractive options for students both entering and leaving IUP.

2. Need:

During the recent five year evaluation of the Department of Physics, the outside evaluators agreed with the Physics faculty that there was a real need for a degree in applied physics and that the faculty within the Department possessed the knowledge and expertise to develop such a program. The administration's action plan sent down to the department in response to the evaluation called for: "...the development of an applied physics curriculum or concentration, and (for the department) to determine the modification and/or additional resources necessary to implement this program."

The current direction taken by today's society is in large part the result of faster and faster computer systems which have opened up previously undreamt of areas of research and information processing. This explosion of information has produced an enormous demand for highly skilled scientists in the areas of development and manufacturing. That need has stripped the faculties of the engineering schools of this country, and as a result , many capable students interested in entering engineering fields find it impossible to be accepted into engineering schools.

But the problem of meeting the demand for scientists is even more complex. The enormous growth in information is leading us into new areas of study that, unlike traditional studies of years past, require a rather comprehensive knowledge of several sciences. For example, scientists are at work today on the development of new materials tailored to meet specific needs for areas such as power generation, device fabrication, and human implantation. This type of work requires a partnership of physicists, chemists, and biologists working on the problem. Engineering groups presently at work on the development of tomorrow's computers are made up of teams of scientists from all areas of the sciences, developing faster technologies, cheaper materials and studying their impact upon the end user - man.

The applied physics program contained in this proposal will offer students from the Commonwealth of Pennsylvania the opportunity to enter these new and developing areas of technology.

In 1986 a survey of 75 four-year institutions in the Commonwealth of Pennsylvania was performed to determine the numbers of students that applied to and enrolled in engineering (electrical, computer, etc.) and applied physics programs. Of these schools, 26 responded producing the following raw data:

	Applications	Enrollments
Engineering	11,265	2,511
Applied Physics	1,413	424

Based on information in the "IUP Official Annual Report, 1985-86," phone conversations with admissions personnel at IUP and other universities (Carnegie Mellon, University of Pittsburgh, and Pennsylvania State University), we found that students on the average apply to approximately three universities before determining a preference. Therefore, approximately one third of the applicants are interested in engineering and applied physics. The differential between this number and the total enrollment is 1,291. This represents the pool of students available who might be interested in an applied physics program at IUP. A copy of the survey questionnaire is enclosed in Appendix A. These numbers do not reflect a correction for out-of-state students because on the average a state will import as many students as it exports.

Employment trends in Pennsylvania published by the Pennsylvania Department of Labor and Industry in the publication "Pennsylvania Occupational Trends and Outlook for Total Civilian Employment 1984 and Projected 1995" indicate that the average annual job openings in several significant areas of interests to applied physicists will exceed 6000 (per year) between 1984 and 1995. The job breakdown for the included fields is given below:

Engineering Related:	Annual Average Jobs Total	Percent Change 1984-1995
Aeronautical & Astronomical	15	24.5
Civil	327	15.6
Electrical & Electronics	704	22.1
Engineering & Science Technicians	1550	4.3
Computer Related:		
Nat., Computer & Math Scientist	1324	27.9
Computer Systems Analyst, EDP	835	43.2
Computer Programmers	1248	56.7

Physical Science Related:		
Chemist	128	0.2
Geology, Geography, Oceanography	17	18.7
Meterologist	20	42.3
Physicists & Astronomers	4	-12.3
All other Physical Scientists	52	8.3
Life Science Related:		
Biological Scientists	67	18.0
Medical Scientists	46	22.8
TOTAL	6337	

These numbers do not include teaching and graduate assistant positions as well as several other indirectly related areas. Thus the above numbers represent a relatively conservative estimate of the number of positions that are open to a student with a degree in applied physics as proposed herein.

3. Academic Integrity:

This program is a rigorous intellectual experience for students. Comparison of the required courses for this program with those for the standard physics curriculum show no reduced requirements. The faculty who will develop this program have Ph.D. degrees in physics and many years of experience in the university as well as the industrial environment.

Our experience with physics majors and pre-engineering students convinces us that we can attract high-caliber students if we have a sound program to offer them. Setting out to attract the best possible applicants has set the tone for this proposed program.

We surveyed the catalogs of all the colleges either near to us or that we considered to have particularly strong academic programs in physics. We quickly obtained a cross-section of applied physics programs ranging from those that simply called their physics program an applied physics program to the larger schools, such as Cornell, that have departments of applied physics which draw heavily upon both the physics and engineering departments. We also found that a few schools had adopted programs that linked the various areas of study into new interdisciplinary programs. This was the direction we opted to take, considering it to be the most viable in terms of the ability to attract students, utilization of present faculty and space, and cost of implementation.

The program consists of a core of courses from the liberal studies package of the university and from the College of Natural Sciences and Mathematics. The program has five tracks:

i) Solid State Electronics

ii) Computer Science

iii) Chemistry

iv) Biology

v) Geology

Most of the courses are in place for these programs and only four new courses are proposed:

i) PY 352 Applied Physics Laboratory (3 sh) ... 6 hours of laboratory instruction per week.

ii) PY 353 Solid State Electronics Laboratory (3 sh) ... 6 hours of laboratory instruction per week.

iii) PY 475 Physics of Semiconductor Devices I ... 3 hours of lecture per week.

iv) PY 476 Physics of Semiconductor Devices II ... 3 hours of lecture per week.

This program has been developed with two fundamental objectives in mind: (1) Students can enter directly into the industrial marketplace confident that their background would allow them to adapt with relative ease to the ever changing challenges of high technology; (2) Students can pursue their chosen field of study in graduate school.

The resumes of the faculty members who will be associated with the Applied Physics program are attached to this proposal.

Dr. Larry Freeman will direct the program. Before coming to IUP he was associated with the U.S. Army's Night Vision Laboratory. At that laboratory he was in charge of a section that studied the properties of semiconductors of current interest and the fabrication of semiconductor devices.

Dr. Dennis Whitson, presently on leave at the research center at Wright-Patterson Air Force Base, is actively involved with computer modelling of semiconductor devices. His present work involves the study of GaAs devices. These devices are of current interest and a great many industrial laboratories are interested in devices fabricated from this material.

Dr. Muhammad Numan's research is in the area of applied physics. He currently is interested in the properties of thin film semiconductors and high temperature superconductors. He is currently involved with a joint research venture in applied physics with associates at the University of Texas at Houston.

Dr. Devki Talwar is internationally known for his theoretical work on semiconductors. He works with associates at Wright-Patterson and the University of Texas at Houston.

Dr. John Fox has done experimental work in the areas of amorphous semiconductors and the high temperature superconductors. He has close ties with work being done in the applied physics area at the Colorado School of Mines.

For further credentials on each individual, please review the resumes attached.

4. Coordination with Other Programs

A review of the programs available to students throughout Pennsylvania was completed by the faculty. The source of the information for this review was the current catalogs of the universities in this Commonwealth. Our findings are as follows:

A. Universities that offer a program titled "Applied Physics"

Shippensburg is the only university that has an "Applied Physics Program." However, the program is really a 3/2 engineering program in conjunction with Penn State and Wilkes College. This is similar to the program that we are preparing with the University of Pittsburgh. In our program we offer the student a B.S. in Natural Sciences when they complete their B.S. in Engineering at the University of Pittsburgh. Therefore, Shippensburg's program is quite different from the Applied Physics program presented in this proposal.

B. Universities that offer an interdisciplinary option with a Physics program

These universities include Millersville (engineering physics and computer science option), West Chester (computer science/geology-geophysics options, East Stroudsburg (biophysics option), Penn

State (acoustics/electronics/physical metallurgy options), and Carnegie Mellon (computer science/scientific instrumentation options).

The programs at these universities vary widely in quality and level of difficulty. In comparison to programs at Millersville, West Chester and East Stroudsburg, our proposed program is much more applications-oriented and based upon a stronger laboratory component in physics. Although the levels of the options offered by these universities are similar to those offered in our program, students in the applied physics program will have a much more extensive training in laboratory work, including computer interfacing, semiconductor physics, and device fabrication. IUP's research component offers a great deal of support for the applied physics program, with specialists within the department who are currently engaged in applied physics research.

