Graduate Academic Council
2002 – 2003

Minutes of the Council meeting of November 15, 2002
Approved by the Council on Februrary 28, 2003

In attendance: S. Maloney, H. Charalambous, B. Spanier, C. Bischoff, E. Block, J. Mumpower, K. Trent, K. Sarfoh, L. Raffalovich, L. Trubitt, M. Genkin, R. Irving , C. MacDonald (Chair), J. Bartow (staff)

Unable to attend: M. Gallant, L. Cohen, C. Smith, G. Singh, J. Rudolph

Guests: Dean Kaloyeros and faculty from the School of Nanosciences and Nanoengineering; faculty from the Physics Department; Senate Chairperson John Pipkin

1. Minutes from the GAC meeting of 11/1/02 were approved without amendment.

2. Chair's Report – Carolyn MacDonald
    - A faculty forum will be held on 11/25/02 with the topic to be changes to the By-Laws.
    - A request has been received from a grad student asking that open assistantships be listed on the website.

3. Report of the Committee on Curriculum & Instruction – L. Raffalovich (report appended to the end of these minutes)

    Prof. Raffalovich presented the committee report, noting a correction in item five, first sentence, to be the word importance, rather than important. The Council acted to unanimously accept the report and approved the items within it.

4. Report of the Committee on Educational Policy and Procedures – Richard Irving

    The committee has been discussing the proposal received from the UAC regarding grading grievance policy and procedures. Further contact with the UAC is being pursued.

5. Old Business – NanoSciences and NanoEngineering Programs Proposal

    Discussion resumed regarding the Proposal. It was reported that since the last GAC meeting that correspondence has been received from the Chemistry and Physics departments indicating that both were supportive of the Nanosciences proposal. The message from Physics indicated that there was some on-going concern about cross-listing or overlap of course offerings. These concerns were detailed in an additional letter signed by six members of the Physics department. An additional letter from the Nanosciences faculty was distributed which responded to the concerns expressed in the letter from the six Physics faculty.

    Council members focused on the issue of cross listing of courses. Prof. Caticha from Physics explained that the six faculty members did not wish to delay the Nanosciences proposal, but would like to have the two faculty bodies talk about the potential cross-listings. Dean Kaloyeros from the SNN drew reference to the supporting letters from both the Chemistry and Physics departments. In regard to the cross listing issue, he indicated that it was important for SNN core courses to be taught within the SNN. Professor Block expressed frustration that since the last GAC meeting the Physics faculty had been unable to meet as a whole to discuss the SNN proposal, like the Chemistry department had. He suggested that one of the deans should convene such a meeting and made a motion to that effect. Dean Mumpower said that the Council's by-laws implied that it should focus on the academic merit of the proposal rather than the resource implications. Dean Kaloyeros drew attention to the external site visit report that strongly supported the proposal. Professor Raffalovich spoke against the motion to require a Physics department meeting, questioning what was to be gained. Dean Mumpower suggested that moving the proposal forward was a priority. Prof. Bakru, Physics Chair, commented that while there had not been a time since the last GAC meeting when all Physics faculty could meet, all had been individually consulted regarding their support for the SNN proposal and all were supportive. Prof. Block withdrew his motion to table the proposal and require the Physics department to meet.

Dean Mumpower moved that the curriculum proposal be approved and that the Physics department and SNN be encouraged to meet to discuss possible cross-listings. Professor Raffalovich inquired as to whether an influx of students from Physics to SNN was expected. Dean Kaloyeros indicated yes. Mr. Bartow inquired as to whether the issue at hand was of cross-listed *identical* courses or the establishment of approved course substitutions.

A question was raised about the quality and cohesiveness of the curriculum. Dean Kaloyeros pointed the Council to the external site visit report. He noted that some additional pre-requisites had been added. He clarified the intent of the three program "tracks." Professor Block inquired about library resources in support of the proposal. Dean Kaloyeros indicated that the SUNY format was being followed and that such matters had been considered by EPC when it reviewed and approved the Letter of Intent. Professor MacDonald asked the Council to continue to meet for an additional 15 minutes. A question was raised about campus ability to provide course pre-requisites. Dean Kaloyeros indicated that the numbers were small and that shouldn't be a significant issue, but deficiencies in prerequisites would need to be made up by students. A question was raised about the publications requirement. Prof. Bakru indicated this was not uncommon in Physics.

