
Department of Physics, Geology and Astronomy

Physics and Astronomy Program
TABLE OF CONTENTS

TEXT                         Page  
Part a  Preface               4  
Part b  Department History    6  
Part 1  Physics Program Outcomes 11 
Part 2  Curriculum             13 
Part 3  Teaching and Learning Environment 23 
Part 4  Physics Faculty         26 
Part 5  Support                31 

APPENDICES: FIGURES & TABLES

Appendix 1: Preface/History  
1.1  Grote Hall, 3rd Floor, Physics Space  
1.2  Major Laboratories: Physics Program  
1.3  Operating budget Physics  
1.4  Physics, Geology and Astronomy Grant Activity  
1.5  Physics and Astronomy Scholarship Funds  
1.6  Department Heads since 1967  
1.7  Outcomes Assessment Tables  
1.8  Letter of Jonathan Baugh  
1.9  UTC Faculty Development opportunities

Appendix 2: Curriculum  
2.1  UTC Catalog: Physics, Geology, and Astronomy  
2.2  General Education Course Syllabi  
2.3  Major Course Syllabi

Appendix 4: Faculty  
4.1  EDO blank form  
4.2  Faculty Load Blank form

Appendix 5: Support  
5.1  Grote Hall Renovation Plan  
5.2  Library Expenditures and Serial Subscriptions  
5.3  Equipment List

Appendix 6: Mission, Goals and Objectives  
6.1  Mission of the Department of Physics, Geology, and Astronomy  
6.2  Goals of the department  
6.3  EDO Performance Standard  
6.4  Weighting of EDO standards  
6.5  EDO standards, College of Arts and sciences  
6.6  EDO Standards by rank, College of Arts and sciences
Appendix 7: Curriculum Vitae of Faculty
7.1 Allen, Tatiana
7.2 Churnet, Habte
7.3 Marlowe, Robert
7.4 Wang, Lin Jun
7.5 Wang, Jin

Appendix 8: Figures
Data supplied by office of grants and research
8.1 Enrollment Trends
8.2 Degrees Awarded
8.3 Student Retention Rates
8.4 College Base Scores
8.5 Courses Offered in the Past Two Years
8.6 Student Enrollment in Courses Offered in the Past Two Years
8.7 Majors Involvement in Research Projects
8.8 Student Ratings of Faculty
8.9 Courses Taught by Regular Vs. Adjunct Faculty
8.10 Internal UC Foundation Support
8.11 External Grants
8.12 Student Credit Hour Production Per FTE Faculty (Adjuncts Not Included)
8.13 Student Credit Hour Production Per FTE Faculty (Adjuncts Included)
8.14 Faculty Gender and Ethnicity
8.15 Student Majors: Gender and Ethnicity
8.16 Library Holdings of Materials Relevant to Program
8.17 Operating Budget Per Full-Time Faculty Member
8.18 Operating Budget Per Student Major
8.19 Operating Budget Per Student Credit Hour
8.20 Department Salary Budget Per AY Student Credit Hour Production: Compared to Similar Programs
Preface
The Department of Physics, Geology, and Astronomy offers two undergraduate degree programs, one in physics and the other in geology. Majors in geology graduate either in classical geology or in environmental geology. The department also contributes to programs leading to degrees in other sciences, engineering, and professional areas. In addition, the department offers minors in geology and in physics. The department also has an astronomy program that is augmented by specialized equipment for astrophotography. The off-campus UTC Clarence T. Jones Observatory provides astronomy presentations to the community at large.

The Department of Physics, Geology, and Astronomy was created in 1992 by a reorganization that was partly aimed at reducing the administration costs of running low-enrollment programs. Low numbers of majors in the physical sciences, particularly in physics, are a national condition and continue to be a challenge for our department. Low numbers of tenure-track faculty and the unavailability of adjuncts particularly with degrees in geology pose another challenge. Inadequate space, particularly for the geology program, is yet another challenge.

To meet these challenges, the department, under the leadership of Dr. Habte Churnet, has identified opportunities that can be exploited to minimize loss and maximize gain. Upper-level core courses are offered every other year because of low enrollment and the low number of faculty. The faculty offers more sections of lower-level courses. In the physics program, adjunct faculty and tenure-track faculty are assigned to teach lower-level courses and laboratories, while in the geology program the unavailability of adjunct faculty places a greater teaching load on the tenured and tenure-track faculty. In the period 2001 to 2003 all tenured physics faculty went on sabbatical leaves of absence in sequential years. They returned invigorated and the program saw an increase in number of majors and publications (Appendix 8.1). However, geology faculty have not taken sabbaticals. The anticipated hiring of a laboratory instructor/coordinator in the geology program will increase the ability of the geology faculty to have time to conduct research, write grant proposals and journal articles and take sabbaticals. Both programs will benefit from getting release time from their teaching loads so that they may continue and or increase their productivity in the area of publication and grant acquisition. Enticing more majors remains a challenge an the department will continue to explore different ways of meeting it, including scholarship awards to students who major or minor in physics. To satisfy the needs of students, a concentration in environmental geology was added in 1997 as a new-degree offering, while a degree in physics with a concentration in health physics was cancelled in 2000 for lack of qualified faculty to offer required courses. Further examination of student needs as well as the qualifications of faculty to meet those needs has helped the department to streamline its long- and short-range objectives (see Appendix 6: Mission, Goals and Objectives).