Penn State and Carnegie Mellon's options are, of course, both excellent options. However, Penn State's option is not application-oriented while Carnegie Mellon's option is presented at a level out of reach for many of the Commonwealth's students.

C. Universities that offer technology programs with components similar to the proposed applied physics program

Universities that offer a technology program are The University of Pittsburgh at Johnstown (civil engineering technology/electrical engineering technology/mechanical engineering technology) and California University of Pennsylvania (electrical engineering technology/petroleum technology).

These programs in technology are based upon introductory level courses in physics and followed by a study of the particular technology. The programs are obviously intended to be terminal degrees. Our program will offer the students a much stronger foundation upon which to build a future in a world of technology which is constantly changing.

Overall, there are a number of programs available in the Commonwealth for students interested in today's technology. In summary, the proposed Applied Physics program clearly presents a well coordinated program that ties a number of technologies to the same foundation of fundamental science/laboratory courses. As we have shown elsewhere, there is a large number of qualified students unable to obtain admittance to schools such as Carnegie Mellon and for whom the applied physics program will be an extremely attractive alternative.

5. Periodic Assessment:

IUP provides for review of departmental programs by conducting departmental evaluations every five years. The applied physics program would be included in the five year evaluation of the physics department. There is no accrediting body for any physics program.

6. Resource Sufficiency:

A. Staff:

Although our present faculty has the skills and knowledge to introduce this program, we do not have the man hours available to handle the additional 18 hour load for the academic year. Therefore, we will request the addition of one faculty complement to handle this increased course load.

B. Learning Resources:

No additional resources beyond what has already been allocated to the physics department are needed for books, periodicals, or films. Over the past few years the physics department has acquired a number of Apple IIe, Apple IIGS, IBM, and Macintosh computers which will be used in the proposed program. The University is acquiring a VAX from the Digital Equipment Corporation. This machine is being purchased by the University, but it will also be useful in our proposed program.

C. Instructional Equipment:

A reasonable amount of financial assistance is required to establish the Applied Physics program and to assure that it realizes its potential. However, the development of the program will occur over a period of 3 to 5 years which should minimize the financial impact upon other university programs.

In order to teach the course entitled "Solid State Electronics Laboratory" the physics department requests a sum of $40,000 for the purchase of several pieces of equipment that are necessary if we are to prepare applied physics majors for positions in the solid state electronics industry. This number represents a substantial reduction in the originally proposed budget due to the donation of significant amounts of equipment to the department of physics by the IBM and Westinghouse Corporations. The donated equipment is valued in excess of $436,000. A list of this donated equipment is given below.

<u>Donations to IUP Physics Department</u>

Transient Recorder	IBM	$ 15,000
Microscope	IBM	6,000

E-Beam Power Supply	IBM	100,000
High Vacuum System	IBM	100,000
Sputtering System	IBM	100,000
Wire Bonder	IBM	12,000
Gas Analyzer	IBM	15,000
Nikon Comparator	IBM	13,000
Varian Vacuum System	Westinghouse	30,000
Ion Power Supply	Westinghouse	40,000
Shell Furnace	Westinghouse	3,000
Bell Jar	Westinghouse	2,000

It should be noted that the equipment purchased for the Solid State Electronics Laboratory will also find extensive use in other operations of the Physics Department. This equipment will be used by undergraduate and graduate students to pursue research projects.

Just as important is the fact that all of the additional equipment requested will establish an expanded base for future research. This equipment can be used to not only make measurements on Si but also other semiconductors of the future such as GaAs, InP, HgCdTe, etc. This significantly enhances the Physics Department's ability to attract new faculty and students, as well as outside funding for research and development in semiconductor physics.

The proposed program will rely heavily upon the equipment already available in the department and will certainly assure maximum use of our resources.

D. Facilities or facility modifications:

The program requires an additional 750 sq. ft. of laboratory space which has already been allocated (room 331 Weyandt). Plans have been made to convert this space into a laboratory space. Work orders have been submitted for 110 and 208 electrical power lines and for water supplies for the room. This work will be completed by IUP's Maintenance staff when the program is approved. The necessary laboratory furniture is in the department. The furniture was obtained through the inventory department on campus. The physics department has all of the other facilities needed to teach the courses and laboratories associated with the applied physics program. In addition, the department has research facilities in the areas related to this program.

E. Other: N/A

7. Impact on Educational Opportunity:

One of the mission statements of SSHE deals with preparing students for careers in the applied sciences and advanced technology. The proposed Applied Physics program certainly does this. It is as close to an engineering program as can be afforded by the SSHE system. The cost of the program is quite modest especially when it is compared with engineering programs.

The program can be marketed as an alternative to an engineering degree. The cost to the student is much less than at schools that offer engineering programs. This program thus becomes affordable to minority groups and to low income groups. The program can be a terminal degree program which would appeal to some students.

In addition the department of physics is seeking support for scholarships and internships through contacts at IBM. A special scholarship is being proposed for minority students. That scholarship requests tuition, room and board for the minority student.

JOHN N. FOX

Department of Physics
Indiana University of Pennsylvania
Indiana, PA 15705
412-357-2371

Residence:
201 Sunset Drive
Indiana, PA 15701
412-349-8788

Personal:

Born June 20, 1937 in Utica, NY.
Married with two sons.

Education:

B.S. in Physics, 1959, LeMoyne College, Syracuse, NY.
M.S. in Physics, 1961, The Catholic University of America, Washington, DC.
Ph.D. in Physics, 1971, Wesleyan University, Middletown, CT.

Experience:

1987 to present: Chairman, Department of Physics, Indiana University of Pennsylvania
1974 to 1987: Professor of Physics, Indiana University of Pennsylvania
1971 to 1974: Associate Professor of Physics, Indiana University of Pennsylvania
1961 to 1967: Instructor in Physics, Utica College of Syracuse University

Academic Achievements:

Renewal of Project ExCELS by NSF, $420,000, 1987-1990.
IUP Creative Teaching Grant, 1987, $2600.
NSF CSIP Grant, 1987, $18,000.
Faculty Research Associate in the IUP Institute for Advanced Research, 1985-1986.
Co-author of Project ExCELS: a $350,000 NSF grant for summer institutes on Interfacing Computers in Secondary School Laboratories, 1985-1987.
IUP Work-Study Grant, 1985, $500.
IUP Creative Teaching Grant, 1985, $3000.
IUP Creative Teaching Grant, 1984, $2200.
IUP Research Grant, 1984, $2500.
IUP Merit Sabbatical spent at the Colorado School of Mines, Golden, Co.,1982-1983.
Visiting NSF Faculty at Colorado School of Mines, Summer, 1979.
IUP Research Grant, 1976, $5000.

Visiting NSF Faculty, Wesleyan University, Middletown, CT, Summers of 1972, 1974, and 1976.
National Science Foundation Science Faculty Fellow, Wesleyan University, 1968-1971.
New York State Scholarship, LeMoyne College, 1955-1959.
Elected to Sigma Pi Sigma Honor Society.
Elected to Sigma Xi Honor Society.

Professional Affiliation:

American Physical Society.
American Association of Physics Teachers. Reviewer for the American Journal of Physics for the past fourteen years.
Pennsylvania State Teachers Association.
National Science Teachers Association.

Teaching Experience:

General Physics at all levels.

At the advanced undergraduate level:

Atomic Physics	Solid State Physics
Classical Mechanics	Thermal/Statistical Physics
Senior Laboratory Program	Optics
Senior Research Projects	Electricity and Magnetism
Modern Physics	Physical Electronics
Quantum Mechanics	

At the graduate level:

Statistical Mechanics	Advanced Mathematics
Solid State Physics	Quantum Mechanics
Mechanics	Electricity and Magnetism

Thesis direction:

Ten M.S. theses and eleven undergraduate research projects were directed by me during the past sixteen years at IUP. During four years of this period, the department did not accept students into the M.S. program. A number of my undergraduate students have been awarded University research grants for their work and several have received the local Sigma Xi award for their research.