Chairperson MacDonald asked for clarification of the motion and of which version of the proposal was to be considered. Dean Mumpower indicated it should be to approve the curriculum proposal, with its three tracks. In reporting to the Senate, it could also be recommended that the Physics department and SNN meet to discuss the potential course overlap/cross-listing issues. Dean Kaloyeros reiterated the establishment of the three "tracks." Professor Spanier indicated that academic integrity and coherence is important and that efforts of the faculties to meet are important, but should not delay the proposal approval process.

Mike Genkin called for the question (motion) to be voted on. Professor Raffalovich seconded this call. The Council voted unanimously to approve the SNN proposal and recommend its approval by the Senate.

5. A motion for adjournment was made, seconded and approved.

Appended to these minutes are the nanoscience proposal, and letters from members of the physics and nanoscience faculty.

END OF 11/15/02 GAC MINUTES

To: Graduate Academic Council

From: Larry Raffalovich, Chair
GAC Committee on Curriculum & Instruction (CC&I)

Date: November 13, 2002

Subj.: Report and Recommendations

The CC&I met on 10/29/02. In attendance were: L. Raffalovich (Chair), G. Pogarsky, D. Parker, J. Bartow (staff), R.-M. Weber, F. Henderson, E. Block, & A. Cervantes-Rodriguez. Professors M. Gallant, K. Quinn & K. Sarfoh were unable to attend, although Prof. Gallant did forward comments in advance pertaining to agenda items.

Four proposals were considered. Two (items 1 & 2 below) are recommended to the GAC for approval, while two more (item 3 below) pertaining to graduate instruction have been tabled for further inquiry. The matter of graduate instruction policy is also a topic for further report to the Council (items 4 & 5 below).

1. The faculty of French Studies have requested that the admissions application requirement for the submittal of GRE scores become optional for applicants to their programs. The faculty submit that "that the exams do not serve as reliable predictors of student success in our programs, and that this is especially true for our many applicants who are not native speakers of English. Though we wish to encourage our applicants to take the exams, we feel that requiring them to do so often acts as a deterrent to their completing the application process." The Committee discussed the request and unanimously (7 – 0) recommends approval to the Council.

2. The faculty of Criminal Justice propose the establishment of an optional information technology concentration within their MA and PhD programs. For both, the concentration would be optional within the elective course components of the programs. The Committee discussed the request and is supportive of the proposal. Minor discrepancies in credits and course numbers were noted. The Committee voted unanimously (7 – 0) to recommend approval to the GAC, contingent upon corrections of these discrepancies (received 11/5/02).

3. The Committee received requests to authorize graduate instruction by individuals not possessing the doctoral degree, or holding the rank of Associate Professor, from the Department of Economics (3) and Department of Educational Administration (1). The Committee discussed the issue of quality assurance in graduate instruction at great length. It was determined that such requests for exception to policy should contain:
    - Proposed name of instructor, course to be taught and term of instruction
    - Course syllabus
    - Instructor's résumé
    - Support correspondence from Chair explaining why the exception is warranted, summarizing qualifications in relation to course content, audience, enrollment, need and essentiality.
    - Support statement from Dean of the School/College.

   Although noting that the requests before the Committee were for Fall 2002 course offerings, the Committee tabled the requests, to allow for any missing components from the above list to be solicited from the respective proposing units. Further action on the general matter of graduate instruction policy was taken by the Committee (4 & 5 below).

4. The Committee unanimously recommends that the Council pass a resolution asking the administration to take definitive steps to insure that graduate courses not be scheduled with instruction to be provided by individuals who do not meet the criteria spelled out in graduate policy.

5. The Committee considers the policy on graduate instruction of great importance in regard to quality assurance. Yet, recognizing the pragmatic difficulty of obtaining consideration of graduate instruction exceptions (from the GAC) in a timely manner, as currently specified in policy, the Committee recommends the Council ask its Committee on Educational Policy & Procedures to examine the current policy and consider proposing revisions that would enable more timely review of such requests.