In the past, the university’s general-education requirements for all students included at least one natural science (Category D), a laboratory-based course with 4 credit hours. The latest general-education requirement (Category 8) specifies 7-8 hours; two courses in the natural sciences, with at least one four-hour course including a laboratory component. To meet this requirement, our
The department has successfully created non-laboratory science courses and has obtained Category 8 certification for three non-laboratory courses (three credit hours each): Current Geologic Perspectives of Earth (GEOL 116), Oceanography (225), Science and Society (GNSC 115), and Introduction to Astronomy (ASTR 101). In addition, the department has received Category 8 certification for the following laboratory-based courses, each four credit hours; Physical and Historical Geology (GEOL. 111/181 and 112/182), General Physics: Electromagnetism and Optics (PHYS. 104/184), Introduction to Astronomy (ASTR. 101/181). When this new category was created, the UTC General Education Committee deliberated on the impact of these courses and supported the need for a new faculty line in the Department of Physics, Geology, and Astronomy. That faculty line was awarded by the help of Dean Timothy Summerlin in the form of a non-tenure full time position to the Geology Program. Subsequently, Dean Herbert Burhenn helped the department convert the non-tenured position to a tenure-track position. Recently, Dean Burhenn has also succeeded in helping us obtain permission to hire a laboratory instructor/coordinator for the geology program, a position that would be filled by July 2006.

Pursuant to the last self review of the physics program it was determined that the upper-level physics laboratory courses, Phys 381, 382, 481, and 482 be combined in two courses and offered in the same room and over a span of year with the view of increasing enrollment in the courses and permitting students to graduate in a timely manner. Consequently, the department has now prepared a proposal to offer Phys 398 and 399. The proposal will be submitted in December 2005.

This overview serves to highlight past changes and those anticipated in the near future. The changes are in response to pressing needs of the programs in our department. The two programs (geology and physics/astronomy) of this department were reviewed five years ago in 2000. In previous years, the geosciences department was reviewed in 2000, 1995-1996, and in 1990, while the physics department was reviewed in 2000, and 1995-1996.

This review document was prepared and submitted by the faculty of the Department of Physics, Geology, and Astronomy. Some aspects of the review document are shared in both programs, whereas others pertain only to the physics or the geology program review. In addition to the preface/history, the review document has 5 parts, with diagrams and tables that provide supporting data and illustrations in the form of appendices. We wish to acknowledge the valuable help given by the Office of Grants and Research who provided the tables, figures, and comments, which are included as Appendix 8 in this report.
Department History
This section presents a brief review of changes in space, faculty, department heads over the decades, and changes and trends in parameters of course offerings, measures of teaching effectiveness and program evaluation over the last five years.

Changes in Physical Space
The various programs of our department have been grouped and housed in different ways during the past. An undergraduate college with instruction facilities in different areas, including physics and astronomy was established in October 1904 under Dean Wesley Hooper. The sciences were housed in Science Hall, the construction of which began in 1917; later it was called Hooper Hall. Bretske Hall was built in 1947 and Grote Hall in 1968. The science disciplines moved to Grote Hall in 1968. The geology program moved from Grote Hall to Bretske Hall in 1981. The two programs in the Department of Physics, Geology and Astronomy are currently housed in separate buildings, both of which were constructed before the University of Chattanooga (UC) merged with the University of Tennessee system in 1969.

Physics and Astronomy Program
The physics and astronomy program has been housed on third floor of Grote Hall since 1968 (Appendix 1.1). A teaching laboratory (Room 313) and student faculty common room (Room 320) have been turned into faculty research laboratories, the atomic/laser laboratory and the semiconductor laboratory (Appendix 1.2).

The department has been managing the University's Clarence T. Jones Observatory since 1944. The observatory is an off-campus facility that was deeded to the university in 1944 by the city of Chattanooga. A planetarium annex to the observatory was built in 1958. Light pollution from security lights installed recently around neighboring church buildings has created difficulties for telescope observation of the sky from the observatory. The pastor and the department chair are currently negotiating this issue.

Geology Program
When the sciences moved to Grote Hall, the geosciences department was housed on the second floor. However, in 1981 that space was given to the engineering program and the geosciences department was moved to Bretske Hall, a building that was constructed and dedicated as a dining hall in 1947. Reconfiguring internal Bretske Hall created several small rooms intended to teach small (less than 10 students) classes. The walls separating the small rooms were torn down two create two teaching laboratories that could accommodate 20 to 35 students.