My teaching experience is widely varied and I have had considerable experience in the development of new laboratory programs. At present I am involved with the organization and development of laboratory experiences that introduce students to computer controlled data acquisition. I have served on all the major committees of the department and have been a major contributor to the development of the department, including its proposed applied physics program. I served on the committee that rewrote our general physics laboratory program, and I directed the development of the department's senior laboratory program.

Research Experience:

My present research deals with the measurement of the resistivities and thermopowers of amorphous semiconductors and the thermal properties of coal liquids. In addition I recently manufactured the new high temperature superconductors $GdBa_2Cu_3O_y$ and $YBa_2Cu_3O_y$ and plan to measure their thermoelectric power. My previous work has included heat pulse studies in liquid and solid helium, metals and superconductors; a study of the enhanced transition temperature in thin film superconducting alloys; and the study of sound absorption in gases. While at IUP I have been nominated by the department three times for the Distinguished Faculty Award for Research.

Present Grant Activity:

Several activites are presently being pursued by me. The first is an NSF College Science Instrumentation Program grant awarded to me for a small sputtering facility that is to be a part of the senior laboratory program. I am preparing a $85,000 grant proposal to the NSF Undergraduate Research Program. This proposal is for a program of experimental studies on thin film amorphous semiconductors and would give my students the opportunity to use equipment at the Colorado Center for Amorphous Studies during the summer months. I have acquired for the department through the IBM Technical Gifts Program an Airco E-Beam evaporator and CVC high vacuum system, a five year old sputtering system, a transient recorder, a residual gas analyzer and an optical comparator for our research labs. We are also seeking additional equipment to support the new applied physics program.

Publications

1. Complex Cluster Integrals for an Augmented Gaussian Gas, Bull. Am. Phys. Soc. 6, (1961).
2. Complex Cluster Integrals for an Augmented Gaussian Gas, J. of Chem. Phys. 36, 731, (1962).
3. Inexpensive Photodensitometer, Am. J. Phys. 35, 359 (1967).
4. Laboratory Built on Air, Am. J. Phys. 35, 789 (1967).
5. Experiment to Determine the Relation Between Force and Potential Energy, Am. J. Phys. 35, 886 (1967).
6. Mechanical Demonstration of Excited States, Am. J. Phys. 36, 49 (1968).
7. Y-T Plotter for Linear Air Track, Am. J. Phys. 36, 61 (1968).
8. Demonstration Experiment Using a Dissectable Anharmonic Oscillator, Am. J. Phys. 36, 326 (1968).
9. Transmission Characteristics of Filters, Am. J. Phys. 36, 451 (1968).
10. Impulse Experiment for a Linear Air Track, Am. J. Phys. 36, 637 (1968).
11. A New Approach to Teaching of Elementary Physics, Am. J. Phys. 36, (1968).
12. Onset of Ballistic Pulses in Solid He^4, Phys. Rev. Letters 28, 15 (1972).
13. Low Temperature Characteristics of Carbon Films, Cryogenics 12, 438, (1972).
14. Magnetic Induction and the Linear Air Track, Am. J. Phys. 41, 75(1973).
15. A New Epoxy Putty for Low Temperature Applications, Rev. Sci. Inst., 44, 912 (1973).
16. Experiments Using a Tunnel Diode Oscillator, Am. J. Phys. 43, 662 (1975).
17. Measurement of the Thermal Properties of a Metal Using a Relaxation Method, Am. J. Phys. 43, 1083 (1975).
18. Second Sound in Solid He^4, Bull. Am. Phys. Soc. 3, Vol. 22 (1977).
19. Shape Analysis of Pulsed Second Sound in Crystalline He^4, J. Low Temp. Phys. 29, Nos. 5/6, 533 (1977).
20. Temperature and Field Dependence of Superconducting Thermometer Sensitivity, Cryogenics 6, 316 (1979).
21. Pulse Generated Sound in Helium Vapor, Bull. Am. Phys. Soc. 3, Vol. 25 (1980).
22. Absorption of Sound in Helium Vapor, J. Low Temp. Physics 41, Nos. 1/2 (1980).
23. Thermoelectric Properties of Amorphous Antimony, J. of Non-Crystalline Solids 65 215 (1984).
24. A Study of the Phase Transition of a Ferromagnetic Material, Am. J. Phys., 54, 723 (1986).
25. Measurement of the Thermal Conductivity of Liquids Using a Transient Hot Probe Technique, Am. J. Phys., 55, 272 (1987).
26. An Automated Experiment to Demonstrate the Full Capabilities of Computer Interfacing, Eur. J. Phys. 8, 273 (1987).
27. An Inexpensive Linear Transducer. Accepted for publication by the Physics Teacher.
28. Simple Free Fall Apparatus. The Physics Teacher, Feb. 1988.
29. The Velocity of Sound in a Closed Tube. Am. J. of Phys., 55, 1136 (1987).
30. A Real-Time Demonstration of the Depth Dependence of Pressure in a Liquid, Accepted for publication by the Am. J. of Phys.
31. Measurement of the Transition Temperature of a High T_c Superconductor. Accepted for publication by the Am. J. of Phys.

RESUME'

WALLACE LARRY FREEMAN
894 Marion Road
Indiana PA 15701
Phone: (412) 349-3808

EDUCATION:

Ph.D. Clemson University, Clemson SC - August 1976 - Physics

M.S. University of North Carolina at Greensboro, Greensboro NC - August 1971 - Physics

B.S. Appalachian State University, Boone NC - June 1969 - Physics

PROFESSIONAL EMPLOYMENT HISTORY:

I. ASSOCIATE PROFESSOR OF PHYSICS - Indiana University of Pennsylvania, Indiana PA - September 1987 - present.

II. ASSISTANT PROFESSOR OF PHYSICS - Indiana University of Pennsylvania, Indiana PA - August 1984 to September 1987.

MAJOR RESPONSIBILITIES:

1. Plan and teach Electronics and Advanced Electronics.
2. Plan and teach all Electronics laboratory exercises.
3. Teach General Physics.
4. Teach graduate level physics courses.
5. Supervise graduate students at the Masters degree level.
6. Supervise independent study projects at the senior undergraduate level.

III. CONSULTING PHYSICIST - Night Vision & Electro-Optics Center, Fort Belvoir VA - Summer 1987.

MAJOR RESPONSIBILITIES:

Collect and analyze data dealing with contact noise and resistivity associated with ion-beam sputter deposited contacts on Mercury Cadmium-Telluride resistor bars.

Night Vision & Electro-Optics Center, Fort Belvoir VA - Summer 1986.

MAJOR RESPONSIBILITIES:

1. To develop processes for the fabrication of indium diffused and ion implanted diodes to be used in the development of infrared imaging systems.

2. To devise experiments to determine the properties of diodes fabricated from Mercury Cadmium-Telluride and to analyze the resulting data.

3. To develop a computer model predicting the performance of a thermal imaging system based upon the bolometric process.

IV. PHYSICIST - Night Vision & Electro-Optics Laboratory, Fort Belvoir VA - November 1979 to August 1984.

MAJOR RESPONSIBILITIES:

1. Plan and direct development projects involving state of the art infrared sensor technology. This includes the extension of theories and practices to resolve a variety of problems related to the construction of integrated focal-planes for use in infrared imaging systems.

2. Perform independent study and analysis directed at the optimization of photo-detector properties as applied to advanced infrared imaging systems. This involves the correlation of fabrication procedures with the electrical characteristics of detector arrays and research into deposition techniques for thin (and thick) layers of metal and/or dielectrics.

3. Prepare and present briefings covering the results of investigations and findings of external contracts and in-house programs. This involves both theoretical and experimental evaluation of procedures, processes and concepts which relate to the physical characteristics of photo-detectors.

4. As a contracting officer's representative, provide input into the technical aspects of research and development contracts. Review and evaluate technical progress and recommend action, when necessary, that may redirect the technical effort.