End of 11/13/2002 GAC CC&I Minutes

The undersigned physics faculty congratulate the School of Nanoscience on its nascence and support its pursuit of excellence in this topical field. Nanoscience is a natural outgrowth, nationally, of materials science and bioengineering and, locally, of materials physics at this university. In 1976 this physics department chose to change its focus from nuclear to materials physics, metamorphosing the nuclear accelerator facility into an unparalleled materials modification and analysis laboratory. Nuclear chemist Walter Gibson, now James Corbett Distinguished Professor Emeritus, was recruited to chair the physics department and lead that venture. Under his leadership, and in the years that followed, the physics department developed as its primary focus of excellence a mature world-class materials physics program, and recruited and nurtured a number of outstanding young materials physicists. This program has been extraordinarily successful and forward-looking, spawning, in 1993 the Center for Advanced Technology in Thin films. The 1997 long-range plan of the department predicted that the next major thrust of department would be in the field of nanotechnology, which has now, in fact, generated the new school.

The new school will provide students a unique opportunity to receive an interdisciplinary education and training in a new technology area in an environment specially designed for the purpose. This is something that the physics department could not possibly provide while still remaining what it is supposed to be, a department devoted to physics. Thus, we regard the new school as a natural continuation of several decades of sustained effort by this department in the area of materials physics, and we endorse this new school's development of a specialized curriculum. However, we do have a few concerns about some specifics of the current proposal.

A primary concern is the high degree of overlap between several proposed nanoscience courses and existing physics courses. It could be argued that it is not unusual for engineering schools to teach courses which appear to duplicate in title, if not content, offerings of traditional science departments. However, the overlap here is more substantive, precisely because of the long history of this department in producing and supporting cutting edge materials and nanomaterials research. Further, there are important considerations beyond those of resource conservation, however compelling they might be in the current budget climate. It is a raison d'être of a research university that students benefit substantially from the unique disciplinary perspective of courses taught by professors actively engaged in research. It is also argued that, however efficiently physics faculty believe they could teach the necessary tools of calculus to physics students, there is a true pedagogical advantage in exposing students to the full theoretical foundation of a traditional mathematics course. We would argue along similar lines. A physics perspective on such fields as quantum mechanics is broad-based, an essential foundation for students who would strive to keep pace with, and even drive, the evolving field of nanotechnology. This is particularly true from a physics department with a mature materials focus and many years of providing eminently successful core education to students who have performed their doctoral theses on topics ranging from atmospheric science to protein crystallography. Further, we believe that we would benefit from the consequent closer association with nanoscience students and their faculty, and their faculty from us.

In some courses, an increased emphasis on some practical aspects of nanostructure devices may be desirable. We have no objection to this and will be happy to adapt our courses as necessary to serve the needs of the students, of both nanoscience and physics, to keep abreast of changing technology. This adaptation has always been a natural evolution in our curriculum. A historical example has been in response to the differing needs of exchange program students. We especially welcome input from the nanoscience faculty. A primary descriptor of the nanoscience initiative is "interdisciplinary", and we welcome their continuing interaction with the physics department.

We do understand that some duplication of material is unavoidable whenever a program in an interdisciplinary field is being launched. However, we feel that a closer coordination between the two programs is possible. Indeed, given the close ties between the physics department and the new school, we are somewhat surprised that an effort in this direction has not already been undertaken. We can only attribute this to the urgency with which the new school is being established and with which we have no intention to interfere. Therefore, in the interests of expediency we suggest the following slight modifications to the curriculum:

> The two currently proposed tracks of EITHER seven physics courses, OR seven nanoscience courses, should be replaced with a single more flexible, combined track, more in keeping with the

original proposal. The nanoscience courses listed in the table below should be replaced by physics courses that already cover a very substantial fraction of the material. This fraction, through a proper coordinating effort, can be increased. In cases where a 400 level physics course has been deemed equivalent to a 500 level nanoscience course, because of the high degree of specialization typical for undergraduates in physics, the physics department should apply for 400/500 shared resource status.