Current space issues
Bretske Hall offers inadequate space for the geology program. Only two rooms are dedicated to teaching geology laboratories at UTC, and they are grossly inadequate. They are not equipped with appropriate furnishings. The space is not sufficient to place cabinets and tables for housing rock specimens. The wall space is not adequate to hang necessary maps, charts, and other poster materials for teaching and demonstration purposes. The bathroom facilities in general are substandard for normal use and are not in ADA compliance. The department has always been in limbo because of a presumed impending move to another location.
We anticipate that Grote Hall will be renovated in the period 2007 to 2009. The geology program will occupy parts of Grote Hall floors 2 and 1. Also physics program will move from the 3rd floor to the 2nd floor of Grote Hall. Thus, both programs will have a fair amount of adjustments to make as they occupy new space.

Changes in Administrative and Program Organization
Department heads were assigned to science programs in 1967. Appendix 1.6 shows the names of the heads in the departments of Physics and Astronomy, Geology and Geography (Geosciences), and the Environmental Studies Program since 1967.

From 1986-1991, the programs of 1) Physics and Astronomy, 2) Geology and Geography, and 3) Environmental Studies (EST) were headed by Dr. Patricia Perfetti, a biologist. By this arrangement, Geosciences and EST were merged and had one budget allotment, separate from Physics and Astronomy. In August 1991, Dr. Churnet became acting head of an assortment of programs. After 1992, EST merged with the Department of Biology, Geography merged with the Department of Sociology and Anthropology, and Geology was placed with Physics to produce a Department of Physics, Geology and Astronomy.

A program in geology and geography (geosciences) with an undergraduate degree in geology (B.A.) was established in 1939 and was offered until the academic year 1979-1980, when a B.S. degree was offered. The physics program offers a B.S. degree. A master's degree in the physics program was initiated in 1964 and was apparently discontinued by 1971. The reason for discontinuing the physics master's program is probably due to the creation of the School of Engineering at UTC.

Outcomes, Physics
As measured by students' success subsequent to graduation in previous self-study cycles, the physics program had achieved its intended educational outcomes and was successful at preparing its graduates for physics-related professions or graduate studies. In the current self-study cycle however, our majors were few and those that graduated much fewer. Thus, though we have assembled a battery of assessment instruments it was difficult to implement them meaningfully.

Curriculum, Physics
Courses offered by the physics program serve curricular needs of its Bachelors degree and contribute significantly to students' competencies in the areas of written and oral communication, cognitive skills, mathematics, and computer skills. These courses also serve needs of other programs that specifically require physics courses, the University's general education requirements, and the occasional graduate student. The department has proposed the placement of four upper level physics laboratory courses into two repeatable courses that will be offered every semester. This will help students graduate on time.

Changes in Teaching and Learning Environment
UTC now requires students to complete 120 hours of credit for graduation, 8 hours fewer than in previous years, prompting an adjustment in core curricula for the physics majors. The faculty of the physics program are well prepared to provide career advisement by virtue of their diverse professional experiences. Faculty contacts with the national laboratories at Oak Ridge and the
Universities of Toronto and Toledo continue to be assets to students who may travel to these places and perform research by using instruments that are not available at our campus. In the last five years, the department has sacrificed university library subscriptions to several print professional journals as theses maybe accessed through the Internet.

**Changes in Faculty and Staff Support: Physics and Astronomy Program**

The Physics program maintains four tenure-track lines. Except for Dr. Eric T. Lane, who had been here for over 30 years before he retired in June 2003, the other faculty are relatively new. Faculty turnover included the movement of Dr. Grayson Walker to administrative positions outside of the department in 1986, the death of Dr. Joel Davis in 1989, and the departure of Dr. Randall Peterson in 1990. Dr. Robert Marlowe in 1985, Dr. Ling-Jun Wang in 1990, and Dr. Mao-Zu Liu in 1990 replaced these individuals. After a year of service, Dr. Liu had to go on sabbatical leave from which he did not return. Dr. Xiu Qiu temporarily replaced him in 1992, was replaced in turn by Dr. Tatiana Bilgildeyeva in 1993 (Tatiana Allen, since August, 1995).

Dr. Joel Davis and his replacement Dr. Liu had strong backgrounds in biophysics and health physics, but their replacement does not. Thus, the health physics component of the department offering has been de-emphasized. In June 2003, Professor Eric Lane retired, and he was replaced by Dr. Peter Groves on a one-year non-tenure track position, until Dr. Jin Wang was hired in August 2005. From 2002 through 2004, three professors, Allen, Marlowe and Wang went on sabbaticals and they were replaced by Dr. Jim Gumnick, who taught on a full time basis for three years.

In the area of adjunct professors, except for Mrs. Li-Hwa Huang who has served as adjunct faculty since 1981, others are relatively new additions. Mrs. Chantana Lane began service as adjunct faculty in 1990 and Mr. Harold Climer temporarily in 1988, and more continuously since 1992. Mrs. Chantana Lane retired in June 2003 along with her husband Professor Lane. Dr. Jim Cunningham from the college of engineering helped the department by teaching an introductory course and a laboratory course, as Mr. Kleiner, a retired engineer, taught Laboratory courses. Dr. Akers, who served as acting head of department in the past and worked as adjunct professor and radiation safety officer, retired in June 2005.