V. PHYSICIST - Naval Intelligence Support Center, Suitland MD - July 1978 to November 1979

MAJOR RESPONSIBILITIES:

1. Perform independent analysis of telemetry emissions from naval missile systems. The objective was to decode the detailed performance characteristics of advanced missile systems in order to realistically determine their applications and limitations.

2. Prepare and present technical reports disclosing findings from the analysis of telemetry emissions from advanced naval missile systems.

3. As contracting officer's representative, provide expertise in negotiating technical aspects of specialized equipment acquisition contracts and external analysis contracts.

VI. INSTRUCTOR - Clemson University, Clemson SC - August 1977 to May 1978

MAJOR RESPONSIBILITIES:

1. Teach General Physics at the calculus and noncalculus level.

2. Perform research in the study of ionic transport in the Ammonium Halides by means of conductivity and diffusion measurements.

VII. INSTRUCTOR - Greenville Technical College, Greenville SC - March 1977 to August 1977 (part time evenings).

MAJOR RESPONSIBILITIES:

1. Teach General Physics at the noncalculus level.

VIII. HIGH SCHOOL SCIENCE TEACHER - Wade Hampton High School, Greenville SC - September 1976 to May 1977.

MAJOR RESPONSIBILITIES:

1. Teach courses ranging from Advanced Placement Physics to Honors Physical Science.

PATENTS:

"Method of Making Cold Shield for Infrared Detector Arrays," U.S. Patent Number 4,366,229. Filed 6 November 1981 and awarded 28 December 1982.

"Method of Making Cold Shield and Antireflector for Infrared Detector Array." Filed 28 April 1983 and awarded in the winter of 1984.

CONTRIBUTED AND INVITED PAPERS:

"The Fabrication and Characterization of Photoconductive Arrays from Epitaxial Cadmium Mercury Telluride Material." Society of Photo-Optical Instrumentation Engineers, April 1983.

"LPE HgCdTe for Common Module Arrays," Infrared Information Symposium," July 1982.

"The Anomalous Specific Heat of Silver Chloride," Department of Physics, Miami University, Oxford OH, May 1978 (invited).

"The Anomalous Specific Heat of the Silver Halides," American Physical Society, Washington DC, November 1976.

"The Quantum Size Effect in Thin Bismuth Films," American Physical Society, Virginia Beach VA, November 1976.

"The Quantum Size Effect in Thin Bismuth Films," American Physical Society, Atlanta GA, March 1976.

PUBLICATIONS:

"Contact Resistance and Noise in Mercury Cadmium Telluride Infrared Detectors," Final Report, Scientific Services Agreement by Battelle, Research Triangle Park Office for Night Vision & Electro-Optics Center, 10 September 1987.

"An Attempt to Fabricate and Make a Comparison Between Diffused and Ion Implanted Diodes in Liquid Phase Epitaxial Mercury Cadmium Telluride," Final Report, Scientific Services Agreement by Battelle, Research Triangle Park Office for Night Vision & Electro-Optics Center, 01 September 1986.

"LPE HgCdTe for Common Module Arrays," Infrared Information Symposium Proceedings, July 1982.

"Technical Analysis of Two Missile Infrared Sensors," Naval Intelligence Support Center, June 1980.

"Quantum Size Effect and Electric Field Effect in Thin Bi Films," Physical Review B, Vol. 17, No. 2, 15 January 1978.

"Quantum Size Effect in Thin Bismuth Films," Clemson University, Clemson SC, August 1976 (Ph.D. Dissertation).

"The Lattice Dynamics in Gallium Using the 6-Exp Potential with Parameters Determined by the Least Squares Method," University of North Carolina at Greensboro, Greensboro NC, August 1971 (M.S. Thesis).

PROFESSIONAL ORGANIZATIONS:

American Physical Society
The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
The American Association of Physics Teachers (AAPT)

PARTICIPATION IN PROFESSIONAL MEETINGS:

Short Course: "Submicron Electonic Devices," UCLA, 5 January 1987.

Solid State meeting of the American Physical Society, 30 March 1986.

GRANTS:

United States Department of Energy equipment grant contract number: DE-FG04-87AL42245, 7 August 1987, $6,626.00.

Muhammad Z. Numan

Physics Department
Indiana University of Pennsylvania
Indiana, PA 15705
Ph. (412) 357-2318

831 Oak Street
Indiana, PA 15701

Ph. (412)349-3935

Education:

Ph.D. College of William and Mary, Williamsburg, VA, 1982, in Solid State Physics. M.S. William and Mary, 1977.
M.Sc. First Class, 1974, and B.Sc. (Hons) First Class, 1972, Dhaka University, Bangladesh, Government merit scholar.

Employment:

1987 - present:	Assistant Professor, IUP, Indiana PA.
1984 - 1987:	Research Associate and Visiting Lecturer, University of North Carolina at Chapel Hill, NC.
1983 - 1984:	Research Instructor, East Carolina University, Greenville, NC.
1982 - 1983:	Research Associate, Virginia Commonwealth University, Richmond, VA.

Teaching Experience:

General Physics, Calculus and Non-Calculus
Electricity and Magnetism, Modern Physics
Physics of Solid State Devices
Advanced Electronics, Lecture and Laboratory. Microprocessor Interfacing
Supervision of Graduate and Undergraduate Physics Majors.

Research Experience:

Thin film characterization using Rutherford backscattering and channeling with MeV He^+ ions. TEM microanalysis. Auger electron spectroscopy. Electrical measurements: carrier concentration profiling by Van-der-Pauw method, capacitance-voltage measurements for dielectric characterization, metal-semiconductor contact resistance measurements.

Microelectronics: Shallow junction for VLSI. Transient enhanced diffusion of implanted dopant impurities in silicon. Thin dielectric films for CMOS technology. Thermal, high pressure, plasma, and anodic oxidation of ion implanted silicon -- impurity segregation effect. CMOS processing -- ion implantation, physical and chemical vapor deposition, photolithography, and dry etching.

Muon spin resonance studies of diffusion and trapping of light interstitials in metals. Nuclear particle detection, logic electronics, data acquisition, and analysis.

Cryogenics - liquid helium and liquid nitrogen temperatures. High and ultra-high vacuum systems.

Extensive use of micro, mini and mainframe computers. FORTRAN, PASCAL, BASIC and machine language programming.

Professional Affiliations:

American Physical Society, Materials Research Society.
American Association of Physics Teachers.

PUBLICATIONS

1. C. Boekema, R. H. Heffner, R. H. Hutson, M. Leon, M.E. Shillaci, W. J. Kossler, M. Numan and S. A. Dodds. Diffusion and Trapping of Positive Muons in Niobium, Phys. Rev. B26, 2342 (1982).

2. G. Bissinger, J. Geiser, J.M. Joyce, and M. Numan. Wake Formation by Mega Electron Volt-per-nucleon Bare H and He Ions in Large Hydrogen Molecules, Phys. Rev. Lett. 55, 197 (1985).

3. K. Cho, M. Numan, T.G. Finstad, W.K. Chu, J. Liu and J.J. Wortman. Transient Enhanced Diffusion During Rapid Thermal Annealing of Boron Implanted Silicon, Appl. Phys. Lett. 47, 1321 (1985).

4. M.Z. Numan, Z.H. Lu, W.K. Chu, D. Fathy and J.J. Wortman. Stability of Heavily Doped Silicon Formed by As Implantation and Rapid Thermal Annealing, MRS Symp. Proc. Vol 52, 31 (1986).

5. S.S. Choi, M.Z. Numan, T.G. Finstad, W.K. Chu, D. Fathy and J.J. Wortman. Oxidation of High Dose Arsenic Implanted Si, MRS Symp. Proc. Vol. 54, 567 (1986).

6. S.S. Choi, M.Z. Numan, W.K. Chu, J.K. Srivastava and E.A. Irene. Redistribution of Arsenic in Silicon During High Pressure Thermal Oxidation, Appl. Phys. Lett. 50, 688 (1987).