We also look forward to future discussions and the possibility of joint undertakings such as cross-listing new or jointly taught material. We certainly do not feel that there is any shortage of courses that should be taught which would justify duplication, and cite the large number of exciting proposed new courses listed in the proposed curriculum as examples.

Of the 55 proposed new courses, we feel that there is particularly high degree of overlap for the 9 courses listed below. This exists partially because of the unusually strong focus of this physics department on materials and nanoscale phenomenon.

Proposed		Existing	
SNN 502	Mathematical Methods for Non-Biological Nanosciences	Phy 510	Mathematical Methods in Physics
SNN 505	Crystallinity and Structure of Nanomaterials	Phy 566	X-Ray Optics, Analysis and Imaging (Phy 566 and 562 together cover SNN 505 and 519)
SNN 511	Quantum Theory of Solids I	Phy 450	Quantum Mechanics II
SNN 512	Quantum Theory of Solids II	Phy 532	Solid State Physics
SNN 516	Physical Kinetics	Phy 460	Thermodynamics and Statistical Physics
SNN 517	Science and Nanoengineering of Semiconductor Materials and Nanostructures	Phy 567	Physics of Semiconductor Devices
SNN 519	Principles of Materials Nanoengineering	Phy 562	Structure and Properties of Materials
SNN 667	Surface Analysis	Phy 563	Particle-Solid Interactions
SNN 670	Transmission Electron Microscopy	Phy 580	Electron Diffraction and Microscopy

Finally, we would like to offer some suggestions to the Nanoscience faculty that we feel would strengthen their curriculum proposal.

1) Several of the courses, e.g. SNN 541, 606, 632, etc. would appear to be parts of natural sequences or otherwise need more clearly defined prerequisites. Other courses, for example 632, 665 and 670 appear to have some overlap which should be clarified, perhaps by specifying prerequisites..
2) Clarification of prerequisites for 600 level courses needs to be made if multiple non-identical core sequences exist.
3) Explicit suggestions could be listed for the "external", elective courses, such as Phy 560 or 570, or specific biology, chemistry or computer science courses.

Respectfully,

Ariel Caticha
Jesse Ernst
T.S. Kuan
William Lanford
Susanne Lee
Carolyn MacDonald

End of Letter

The undersigned SNN faculty and instructors wish to thank the group of physics faculty for their well meaning and eloquent open letter of Thursday November 14. The SNN faculty members echo the desires and feelings of the group of physics faculty, particularly in terms of building a mutually beneficial collaborative relationship between the SNN and the physics department to best leverage inter-departmental instructional resources, and position the faculty of both academic units to optimize joint capabilities to support teachings loads across departmental lines.
However, the letter contains a number of erroneous assumptions and inappropriate concepts that require a thorough and detailed response for the sake of historical accuracy and scientific veracity, as outlined below.

1. The fields of nanosciences are not "a natural outgrowth, nationally, of materials science and bioengineering." As succinctly captured in the 2001 Report by the U.S. Commission on National Security in the 21st Century, "the world is entering an era of dramatic progress in bioscience, materials science, and information technology... Brought together and accelerated by nanoscience, these rapidly developing research fields will transform our understanding of the world and our capacity to manipulate it." Clearly, nanoscience is not a "topical field" that is a "natural outgrowth of material science and bioengineering," but instead the fundamental knowledge base that underlies and drives materials science and bioengineering, as well as many other fields.

   As further affirmation of the definition of nanosciences, the 2002 Edition of the National Nanotechnology Initiative, published by the National Science Foundation (NSF), emphasizes that nanosciences consist of those interdisciplinary fields that reside at the intersection of chemistry, physics, and biology. These fields are intended to develop and disseminate the "knowledge base necessary for controlling the growth of the basic building blocks of physical, chemical, and biological systems at the molecular level, atom by atom, leading to the formation of real life systems with novel properties, unique performance, and innovative functions."