The department was fortunate to obtain a position of Laboratory Preparator. Mr. George Gooden served as Laboratory Preparator from 1989-1993. Mr. Bobby Thompson replaced him. Bobby Thompson's strength as an amateur Astronomer has greatly helped in revitalizing the activities and functions of the UTC's Clarence T. Jones Observatory. Upon Mr. Thompson's retirement in June 2002, Mr. Jack Pitkin took over the job of serving as laboratory manager and running the Observatory. In Addition, upon the retirement of Dr. Akers, Mr. Pitkin serves as UTC's Radiation Safety Officer.

The department has a position for a part time secretary. Mrs. Jane Buckner served until 1993. Then Mrs. Temperance Carter was hired until Mrs. Phyllis Renneisen replaced her. Mrs. Susan Taylor was then hired in July 1997, until she relocated to the geology program. As her replacement Mrs. Diane Welch was hired in August 1, 2001 and served for about six months. Then Mrs. Dale Davis was hired in December 2002.
Changes in Operating Budgets and Equipment
The two programs (Physics/Astronomy and Geology) currently have separate budget allotments. The operating budget of the Physics & Astronomy (P&A) program is given in Appendix 1.3. As of July 2000 funds for employing student help (Biweekly budget) reduced by 23% since the chancellor wished to use the funds to increase faculty salary. In addition travel expenses were reduced as of July 2003. Since 2005, the travel budget is reinstated at the level of 59% of the travel allotment for the years prior to 2003. The department does not have equipment budget. However, Dean Herbert Burhenn has provided funds for the purchase of necessary teaching equipment when he receives funds for the college. Such funds are shown as budget revision in Appendix 1.3. The budget revision in the last row in Appendix 1.3 is from indirect costs received by the department for overhead budget in external grants received by the faculty. The revision the bottom right corner of Appendix 1.3 includes about $50,000.00 given as start up fund for our newest faculty member, Dr. Jin Wang. In addition to getting indirect costs from external funds, faculty had applied for and received internal sources of grant (Appendix 1.4) for the purpose buying equipment for teaching and instruction. Another resource the department has is the endowments that help provide scholarships to students (Appendix 1.5)

Mission/Goals and Instruments of Evaluation
The mission of the department is to provide excellent instruction to our majors in order to enable them to go to graduate schools or join the work force in their field of study. We also provide excellent service courses for majors in other disciplines. We have designed a variety of strategies to attain the goals, and we also have assembled a battery of instruments to measure our teaching effectiveness. The missions, goals, evaluations by developmental objective, et cetera are given in Appendix 6. Important to achieving our mission is the set of courses that we offer, which is discussed in Part 2. Student outcomes assessments are described in Part 1, while Part 3 evaluates the teaching-learning environment. Part 4 describes the faculty and their teaching effectiveness as measured by instruments that include student rating of faculty, yearly evaluation of faculty by the head, and evaluation of faculty by their peers every six years. Part 5 describes the resources available to the faculty for carrying out their jobs.
PART 1: PHYSICS PROGRAM OUTCOMES

The mission (Appendix 6.1) and goals (Appendix 6.2) of the department clearly outline the teaching and learning expected in the physics program. Core courses and electives for the major and service courses to other disciplines discussed in Part 2 and Part 3 of this report demonstrate the emphasis on the types of courses the department offers to students. The syllabi for the various course offerings (Appendix 2.2 and 2.3) provide the details of the course offerings of the program and the learning that is expected from each course. The syllabi are given to students in the form of electronic and/or hard copies at the beginning of the semester. All syllabi should state clearly the goal of the course, the textbooks, the plan of the lectures and exams, the office hours, the evaluation policy, and an accommodation statement for students with disability.

Beyond the grades assigned by teachers, which we hope are fairly devised to measure the materials learned by the students, outcomes of the physics program can be assessed by means used to satisfy the requirements of SACS (Southern Association of Colleges and Schools), by student performance on the College Base Exam, by indicators of student satisfaction with the physics program, and by the success of its recent graduates.

As part of the SACS (Southern Association of Colleges and Schools) accreditation process, all units of the University are required to define and assess their intended educational outcomes. SACS-related outcomes assessment has been used annually since the 1997-98 academic year. For the years from 2000-2005, the SACS related outcomes are tabulated in Appendix 1.7.

For the physics program, as indicated in Appendix 1.7, the intended outcomes assessment items are three: 1) Students completing the baccalaureate program in physics at UTC will compare favorably in their general knowledge of physics with respect to students that have completed similar programs; and 2) Students completing the baccalaureate program in physics at UTC will be well prepared to obtain admission to graduate schools or to obtain employment. 3) Students will be satisfied with the education and training that they received in the physics program at UTC. We expect the mean score of graduating seniors on the Area Concentration Achievement Test (ACAT) in physics (senior outcomes test) will be at or above the 50th percentile compared to national norms. Graduating students will indicate their satisfaction with the program (and elements of the program) on an exit questionnaire designed by physics faculty and OPEIR. Graduating students will indicate their satisfaction with the program (and elements of the program) during an exit interview conducted by the department head or OPEIR.