7. S.S. Choi, M.Z. Numan, W.K. Chuy, E.A. Irene. Anomalous Oxidation Rate of Silicon Implanted with Very High Doses of Arsenic, Appl. Phys. Lett. 51, 1001 (1987).

8. E.C. Frey, N.R. Parikh, M.L. Swanson, W.K Chu and M.Z. Numan. The Effect of Ge Segregation on Oxidation of Si, MRS Sump. Proc. (to be published).

9. A.E. Michel, M.Z. Numan, and W.K. Chu. Anomalous diffusion of Boron implanted into silicon along the [100] direction (to be published in Appl. Phys. Lett.).

10. W.K. Chu, A.E. Michel, and M. Numan, Ion Implantation Technology Conference, June 7-10, 1988, Japan, to be published in Nuclear Instruments and Methods in Physics.

RESUME'

DEVKI NANDAN TALWAR
208 N. Eighth Street
Indiana, PA 15701
(412) 349-3876 (Home)
(412) 357-4589 (Office)

Marital Status: Married
Date of Birth: April 6, 1949

EDUCATION

Ph.D., 1976, Solid State Physics, Allahabad University, Allahabad, India. Specialized in Vibrational Properties of defects on solids with dissertation on "Study of Lattice Dynamics of Perfect/Imperfect zinc-blende type crystals".

Examiners: Professor A. A. Maradudin, Irvine, California
Professor L. S. Kothari, New Delhi
Professor Bal K. Agrawal, Allahabad

M.S., 1970, Physics (Electronics), Agra University, Agra, India

B.S., 1968, Physics, Chemistry and Mathematics, Agra University, Agra, India

PROFESSIONAL EXPERIENCE

Aug. 1987 - Present: Assistant Professor, Department of Physics, Indiana University of Pennsylvania, Indiana PA 15705.

Sept. 1982 - Aug. 1987: Assistant Professor, Texas A&M University at Galveston, Department of Marine Sciences, P.O. Box 1675, Galveston, Texas. 77553.

Summer 1983: Visiting Scientist, Department de Physico-Chimie, Cea/Saclay, France.

Jan. 1980 - Aug. 1982: Visiting Assistant Professor, Department of Physics, University of Houston, Central Campus, Houston, Texas 77004. Collaborated with Professor C. S. Ting on problems related with the electronic properties of defects in semiconductors. Also taught undergraduate courses in Physics for seven semesters.

Dec. 1977 - Dec. 1979: Visiting Scientist, Service Electronique de Saclay, LERA, CEA/Saclay, France. Also collaborated with the theoretical/experimental group of Professor M. Balkanski at the Universite de Paris VI, Jussieu 75238, Paris, France.

Apr. 1976 - Dec. 1977: CSIR Post Doc. and taught Physics to freshman, sophomore and engineering students at Allahabad University.

THESIS DIRECTION

(i) One Ph.D. thesis (of Dr. K. S. Suh of University of Houston, 1988) was directed by me.
(ii) Supervising M.S. theses at IUP.

RESEARCH INTERESTS

Lattice dynamics: vibrational properties of defects in semiconductors. Band structure: electronic properties of disordered semiconductors/ super lattices, study of deep levels due to impurity centers (DX, E12, etc.) in II-VI, III-V compounds. Electronic and vibrational properties of hydrogenerated, chlorinated and flourinated amorphous semiconductors.

HONORS AND ACTIVITIES

Awarded National Merit Scholarship, 1964-1970
Awarded "Gold Medal" for securing highest marks in Physics B.S., 1968
Awarded "Kothari Gold Medal" for securing highest marks in Physics in the College M.S., 1970
Vice-President of Physics Society of Allahabad University, 1976

SPECIAL SKILLS

Knowledge of Fortran language to develop research oriented programs in the field of optical and electronic properties of crystalline disordered semiconductors, lattice dynamics, phonon conductivity and energy band spectra of solids. Specialized in using the Green's function technique for the phonon and electronic properties of isolated and complex defects in elemental and compound semiconductors.

LIST OF RESEARCH PUBLICATIONS

1. Phonon Conductivity of GaAs: M. D. Tiwari, D. N. Talwar and Bal K. Agrawal, Sol. State Commun. 9, 995 (1971).

2. Lattice Dynamics of II-VI and III-V Compounds: D. N. Talwar and Bal K. Agrawal, Sol. State Commun. 11, 1691 (1972).

3. Lattice Dynanics of Zn-Cd Chalcogenides--A Critical Point Analysis: D. N. Talwar and Bal K. Argrawal, Phys. Rev. 88, 693 (1973).

4. Surface Resonance Modes in Crystals: D. N. Tawar and Bal K. Agrawal, Ind. J. Pure & Appl. Physics, 11, 655 (1973).

5. Optical Studies of Lattice Vibration in Spahalerite Crystals--A Theoretical Approach: D. N. Talwar and Bal K. Agrawal, Phys. Stat. Solidi, B63, 441 (1974).

6. Raman Spectrum in Cubic ZnS-An Interpretation: D. N. Talwar and Bal K. Agrawal, Phys. Stat. Solidi, B64, 71 (1974).

7. Dynamical Displacement of Atoms in II-VI and III-V Compounds: D. N. Talwar and Bal K. Agrawal, Sol. Stat. Commun. 14, 25 (1974).

8. On Debye-Waller Factors and Melting Criteria of II-VI and III-V Compounds Semiconductors: D. N. Talwar and Bal K. Agrawal, J. Phys. C7, 2981 (1974).

9. Local Mode Frequencies Due to Isoelectronic Impurities in Zinc-Blende-Type Crystals: D. N. Talwar and Bal K. Agrawal, Phys. Rev. B9, 2539 (1974).

10. Calculated Far I.R. Lattice Absorption Spectra of Cadmium Telluride Doped with Beryllium: D. N. Talwar and Bal K. Agrawal, Proc. SSP, C17, 225 (1974).

11. Local Mode and I.R. Absorption Due to Substitutional Impurities in Zinc Sulphide: D. N. Talwar and Bal K.Agrawal, Phys. Rev. B9, 4362 (1974).

12. Local Mode Frequencies Due to Substitutional Impurities in Zinc-Blende-Type Crystals II. Effect of Force Constant Changes: D. N. Talwar and Bal K. Agrawal, Phys. Rev. B12, 1432 (1975).

13. Localized Vibrational Modes of Isolated Impurities in Ge: D. N. Talwar and Bal K. Agrawal, Sol. Stat. Commun. 22, 79 (1977).

14. Far I.R. Lattice Absorption in ZnS: Be System: D. N. Talwar and Bal K. Agrawal, J. Phys. Chem. Solids 39, 207 (1978).

15. Impurity Modes Due to Single and Pair of Defects in Ge: Bal K. Agrawal and D. N. Talwar, Phys. Rev. B18, 1751 (1978).

16. Phonon Conductivity of II-VI and III-V Compounds: D. N. Talwar, B. K. Ghosh and Bal K. Agrawal, Phys. Rev. B18, 1762 (1978).

17. Impurity Modes and Infrared Absorption in Doped Semiconductors: Bal K. Agrawal, D. N. Talwar, P. N. Ram and M. D. Tiwari, Proc. of the Int. Conf. on Lattice Dynamics, Paris 5-9, 1977, edited by M. Balkanski, Flammiron 359 (1978).

18. Impurity Modes and Infrared Absorption Due to Paired Defects: Bal K. Agrawal and D. N. Talwar, Proc. of the Int. Conf. on Lattice Dynamics, Paris 5-9, 1977, edited by M. Balkanski, Flammiron 414 (1978).

19. Pair Correlation Functions and Ion-Ion Potential for Liquid K: D. N. Talwar, Ind. J. Pure & Appl. Phys. 16, 1042 (1978).

20. Infrared and Raman Scattering Spectra Due to Single and Pair of Defects in Dilute Ge: Si Alloys: Bal K. Agrawal, Sunil Tripathi, Anil K. Misra and D. N. Talwar, Phys. Rev. B19, 5277 (1979).