   In this respect, for a group of well-intended physicists whose area of expertise is not nanosciences to claim that nanotechnology at the campus level is an outgrowth of materials physics, and ignore the equally important contributions of the chemistry and biology, demonstrates a basic misunderstanding of the entire concept of nanosciences. It is the belief of the SNN faculty that this basic misunderstanding translates into an erroneous perception of the presence of a substantively larger overlap than what really exists between selected SNN courses and their physics counterparts.

2. The "1997 Long-Range Plan for the Physics Department" which, incidentally, was prepared with active and extensive participation by physics faculty who are presently also concurrent members of the SNN, did not "predict that the next major thrust in the department would be in the field of nanotechnology." Not only was the field of nanotechnology not defined by the National Academy of Science until 2000, but the long range plan of the physics department does not mention nanotechnology once, nor does it call for the initiation of a major thrust in the area of nanosciences (a copy of the 1997 1997 Long-Range Plan for the Physics Department is enclosed as reference).

3. The SNN faculty members strongly disagree with the assessment of the group of physics faculty that a substantive overlap exists between selected SNN and physics courses. The SNN courses in question are primarily focused on fundamental treatments of nansocale phenomena and associated applications to nanoscale systems that <u>are at the intersection of physics, chemistry, and biology</u>. This fact was recognized by the physics faculty, who stated that "The new school will provide students a unique opportunity to receive an interdisciplinary education and training …in an environment specially designed for the purpose. This is something that the physics department could not possibly provide while still remaining what it is supposed to be, a department devoted to physics."

   In this respect, it is the unanimous and unambiguous opinion of the SNN faculty that the offer advanced by the physics faculty to modify physics courses to provide "an increased emphasis on some practical aspects of nanostructure devices may be desirable…and…be happy to adapt our courses as necessary to serve the needs of the students of both nanosciences and physics, to keep abreast of changing technology" is well-intending, yet unsuitable and unrealistic because it is based on the flawed premise of replacing SNN courses with physics courses, instead of cross-referencing or cross-listing of courses. The elimination of SNN courses and their replacement with physics courses is a serious problem for the reasons discussed below.

First, by offering to modify physics courses to increase emphasis on "some practical aspects of nanostructure devices" demonstrates again a fundamental misunderstanding of the entire concept of nanosciences. As argued earlier, nanosciences are not a "new technology area" but true scientific fields. We would therefore have serious reservations and significant doubts that faculty who are not well verse in the field of nanotechnology can actually revise physics courses to accommodate the needs of nanosciences. More importantly, modifying physics courses to simply include some practical aspects of nanostructure devices does not provide students with the necessary intellectual tools and scientific knowledge base necessary for a true nanosciences education.

Second, the proposal to modify physics courses "as necessary to serve the needs of the students, of both nanosciences and physics…" could seriously jeopardize the core educational mission of what should be a true physics department. In this respect, it is the consensus of SNN faculty that the proposal to change physics courses violates the essential premise expressed by the group of physics faculty that a physics department could not possibly provide the interdisciplinary education and training required for nanosciences courses "…while still remaining what it is supposed to be, a department devoted to physics."

Thirdly, the SNN faculty is driven by a strong and unequivocal commitment to the development of the SNN curriculum as a sound, viable, self-contained, and comprehensive instructional vehicle that best serves the needs of the university student clientele in the rapidly expanding disciplines of nanosciences and nanoengineering. It is a raison d'etre of any successful academic unit to retain control over the content of its core courses to ensure that a distinctive, student-centered pedagogical experience "which will be highly competitive as the result of its intellectual coherence, rigor and engagement of students with faculty in the process of inquiry and discovery."

Accordingly, the SNN faculty members fully agree with the statement of the group of physics faculty that "students benefit substantially from the unique disciplinary perspective of courses taught by professors actively engaged in research." In this respect, wouldn't be in the best interest of the students to be taught the core courses in question by faculty who are actively involved in nanotechnology research, i.e., the SNN faculty? Isn't this consideration a primary driver in the decision of traditional science departments to teach courses that appear to overlap substantively with their counterparts in other academic departments (see Table 1 enclosed)?