The means of assessment of the intended outcomes, and the assessment results, as shown in Appendix 1.7, have been difficult to implement or difficult to place significance to when implemented because of low number of majors and even lower number of graduates. In the 1999-2000 evaluation period two students graduated. Both students had scored above the national norms in the ACAT (Area Concentration Achievement Test). The two students indicated lab courses needed improvement on their exit interviews with faculty. In the 2000-2001 evaluation no student graduated. In the 2001-2002 two student, Andrew Taylor and William Roes, graduated. Both graduated in August. Mr. Taylor changed his field of study after graduation, and Mr. Roes is gainfully employed at TVA. Mr. Roes participated in a faculty-student research project and performed part of it in the summer at the University of Toronto.
under the supervision of Dr. Allen. Neither of these students took an ACAT exam. No students graduated in physics in 2002-2003, or 2003-2004, or 2004-2005.

The College base score is another measure of assessing quality of instruction. Such a score is given in Appendix 8.4. However, that score reflects the achievements of geology graduates, for physics had graduates only in one of the five years under review.

The responsibility for collating and implementing the assessment instrument for the program changed hands. Professor Lane implemented the assessment protocol until he resigned, then Professor Marlowe took over. As of January 2005 we have assigned Professor Ling Jun Wang to do the job. We anticipate pursuing the assessment instrument methodically.

We expect two to three students to graduate this year. One of them has been requesting financial support to take a GRE. We plan to give future graduates a Physics Educational Test Exam designed by the Educational Testing Service. We plan to give our graduates exit interviews.

We hear from time to time from our former students. We attach one response, an e-mail from Dr. Baugh, one of our former graduates, to Professor Lane (Appendix 1.8)
PART 2: CURRICULUM

1. COMPETENCIES / EDUCATIONAL OUTCOMES
Students completing the B.S. in Physics at UTC have traditionally been prepared to enter graduate school, or enter the work force (often in a related area, e.g., computer programming, meteorology, electronics, nuclear power). Over the years about half of our graduates have opted for graduate school; past graduates of UTC have obtained graduate degrees from Vanderbilt University, U. of Michigan (Ann Arbor), U. of Wisconsin (Madison), and U. of Tennessee (Knoxville), University of Waterloo. In the current issue of *Nature*, our former graduate, Jonathan Baugh, published his research work on quantum commuting. (Appendix 1.8).

During the past 5 years, there has been a nationwide increase in undergraduate and graduate enrollments in physics and astronomy: “(u)ndergraduate physics degree production continues to increase sharply after hitting a four decade low in 1999.” (AIP Pub. Number R-151.40, July 2005). Our program also has seen a noticeable increase in majors over the past five years (see Appendix 8.1). We have not yet realized a growth in the number of our graduates, but there is reason to believe that we will graduate at least three students during the calendar year 2005. We believe that our graduates are still able to enter quality graduate schools without great difficulty, but many of them will pursue areas other than pure physics.

2. PLAN FOR THE CHOICE, SEQUENCING, AND SCHEDULING OF COURSE WORK
2a. Choice
The core courses of the physics curriculum are traditional offerings, which are absolutely necessary in order to pursue graduate work; a descriptive listing of these courses follows (Table 2-1).

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of physics- Mechanics and Heat</td>
<td>Phys 230/280 - 4 credits</td>
</tr>
<tr>
<td>Principles of physics-Electricity and magnetism</td>
<td>Phys 231/232 - 4 credits</td>
</tr>
<tr>
<td>Principles of physics- Optics and Modern physics</td>
<td>Phys 232/282 - 4 credits</td>
</tr>
<tr>
<td>Classical mechanics:</td>
<td>Phys 341 - 4 credits</td>
</tr>
<tr>
<td>Electricity and Magnetism:</td>
<td>Phys 342 - 4 credits</td>
</tr>
<tr>
<td>Introduction to Quantum Mechanics:</td>
<td>Phys 411 - 3 credits</td>
</tr>
</tbody>
</table>

Plus 6 hours (essentially three 2 hr. courses) selected from among the advanced laboratory courses:

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods of Experimental physics:</td>
<td>Phys 381r - 2 credits</td>
</tr>
<tr>
<td>Classical Physics laboratory</td>
<td>Phys 382r - 2 credits</td>
</tr>
<tr>
<td>Atomic Physics laboratory</td>
<td>Phys 481r - 2 credits</td>
</tr>
<tr>
<td>Nuclear and Health Physics laboratory</td>
<td>Phys 482r - 2 credits</td>
</tr>
</tbody>
</table>

This advanced laboratory component of our curriculum is currently being changed: the departmental faculty have approved (on 9/8/05 by a vote of 8-0-0) the consolidation of the four
upper-level laboratories into two three-credit hour course, Physics 389 and 399 Methods of Experimental Physics. These courses would be taken for two semesters, with study concentrating on classical experimental (398) physics during the fall, and modern experimental physics (399) during the spring. Thus, students would still receive 6 credit hours of upper-level experimental laboratory work towards their degree. This change is being instituted on the basis of a recommendation made by Prof. Charles Hawkins, the external reviewer of the physics and astronomy program in 2000, who pointed out that the four low-enrollment laboratory courses could be consolidated into a single course with larger enrollment, offered by a single faculty at one location and time.