21. Lattice Dynamical Study of Impurity Modes in Mixed Cuprous Halides: P. Plumelle, D. N. Talwar, M. Vandevyver, K. Kunc and M. Zigone, Phys. Rev. B20, 4199 (1979).

22. Defect Modes and Optica Behavior of Elemental Semiconducting Alloys: Bal K. Agrawal, Sunil Tripathi and D. N. Talwar, XIV Int. Conf. on the Physics of Semiconductors, Edinburgh Sept. 4-8 (1978) 669 (1979).

23. Green's Function Theory of Impurity Vibrations Due to Defect Complexes in Elemental and Compound Semiconductors: M. Vandevyver and D. N. Talwar, Phys. Rev. B21, 3405 (1980).

24. Impurity Induced Raman Scattering Spectra in Zinc-Blende-Type Crystas: Application of Mixed Indiu Pnicitdes: D. N. Talwar, M. Vandevyver and M. Zigone, J. Phys. C13, 3775 (1980).

25. Lattice Dynamics of Imperfect Homopolar Crystals: D. N. Talwar and Bal K.Agrawal, Crystal Lattice Defects 8, 185 (1980).

26. Concept of Force Variation Due to Charged Impurities in Elemental and Compound Semiconductors: M. Vandevyver, D. N. Talwar, P. Plumelle, K. Kunc and M. Zigone, Phys. Stat. Solidi B99, 727 (1980).

27. Phonon Mode Behavior in Mixed Cuprous Halides: D. N. Talwar and B. K. Ghosh, Ind. J. Pure & Appl. Phys 10, 733 (1980).

28. Possible Mechanism of Superconductivity in Metal Semiconductor Eutetic Alloys: C. S. Ting, D. N. Talwar and K. L. Ngai, Phys. Rev. Lett. 45, 1213 (1980).

29. Raman Scattering Spectra in Mixed $Ga_{1-x}Al_xAs(Sb)$ Crystals: D. N. Talwar, M. Vandevyver and M. Zigone, Phys. Rev. B23, 1743 (1981).

30. I.R. Absorption and Raman Scattering Spectra in Mixed Cuprous Halides: D. N. Talwar, M. Vandevyver, K. Kunc and M. Zigone, Phys. State. Solidi B103, 381 (1981).

31. Lattice Dynamics of Zinc Chalcogenides Under Compression: Phonon Dispersion, Mode Gruneisen and Thermal Expansion: D. N. Talwar, M. Vandevyver, K. Kunc and M. Zigone, Phys. ev. B24, 741 (1981).

32. Raman Scattering and Local Force Variations Due to Transition Element Impurities in Zinc-Sulfide Crystals: Effect of Pressure Applications: M. Zigone, M. Vandevyver and D. N. Talwar, Phys. Rev. B24, 5763 (1981).

33. Pressure Dependence of Impurity Induced Raman Scattering Spectra in ZnS Crystals: M. Zigone, M. Vandevyver and D. N. Talwar, J. de Physique C6-743 (1981).

34. Tight Binding Calculations for the Electronic Structure of Isolated Vacancies and Impurities in III-V Compound Semiconductors: D. N. Talwar and C. S. Ting, Phys. Rev. B25, 2660 (1982).

35. Vibrational Structure of Copper and Zinc Complexes in GaAs: A Theoretical Analysis: D. N. Talwar and M. Vandevyver, Phys. Rev. B25, 6317 (1982).

36. Electronic Structure of Pair Vacancies in Elemental Semiconductors, D. N. Talwar and C. S. Ting, J. Phys. C15, 6573 (1982).

37. Dynamical Behavior of Interstitials in Elemental Semiconductors, D. N. Talwar, J. Appl. Phys. 54, 2366 (1983).

38. Trends in the Local-Force Variations Due to Substitutional Transition Metal Impurities in ZnS: M. Zigone, M. Vandevyver and D. N. Talwar, Physica 116B, 58 (1983).

39. Vibrational Properties of HgCdTe System: D. N. Talwar and M. Vandevyver, J. Appl. Phys. 56, 1601 (1984).

40. On the Anomalous Phonon Mode Behavior in HgSe, D. N. Talwar and M. Vandevyver, J. Appl. Phys. 56, 2541 (1984).

41. High Resolution Infrared Absorption Measurements of Al Doped ZnSe, W. M. Theis, D. N. Talwar, M. Vandevyver, and W. G. Spitzer, J. Appl. Phys. 58, 2553 (1985).

42. Gallium Isotopic Fine Structure of Localized Vibrational Modes Due to Defect Complexes in GaAs: D. N. Talwar, M. Vandevyver, K. K. Bajaj, and W. M. Theis, Phys. Rev. B15, 8525 (1986).

43. Deep Levels Due to Chalcogen Defects in Si-Ge Solid Solutions: D. N. Talwar, K. S. Suh and C. S. Ting, Phil. Mag. B54, 93 (1986).

44. Theory of Impurity Vibrations Due to Isolated Interstitials and "Interstitial - Substitutional" Pair Defects in Semiconductors, D. N. Talwar, M. Vandevyver and K. K. Bajaj, Phys. Rev. 36, 1715 (1987).

45. Phonon Shifts and Widths in Dilute Elemental Semiconducting Alloys: D. N. Talwar, K. S. Suh, Phys. Rev. B36, 6045 (1987).

46. New Evidence of Small Lattice Relaxation for the DX Center in $Al_xGa_{1-x}As$, D. N. Talwar, M. O. Manasreh, K. S. Suh and B. V. Covington, Appl. Phys. Lett. 51, 1358 (1987).

47. Lattice Distortion Due to Isolated Defects in Semiconductors, D. N. Talwar, K. S. Suh and C. S. Ting, Phil. Mag. B56, 593 (1987).

48. Bond Length Relaxation and Thermodyamic Parameter in $A_{1-x}B_xC$ Alloy Semiconductors, K. S. Suh and D. N. Talwar, Crystal Lattice Defects (1988).

RESUME OF DENNIS WHITSON

EDUCATION:

Ph.D., Physics, University of Pittsburgh. 3.8/4.0 Q.P.A.
NASA PRE-DOCTORAL FELLOWSHIP.

M.S., Physics, University of Minnesota.

B.S., Physics, North Dakota State University.

EXPERIENCE:

AFOSR Resident Researcher, Wright-Patterson AFB, September 1987 -
Numerical Simulation of Heterojunction Devices Including the BICFET Devices and the QWITT Diode.

AFOSR Follow-on Grant Summer 1987
Further modeling of BICFET and new modeling of DOES device.

Wright Patterson Air Force Base, Avionics Group, Device Research, Summer 1986.

Wrote computer program to model the Bipolar Inversion Channel Field Effect Transistor (BICFET).

GTE R&D LABS, Waltham MA, Summer 1985

Full time summer and consulting during academic year. Designed and developed a LDMOS power device integrated with low power devices. The isolation was accomplished by trenching down through the epi-layer to the substrate and then refilling the trench using spin-on glass, polymide and polysilicon.

WESTINGHOUSE R&D, Pittsburgh PA: June 1984 to June 1985: Full time, Summer plus sabbatical year.
June 1981 to June 1984: Part time (~22 weeks per year).

Responsible for the design and development of high-voltage switches using deep levels instead of p-n junctions for reverse voltage blocking. The design included MOS and injection gates. Wrote research proposal for this project that was funded by NASA.

Used avalanche electron injection method to measure positive and neutral traps in SiO_2 caused by radiation from semiconductor processes.

Numerous other small projects such as looking into the feasibility of using SiC as a high temperature semiconductor, the effect of deep levels on CCD's, diode measurements of HgCdTe, etc.

INDIANA UNIVERSITY OF PENNSYLVANIA, Indiana PA, 1969 - Present:

Have taught Physics and done research at Indiana University of Pennsylvania (IUP) since 1969. Appointed full professor in 1977.

Among courses taught are electronics, microcomputer interfacing (using M6800 boards), solid state physics, quantum mechanics, electricity and magnetism, thermodynamics and optics.

Received a grant from the Westinghouse Educational Foundation for curriculum development of the microcomputer interfacing course. Other courses that I have developed and expanded include electronics and medical physics for nurses.