In closing, the SNN faculty members strongly believe in a close association with the physics, chemistry, and biology departments. We especially have and will continue to welcome their input in formulating a continuing and expanding partnership with the SNN, and propose leveraging of inter-departmental instructional resources by providing critical faculty capabilities to support the teachings loads in these departments.

However, this close association has to be based on a model that is equitable, mutually beneficial, and consistent with prevailing instructional paradigms. Most importantly, the model must, first and foremost, provide students with the best educational opportunities possible. In particular, a close coordination with physics is already in place, and we are surprised that the group of physics faculty ignored the fact that our initial proposal included cross-listing (or cross-referencing) of the courses in question between the SNN and Physics in a fashion that is consistent with prevailing inter-departmental partnerships. The cross-listing approach is certainly supported by many examples of existing inter-departmental arrangements, such as PHY 570A (CHEM 544) THEORY AND TECHNIQUES OF BIOPHYSICS AND BIOPHYSICAL CHEMISTRY; PHY 563 (CHM 563) PARTICLE-SOLID INTERACTIONS (see Table I).

We are equally surprised that the group of physics faculty chose to ignore the fact that some of its members demanded removal of such cross-listing, a request that was promptly implemented to demonstrate our willingness to be responsive to the concerns of our colleagues, without sacrificing or jeopardizing the integrity and worth of our proposed curriculum.

We urge the group of physics faculty to reconsider their proposal and, in the interests of expediency, accept the recommendation to implement a cross-listing model of courses that best leverages combined resources while ensuring a "…distinctive, student-centered pedagogical experience…" which will be highly competitive as the result of "…its intellectual coherence, rigor and engagement of students with faculty in the process of inquiry and discovery." (University Mission Statement). Thank you.

Hassaram Bakhru; Michael Carpenter; James Castracane; Katharine Dovidenko; Kathleen Dunn; Eric Eisenbraun; Harry Efstathiadis; Michael Fancher; JoAnne Feeney; Robert Geer; Pradeep Haldar; John Hartley; Mengbing Huang; Alain E. Kaloyeros; Vincent Labella; Ernest Levine; Eric Lifshin; Richard Moore; Serge Oktyabrsky; James Raynolds; Fatemah Shahedipour; Timothy Stoner; Vadim Tokranov; Paul Toscano; Bai Xu; John Welch; Di Wu.

Table I. Examples of Existing Chemistry and Physics Courses with Various Degrees of Overlap.

Chemistry Course	Equivalent Physics Course
CHM 525A--Physical Organic Chemistry Topics in physical organic chemistry, including electronic structure, stereochemistry, and conformational analysis.	PHY 532--Solid State Physics A broad survey of the phenomena of solid state physics. Symmetry restrictions on physical properties; electronic and vibrational band structures in crystalline metals, semiconductors, and insulators, and in liquids; electronic properties include transport and optical properties; magnetism; superconductivity.
CHM 535B--Advanced Physical Chemistry Selected topics in thermodynamics, statistical mechanics, and chemical kinetics.	PHY 460--Thermodynamics and Statistical Physics PHY 612 -- Statistical Mechanics
CHM 555--Quantum Chemistry The quantum theory of chemical bonding and structure; abinitio, empirical and semi-empirical methods of approximation including: self-consistent field, Hartree-Fock theory, configuration interaction, Huckel theory, expanded Huckel theory and NDO methods.	PHY 617--Quantum Mechanics II Theory of angular momentum; rotation, Clebsch-Gordan coefficients, Wigner-Eckart theorem. Approximation, methods, perturbation, variation and WKB approaches, identical particles, Thomas-Fermi model, Hartree-Fock equation. Semiclassical theory of radiation
CHM 560--Chemical Thermodynamics Examination of the laws of thermodynamics; application of the laws to chemical and biochemical systems. Topics include: states of matter,	PHY 612--Statistical Mechanics An introduction to statistical methods and the description of a variety of phenomena on a statistical basis. Thermodynamics, statistical mechanics, and kinetic

thermochemistry, chemical equilibrium, phase changes and equilibrium, the nature and descriptions of solutions.	theory are presented from a unified point of view. Topics include elements of probability theory, interaction between macroscopic systems and their parameters, equilibrium, ensembles, classical and quantum statistics, systems of interacting particles, Boltzmann equation, irreversible processes, and fluctuations.