All physics (and all astronomy) courses other than those named above are electives. In order to focus the attention of our physics majors on those upper-level elective courses which are expected by graduate schools to be part of their background, the UTC catalog states under “Major and Related Courses” for Physics and Astronomy: Recommended: Physics 303 (Basic Electronics), 307 (Optics), 310 (Introduction to Thermal Physics), 412 (Nuclear Physics), and 414r (Advanced Modern Physics) are recommended for students who plan on graduate study in physics/astronomy.

Five years ago, the departmental faculty believed that the omission of a physics course during the first semester of the freshman year hurt the department’s ability to attract well-qualified students. We had wished to submit a proposal to the Curriculum Committee, which would create a new course, Physics 190 Introduction to Physics (1), specifically for the purpose of introducing freshmen and sophomore students to current areas of physics research. While we continue to have an interest in presenting this course, we believe that offering another low-enrollment course - as this would likely be - would stretch our manpower resources too thinly.

We also discussed the establishment of a second new course, Physics 410 Mathematical Methods for Scientists (3), as a junior/senior level offering which would be highly beneficial for those majors interested in graduate work. Many university physics departments offer such a course to provide undergraduates with advanced mathematical techniques (e.g., Fourier and Laplace transforms, contour integration, selected partial differential equations, special functions) which are frequently encountered in theoretical physics. The instruction would emphasize the application of the techniques to physical problems. With the consolidation of the upper-level lab courses into Physics 399r, it may now be possible to move ahead with the new offerings Physics 190 and 410. Manpower is still a very real issue.

Certain elective courses (e.g., Physics 304, 419, 424) have not been offered in recent history due to a lack of student demand for them. The faculty needs to follow up discussions on which of these courses should be dropped, thus streamlining our catalog section. Another development under discussion is the possibility of offering Physics 230 Principles of Physics - Optics and Modern Physics on a more limited basis, because it has ceased to be required in certain Engineering programs.

Finally, we should state that our department dropped its health physics minor program; it was last seen in detail in the 2000-2001 UTC Undergraduate Catalog. The physics faculty has discussed whether programs in applied physics and/or physics education should replace this
specialized minor. No final decisions have been made as of this writing, except that we first wish to concentrate our efforts on the excellence of our present curricular offerings before launching new courses.

2b, c. **Sequencing and scheduling.**
Those physics, astronomy, and general science courses, which are regularly presented, are shown below (Table 2-2). Courses and co-requisite laboratories are denoted by a slash, e.g., Physics 103/183; co-requisite recitations are so indicated (rec.). Courses approved as satisfying General Education requirements are denoted by G.

Table 2-2: Sequencing of Course Scheduling

<table>
<thead>
<tr>
<th>Course Schedule Change</th>
<th>2005-06 Catalog Schedule</th>
<th>Possible Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>• G-Phys 103/183</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• G-Phys 104/184</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• G-Phys 230/280</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• G-Phys 231/281</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• Phys 232/282</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• Phys 237/287 fall</td>
<td>semester alternate years</td>
<td></td>
</tr>
<tr>
<td>• Phys 310/500 (rec.)</td>
<td>fall semester alternate years</td>
<td></td>
</tr>
<tr>
<td>• Phys 309/310</td>
<td>spring semester</td>
<td></td>
</tr>
<tr>
<td>• Phys 341/500 (rec.)</td>
<td>fall semester</td>
<td></td>
</tr>
<tr>
<td>• Phys 342/500 (rec.)</td>
<td>spring semester</td>
<td></td>
</tr>
<tr>
<td>• Phys 400r</td>
<td>on demand</td>
<td></td>
</tr>
<tr>
<td>• Phys 411</td>
<td>fall semester</td>
<td>fall semester every other year</td>
</tr>
<tr>
<td>• Phys 412</td>
<td>spring semester</td>
<td>on demand</td>
</tr>
<tr>
<td>• Phys 381r</td>
<td>fall semester</td>
<td>to be replaced by Phys 399r</td>
</tr>
<tr>
<td>• Phys 382r</td>
<td>spring semester</td>
<td>to be replaced by Phys 399r</td>
</tr>
<tr>
<td>• Phys 481r</td>
<td>fall semester</td>
<td>to be replaced by Phys 399r</td>
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<tr>
<td>• Phys 482r</td>
<td>spring semester</td>
<td>to be replaced by Phys 399r</td>
</tr>
<tr>
<td>• G-Astr 102/182</td>
<td>fall semester</td>
<td></td>
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<tr>
<td>• G-Astr 101/181</td>
<td>spring semester (181 lab is optional)</td>
<td></td>
</tr>
<tr>
<td>• G-Gnsc 111/181</td>
<td>every semester</td>
<td></td>
</tr>
<tr>
<td>• G-Gnsc 115</td>
<td>on demand</td>
<td></td>
</tr>
</tbody>
</table>