Have applied electronics techniques such as linear (bipolar and FET transistors, voltage regulators, analog multiplexers, transducers, etc.), digital (latches, multivibrators, transducers, etc.), and A/D and D/A converters. Have designed and built interfaces between MC6802D3 boards and cassette recorder, switches, LED's, speakers, and motors utilizing PIA's, ACIA's, PTM's, etc.

Research while at IUP has included contact resistance to high resistivity silicon, high resistance measurements on bovine bone, and electron resonance studies of flourapatite, ferro-magnetism and defects in silicon.

Supervised six M.S. and fifteen undergraduate students in above mentioned research.

Received five internal grants to undertake this research.

Summer 1975: NSF Summer Post-Doctoral position at the University of Pittsburgh.

Summer 1974: NASA Summer Faculty Fellowship, Manned Space Center in Houston, TX. Literature research on possible high voltage and electrostatic discharge problems for the space shuttle.

Summer 1973: NSF Summer Post-Doctoral Grant at University of Pittsburgh. Built new transmission line type nmr probe.

Summer 1972: NSF Short Course...University of South Carolina, Columbia SC...three weeks Electron Spin Resonance Course.

Summer 1971: NSF Summer Research Participation Program for Faculty at Case Western Reserve University in Cleveland OH...ten weeks. I was involved in Electron Spin Resonance Measurements.

Summer 1970: Employed at Syntron Manufacturing Company, Homer City PA. Did R&D on Electromagnetic vibrating machines.

PATENT DISCLOSURES:

The use of irradiation and selective annealing to produce hi-voltage deep level double injection switches.

Chlorine implantation to improve breakdown voltage, radiation hardness, and thermal stability of MOS devices.

PUBLICATIONS:

1. "Double-Injection Deep-Level Switch Development," Final Report on NASA Lewis Research Center Contract NAS3-23882, 1985.

2. "High Voltage Switching Using Compensated Silicon," Invited Paper, International Conference on the Physics and Technology of Compensated Semiconductors, Feb. 20-22, 1985, Madras, India.

3. "Double-Injection, Deep-Impurity Switch Development," with others, Final Report on NASA Lewis Research Center Contract NAS3-22247, Nov. 3, 1983.

4. "High-Voltage, Double-Injection, Deep-Level Switches: Device Design and Processing," Final Report for Internal Westinghouse Program, 1983.

5. "Homogenous rf Field Delay Line Probe for Pulsed Nuclear Magnetic Resonance:, Rev. Sci. Instr., 48: 268 (1977).

6. "The Prevention of Electrical Breakdown and Electrostatic Voltage Problems in the Space Shuttle and its Payloads. Part I: Theory and Phenomena; Part II: Design Guides and Operational Considerations," prepared for Lyndon B. Johnson Space Center, NASA, Feb. 3, 1975.

7. "Nuclear Magnetic Relaxation in Antiferromagneti $NiCl_2 \cdot 6H_2O$, $CuCl_2 \cdot 2H_2O$, and $MnBr_2 \cdot 4H_2O$," Phys. Rev. B, 6: 3262 (1972).

8. "Simple Pulsed Nuclear Magnetic Resonance Spectrometer," with I. J. Lowe, Am. J. of Phys., 34: 335-338 (April 1966).

9. "Analytical Computer Modeling of the NPN BICFET Device," Final Report, 1986 USAF-UES Summer Faculty Research Program, Air Force Office of Scientific Research, Contract No. F49620-85-C-0013.

10. "Effects on the BICFET of the Fermi Distribution Factor and the Al Mole Fraction," 1987 USAF-UES Mini-Grant Follow-on to Summer Faculty Research Program, AFOSR, Bolling AFB, Washington DC; Contract No. F49620-85-C-0013/SB581-0360.

PRESENTATIONS:

Gain Factors in the BICFET, Workshop on Compound Semiconductors and Microwave Materials and Devices, Monterey CA, Feb. 1988.

Modeling The BICFET and DOES Devices, University of Minnesota, April 14, 1988.

DEPARTMENT OF PHYSICS
FACULTY PUBLICATIONS, GRANTS AND PRESENTATIONS

July 88

PUBLICATIONS

DR. JOHN N. FOX

1. "A New Technique for Measuring the Transition Temperature of a Ferromagnetic Material," American Journal of Physics, with N. Gaggini.

2. "An Automated Experiment to Demonstrate the Full Capabilities of Computer Interfacing," European Journal of Physics 8, 273 (1987), with N. Gaggini.

3. "Measurement of the Thermal Conductivity of Liquids Using a Transient Hot Probe Technique," American Journal of Physics 55, 272 (1987), with N. Gaggini and R. Wangsani.

4. "A Simple Free Fall Apparatus, The Physics Teacher, with N. Gaggini and J. Eddy.

5. "The Velocity of Sound in a Closed Tube," American Journal of Physics 55, 1136 (1987), with J. Eddy, N. Gaggini, D. Ramsey and T. Kirkpatrick.

6. "A Real Time Demonstration of the Depth Dependence of Pressure in a Liquid," American Journal of Physics.

7. "An Inexpensive Linear Transducer," The Physics Teacher, with J. Eddy, N. Gaggini and D. Ramsey.

8. "Computer Interfacing in the Secondary School - A Preliminary Report," Bulletin of American Physical Society, 1987, with J. Eddy and J. Butzow.

9. "A Potpourri of Experiments from Project ExCELS," Bulletin American Physical Society, with J. Eddy and J. Butzow.

DR. JOHN MATOLYAK / DR. GEORGE MATOUS

1. "Simple Variable-Mass Systems: Newton's Second Law," The Physics Teacher.

DR. MUHAMMAD Z. NUMAN

1. "Anomalous Oxidation Rate of Silicon Implanted with Very High Doses of Arsenic," Applied Physics Letters, September 1987, with S. Choi, W. Chu and E. Irene of the University of North Carolina.

DR. DAVID M. RIBAN

1. College Physics, McGraw Hill, 1987, with G. Buckwalter; Instructor's manual for College Physics; Test Bank for College Physics; Solutions Manual for College Physics.

DR. KENNY SCHWARTZMAN

1. "Imaginary Parts of Coupled Electrons and Phonon Propagators," Physical Review B.

2. "Tight Binding Study of the Anomalous Phonon Spectrum of Barium," Physical Review B.

DR. DEVKI N. TALWAR

1. "New Evidence of Small Lattice relaxation of the DX center in $Al_xGa_{1-x}As$," Applied Physics Letters, with others.

2. "Deep Levels Due to Chalcogen Defects in Si-Ge Solid Solutions," Phil. Mag. B54, 93. 1986.

3. "Theory of Impurity Vibrations Due to Isolated Interstitials and Interstitial Substitutional Pair Defects in Semiconductors," Phys. Rev. 36, 1715, 1987, with others.

4. "Phonon Shifts and Widths in Dilute Elemental Semiconducting Alloys," Phys. Rev. B36, 6045, 1987, with K. S. Suh.

5. "Lattice Distortion Associated with Isolated Defects in Semiconductors," Phil. Mag, B56, 593, 1987, with others.

6. "Bond Length Relaxation and thermodynamic Parameter in $A_{1-x}B_xC$ Alloy Semiconductors," Crystal Lattice Defects, 1988, with D. S. Suh.

7. "Proton Threshold States in 27 Si and their Implications on Hydrogen Burning of 26Al," Nuclear Physics, A457 (1986).

GRANTS AND AWARDS

DR. RICHARD E. BERRY

1. Awarded a grant for $34,792 from NASA, NAG5-641.

2. Grant from Northrop Corporation "Purchases" engineering services and an LED optical signal generator.

3. Grant from EG&G renewed consulting agreement.

4. Received IUP award for summer 1988. Joint NASA-IUP continuation of Lidar research at NASA, Wallops Island.

DR. JOHN N. FOX

1. Received a matching $9,147 grant from NSF College Science Instrumentation program, "Sputtering Facility for Undergraduate Students."