Table I. Examples of Existing Chemistry and Physics Courses with Various Degrees of Overlap (Continued).

Chemistry Course	Equivalent Physics Course
CHM 544--Theory and Techniques of Biophysics and Biophysical Chemistry Comprehensive study of the physical chemistry of biopolymers; structure- confirmation-function interrelations, including systematic coverage of theoretical and experimental aspects of such topics as solution thermal dynamics, hydrodynamics, and optical and magnetic characteristics. Prerequisites: One year of biochemistry and one year of physical chemistry.	Phy 570A (CHM 544)--Theory and Techniques of Biophysics and Biophysical Chemistry Introductory theory and applications of thermodynamics, spectroscopy, and diffraction as used to probe biomolecular structure in modern quantitative biology, biophysics, and biochemistry. A Physics Department survey course.
CHM 563--Particle-Solid Interactions (3) A survey of basic phenomena encountered in the interaction of atomic particles with a solid and of their underlying physical principles. Topics include stopping power and particle beam methods for materials characterization, modification, and removal such as backscattering and channeling, ion implantation, and sputtering.	PHY 563--Particle-Solid Interactions A survey of basic phenomena encountered in the interaction of atomic particles with a solid and of their underlying physical principles. Topics include stopping power and particle beam methods for materials characterization, modification, and removal such as backscattering and channeling, ion implantation, and sputtering.
CHM 570--Crystallography The geometry and structure of crystalline solids, and methods of importance in their investigation. Internal and external symmetry properties as a consequence of atomic types and bonding possibilities: lattice types and space groups, x-ray diffraction, and optical techniques. Open to chemistry and physics majors, and others with consent of instructor.	PHY 566--X-Ray optics, Analysis and Imaging A broad survey of x-ray optics and their uses. Introduction to the theory of x-ray interaction with matter, including refraction, diffraction, total reflection, image formation, fluorescence, absorption, and surface roughness. Applications include x-ray astronomy, microscopy, lithography, materials analysis and medical imaging.
CHM 644--Chemical Statistical Thermodynamics Fundamentals of classical and quantum	PHY 612--Statistical Mechanics An introduction to statistical methods and the description of a variety of phenomena on a

Table I. Examples of Existing Chemistry and Physics Courses with Various Degrees of Overlap (Continued).

Chemistry Course	Equivalent Physics Course
statistical mechanics. The calculation of thermodynamic properties of ideal gases, crystals and ideal rubber elasticity. An overview of cooperative systems and their phase transitions. An introduction to topics in transport theory.	statistical basis. Thermodynamics, statistical mechanics, and kinetic theory are presented from a unified point of view. Topics include elements of probability theory, interaction between macroscopic systems and their parameters, equilibrium, ensembles, classical and quantum statistics, systems of interacting particles, Boltzmann equation, irreversible processes, and fluctuations.
Chm 685A,B (PHY 855A,B)--Seminar in Chemical Physics (2,2) Lecture-discussion presented by faculty and graduate students on current literature in their field. Same as Phy 855A and B. Offered jointly with the Department of Physics.	PHY 855A,B (CHM 685A,B) Seminar in Chemical Physics (2,2) Lecture-discussion presented by faculty and graduate students on current literature in their field.

End of Letter 2

Excerpt from Physics Department Long Range Plan of 5/27/1997

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5.5 Developing New Thrusts
Before we consider developing new thrusts, we should resume the build-up of our materials program. However, we should also consider new and exciting areas of research. An incomplete list of new frontiers worth considering would include:

- Micromechanical Structures and Sensors: The is a frontier field, where integrated circuit techniques are used to design micromechanical structures and sensors for applications in a variety of fields.

- AFM and STM Spectroscopy: Manipulation of materials at the level of single atoms and molecules is an exciting new field. A person with experience in atomic force and scanning tunnel microscopy would be ideally qualified for research in this area.