2. Received a $240,000 NSF grant for Project ExCELS (with J. Butzow, T. Giambrone, L. Feldman).

3. Received a $2,600 Creative Teaching Grant from IUP for "Development of a Computer Interface Manual for Secondary Schools."

DR. W. LARRY FREEMAN

1. Received A $6,626 U.S. Department of Energy Used Equipment Grant.

2. Recieved an award from U.S. Army Summer Faculty Research and Engineering Program.

MR. NORMAN W. GAGGINI

1. Awarded Research and Scholarly Activity Grant from IUP for 1988-89.

DR. GEORGE MATOUS

1. Received a $500 grant from Digital Equipment Corportion, 1988.

DR. KENNY SCHWARTZMAN

1. Awarded a Faculty Research Associateship for 1988-89 with D. N. Talwar of the IUP Physics Dept.

DR. DEVKI N. TALWAR

1. Summer work at University of Houston - University Park, with Prof. C. S. Ting, June, July and August 1987 - under the research project Electronic Properties of Defects in Semiconductors.

2. Awarded a Faculty Research Associateship for "Transport in Superlattices" with K. Schwartzman, 1988-89 AY.

DR. DENNIS WHITSON

1. Received a grant of $82,000 from the U.S. Air Force to work on transistors for a year at the Wright-Patterson AFB (Ohio).

2. Received a $20,000 grant on Analytical Computer Modeling of the BICFET Device.

3. BICFET Research grant - $82,310.

DR. VYTHILINGAM WIJEKUMAR

1. Conducted experiments at TUNL at Duke University with collaborators from Duke and North Carolina State University, Summer 1987.

2. Had group discussions on current research at University of Notre Dame and Ohio State University, Summer 1987.

PRESENTATIONS

DR. W. LARRY FREEMAN

1. "An Attempt to Fabricate and Make a Comparison Between Diffused and Ion Implanted Diodes in Liquid Phase Epitaxial Mercury Cadmium Telluride," Final Report - U.S. Army Summer Faculty Research and Engineering Program; Sept. 1, 1986.

2. "Contact Resistance and Noise in Mercury Cadmium Telluride Infrared Detectors" - U.S. Army Scientific Services Program; Sept. 10, 1987.

DR. GEORGE MATOUS

1. Presented a paper at a meeting of Western Pennsylvania Section of the American Association of Physics Teachers held at Carnegie-Mellon (Experiment Combining Computer and Air Track), April 1988.

DR. MUHAMMAD Z. NUMAN

1. Presented a paper at the Materials Rsearch Society meeting in Boston. The paper, co-authored with E. Frey, N. Parikh, M. Swanson and W. Chu of the University of North Carolina, was titled "Ge Segregation and Oxidation Rate Enhancement During Oxidation of Si Containing Ge."

DR. KENNY SCHWARTZMAN

1. Gave a talk titled "Phonon Anomalies and Magnetic Behaviors in Transition Metals" as a colloquium speaker at Dartmouth University.

2. Attended the American Physical Society meeting held in New Orleans where presented the following papers: "Predictions of Anomalous Phonon Dispersion in BBC Transition Metals, and "Effective Complex Quasiparticle-Quasiparticle Interaction in Superconductors."

3. Presented "The Anomalous Phonon Spectrum of Barium: Electron Phonon Effects" at the annual meeting of the American Physical Society, New York, March 1987.

4. Presented "Calculation of the enhanced magnetic susceptibility of Paramagnetic Chromium" at American Physical Society meeting, March 1987.

DR. VYTHILINGAM WIJEKUMAR

1. Gave a talk titled "Unique Determination of the Amplitude and Phase for the Population of the Giant Dipole Resonance in the Reaction 13c(p,y)14N," before the physics faculty at Notre Dame University.

2. Presented paper,"The Spectroscopic Information of the Proton Threshold States in 26Al via the 25Mg(3He,d)26 Al Reaction," at the Ohio Section American Physical Society meeting at Ohio State University, April 14-16, 1988.

IUP

Curricular Offering/Change Authorization

Please Check One For Each Form

- [X] New Course Addition
- [ ] Course Deletion
- [ ] Course Number Change
- [ ] Course Descriptive Title Change
- [ ] Semester Hours Change

PHYSICS

Department

- [X] Undergraduate
- [ ] Graduate

List only one entry per form.
Submit this form to College Dean.

Please list below the full information requested for the course to be added/dropped or changed.

Action	Dept.	Number	Descriptive Title	Semester Hours	Remarks
Add	PY	352	APPLIED PHYSICS LABORATORY	3	
Drop					
Change From					
To					

My signature on this form signifies that I, or the approving agency which I chair on the following date approved the inclusion/deletion or changes listed above to the appropriate Master Course File.

Sign and route as follows
1. Scheduling - White
2. Chairperson - Canary
3. College Dean - Pink

[signature] Chairperson — Date 12/12/88

[signature] Dean of College — Date 12/12/88

Chairperson of Curr. Comm/Grad Council — Date

IUP

Curricular Offering/Change Authorization

Please Check One For Each Form

List only one entry per form.
Submit this form to College Dean.

- [X] New Course Addition
- [ ] Course Deletion
- [ ] Course Number Change
- [ ] Course Descriptive Title Change
- [ ] Semester Hours Change

PHYSICS

Department

- [X] Undergraduate
- [ ] Graduate

Please list below the full information requested for the course to be added/dropped or changed.

Action	Dept.	Number	Descriptive Title	Semester Hours	Remarks
Add	PY	353	SOLID STATE ELECTRONICS LABORATORY	3	
Drop					
Change From					
To					

My signature on this form signifies that I, or the approving agency which I chair on the following date approved the inclusion/deletion or changes listed above to the appropriate Master Course File.

Sign and route as follows
1. Scheduling - White
2. Chairperson - Canary
3. College Dean - Pink

John h. Fox — Chairperson — Date 12/12/88

CKatz — Dean of College — Date 12/12/88

Chairperson of Curr. Comm/Grad Council — Date

IUP

Curricular Offering/Change Authorization

Please Check One For Each Form

List only one entry per form.
Submit this form to College Dean.

- [X] New Course Addition
- [ ] Course Deletion
- [ ] Course Number Change
- [ ] Course Descriptive Title Change
- [ ] Semester Hours Change

PHYSICS
Department

- [X] Undergraduate
- [ ] Graduate

Please list below the full information requested for the course to be added/dropped or changed.

Action	Dept.	Number	Descriptive Title	Semester Hours	Remarks
Add	PY	475	PHYSICS OF SEMICONDUCTOR DEVICES I	3	
Drop					
Change From					
To					

My signature on this form signifies that I, or the approving agency which I chair on the following date approved the inclusion/deletion or changes listed above to the appropriate Master Course File.

Sign and route as follows
1. Scheduling - White
2. Chairperson - Canary
3. College Dean - Pink

John L. Fox — Chairperson — Date 12/12/88

A. Katz — Dean of College — Date 12/12/88

Chairperson of Curr. Comm/Grad Council — Date

IUP

Curricular Offering/Change Authorization

Please Check One For Each Form

List only one entry per form.
Submit this form to College Dean.

- [X] New Course Addition
- [ ] Course Deletion
- [ ] Course Number Change
- [ ] Course Descriptive Title Change
- [ ] Semester Hours Change

PHYSICS
Department

- [X] Undergraduate
- [ ] Graduate

Please list below the full information requested for the course to be added/dropped or changed.

Action	Dept.	Number	Descriptive Title	Semester Hours	Remarks
Add	PY	476	PHYSICS OF SEMICONDUCTOR DEVICES II	3	
Drop					
Change From					
To					

My signature on this form signifies that I, or the approving agency which I chair on the following date approved the inclusion/deletion or changes listed above to the appropriate Master Course File.

Sign and route as follows
1. Scheduling - White
2. Chairperson - Canary
3. College Dean - Pink

John L. Fox — Chairperson — Date: 12/12/88

A Katz — Dean of College — Date: 12/12/88

Chairperson of Curr. Comm/Grad Council — Date