3. **GENERAL EDUCATION COURSES AND THEIR REINFORCEMENT**
The physics and astronomy curriculum presently contains nine introductory courses (most with co-requisite laboratories), which are recognized as General Education, i.e., any of these courses may be used to satisfy 3-4 hours of the university’s laboratory science requirement. The courses are given in Table 2-3 and described sub sequentially in section 3a, 3b, and 3c.
Table 2-3: General Education Courses

<table>
<thead>
<tr>
<th></th>
<th>Course Description</th>
<th>Physics/Astronomy Related Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>General Science 111 The Physical Environment: Atoms to Galaxies (3 hrs)</td>
<td>Phys 103, 230; Astr 102</td>
</tr>
<tr>
<td></td>
<td>General Science 181 General Science Laboratory (1 hr)</td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>General Science 115 Science and Society (3 hrs)</td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>Astronomy 102 Introduction to Astronomy: Stars to Galaxies (3 hrs)</td>
<td>Phys 230 Principles of Physics - Mechanics and Heat (3 hrs)</td>
</tr>
<tr>
<td></td>
<td>Astronomy 182 Astronomy Laboratory – Stars to Galaxies (1 hr)</td>
<td>Physics 280 Principles of Physics Laboratory – Mechanics and Heat (1 hr)</td>
</tr>
<tr>
<td>(4)</td>
<td>Astronomy 101 Introduction to Astronomy: The Solar System (3 hrs)</td>
<td>Phys 231 Principles of Physics – Electricity and Magnetism (3 hrs)</td>
</tr>
<tr>
<td></td>
<td>Astronomy 181 Astronomy Laboratory – The Solar System (1 hr) (optional)</td>
<td>Physics 281 Principles of Physics Laboratory – Electricity and Magnetism (1 hrs)</td>
</tr>
<tr>
<td>(5)</td>
<td>Physics 103 General Physics - Mechanics and Heat (3 hrs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics 183 General Physics Laboratory – Mechanics and Heat (1 hr)</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>Physics 104 General Physics – Electromagnetism and Optics (3 hrs)</td>
<td>Phys 184 General Physics Laboratory - Electromagnetism and Optics (1 hr)</td>
</tr>
<tr>
<td>(7)</td>
<td>Physics 230 Principles of Physics - Mechanics and Heat (3 hrs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics 280 Principles of Physics Laboratory – Mechanics and Heat (1 hr)</td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>Physics 231 Principles of Physics – Electricity and Magnetism (3 hrs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics 281 Principles of Physics Laboratory – Electricity and Magnetism (1 hrs)</td>
<td></td>
</tr>
<tr>
<td>(9)</td>
<td>Physics 119 Light and Life (3 hrs). Cross-listed with Chemistry and Biology, and most recently taught regularly by Chemistry faculty.</td>
<td></td>
</tr>
</tbody>
</table>

3a. General Science 111 The Physical Environment: Atoms to Galaxies

General Science 111 requires the least in the way of mathematical prerequisites, and so is popular among non-science majors as a means of fulfilling their general education science requirement. In this role, it most often serves as a terminal course. This course presents selected topics from the fields of physics, astronomy, geology, and chemistry with an emphasis on how scientists attempt, through the use of the scientific method, to unify and explore our physical universe. The following list provides the majority of topics covered in GNSC 111, along with the physics and astronomy courses, which have direct connections to them (those courses which treat the entire topic in more detail are underlined):

<table>
<thead>
<tr>
<th>GNSC 111 Course Topic</th>
<th>Physics/Astronomy Related Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Phys 103, 230; Astr 102</td>
</tr>
<tr>
<td>Motion</td>
<td>Phys 103, 230, 341, 381r, 382r; Astr 401</td>
</tr>
<tr>
<td>Force and Motion</td>
<td>Phys 103, 230, 341, 381r, 382r</td>
</tr>
<tr>
<td>Work and Energy</td>
<td>Phys 103, 104, 230, 231, 232, 341, 342, 381r, 382r</td>
</tr>
<tr>
<td>Temperature and Heat</td>
<td>Phys 103, 230, 310, 381r, 382r; Astr 401</td>
</tr>
<tr>
<td>Electricity and Magnetism</td>
<td>Phys 104, 231, 232, 303, 307, 342, 382r; Astr 401</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>Phys 104, 232, 318, 411, 412, 482r</td>
</tr>
<tr>
<td>The Periodic Table</td>
<td>Phys 104, 232, 411</td>
</tr>
<tr>
<td>The Solar System</td>
<td>Astr 101</td>
</tr>
<tr>
<td>The Universe</td>
<td>Astr 102</td>
</tr>
</tbody>
</table>

Not only the lecture topics, but also the respective GNSC 111 lab activities emphasize the direct connection to physics concepts, which provides the foundation for all sciences.
3b. Astronomy 101 Introduction to Astronomy - The Solar System
Astronomy 102 Introduction to Astronomy - Stars to Galaxies
The introductory astronomy courses 101 and 102 each provide students with a brief survey of the historical progress of the discipline, and an appreciation of the physical principles which astronomers use to gather and interpret information from space, leading to our current theories on solar system origin and evolution, and the nature of stars and the evolution of the universe, respectively. As in General Science, the laboratory experiments are divided between hands-on activities (e.g., learning how to set up and use a telescope, using triangulation to measure distance) and computer simulations in which students gather and analyze data via role-playing. Either of these courses can serve as a prerequisite for the higher-level astronomy laboratory Astronomy 300r. Concepts introduced in Astr 101 and 102 are met again in the physics courses shown below:

<table>
<thead>
<tr>
<th>ASTR 101 and 102 Course Topic</th>
<th>Physics/Astronomy Related Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kepler’s Laws</td>
<td>Phys 103, 230, 341; Astr 300r, 401</td>
</tr>
<tr>
<td>Newton’s Laws of Motion</td>
<td>Phys 103, 230, 341; Astr 401</td>
</tr>
<tr>
<td>Universal Gravitation</td>
<td>Phys 103, 230, 341, 382r</td>
</tr>
<tr>
<td>Nature of Electromagnetic Radiation</td>
<td>Phys 104, 232, 342, 307, 381r, 382r</td>
</tr>
<tr>
<td>Diffraction</td>
<td>Phys 104, 232, 307</td>
</tr>
<tr>
<td>Planck Blackbody Distribution</td>
<td>Phys 104, 232, 307, 310</td>
</tr>
<tr>
<td>Properties of Telescopes</td>
<td>Phys 104, 232, 307; Astr 300r</td>
</tr>
<tr>
<td>Conversion of Matter into Energy</td>
<td>Phys 104, 232, 412; Astr 401</td>
</tr>
</tbody>
</table>

3c. Physics 103 General Physics – Mechanics and Heat  (co-requisite lab Phys 183)
The basic physical concepts developed in algebra-based Physics 103 (3b) and calculus-based Physics 230 (3c) are essentially the same, and may be summarized as follows:
units of measurement, vectors, Newtonian dynamics and kinematics for both uniform linear and rotational motion, universal gravitation, the conservation principles, the physics of fluids, temperature and heat, the laws of thermodynamics, and mechanical vibrations and wave motion.

The difference in presentation of these two courses stems from the stress placed on the power and the elegance of the calculus in Physics 230, which lays the foundation of Newtonian physics for all higher-level courses. Rather than use a tabular format with these two courses, suffice it to say that vectors, Newtonian dynamics and the conservation principles, mechanical vibrations and wave motion, introduced in both Physics 103 and 230, are used in the majority of higher level courses, and are particularly important in the department’s core courses:
Physics 231 Principles of Physics - Electricity and Magnetism
Physics 232 Principles of Physics - Optics and Modern Physics
Physics 341 Classical Mechanics
Physics 342 Electricity and Magnetism
Physics 381r, 382r, 481r, 482r advanced laboratories
Physics 411 Atomic Physics: An Introduction to Quantum Mechanics

16
The thermodynamics topics contained in Physics 103 and 230 are met again, primarily in Physics 310 Introduction to Thermal Physics, but also in the Physics 414r Advanced Modern Physics when the selected topic is Solid State.

Reference to the 2005-2006 UTC Undergraduate Catalog finds that Physics 103 and/or Physics 230 are listed, either directly or indirectly, as a prerequisite for 20 higher-level physics courses.

4. BALANCE BETWEEN REQUIRED AND ELECTIVE COURSES

A listing of the required courses (along with any concomitant laboratory or recitation) for the B.S. in Physics, as found in the 2005-06 UTC Catalog (Appendix 2-1), are presented below in Table 2-4.

Table 2-4: Required and Elective Courses

<table>
<thead>
<tr>
<th>Title</th>
<th>Lab or Recitation</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phys 230* Principles of Physics – Mechanics and Heat</td>
<td>L</td>
<td>4</td>
</tr>
<tr>
<td>Phys 231 Principles of Physics - Electricity and Magnetism</td>
<td>L</td>
<td>4</td>
</tr>
<tr>
<td>Phys 232 Principles of Physics - Optics and Modern Physics</td>
<td>L</td>
<td>4</td>
</tr>
<tr>
<td>Phys 341 Classical Mechanics</td>
<td>R</td>
<td>4</td>
</tr>
<tr>
<td>Phys 342 Electricity and Magnetism</td>
<td>R</td>
<td>4</td>
</tr>
<tr>
<td>Phys 411 An Introduction to Quantum Mechanics</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

In addition, a minimum of 6 hours must be selected from the following four advanced laboratories:

<table>
<thead>
<tr>
<th>Title</th>
<th>Lab or Recitation</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phys 381r Methods of Experimental Physics</td>
<td>L</td>
<td>2</td>
</tr>
<tr>
<td>Phys 382r Classical Physics Laboratory</td>
<td>L</td>
<td>2</td>
</tr>
<tr>
<td>Phys 481r Atomic Physics Laboratory</td>
<td>L</td>
<td>2</td>
</tr>
<tr>
<td>Phys 482r Nuclear and Health Physics Laboratory</td>
<td>L</td>
<td>2</td>
</tr>
</tbody>
</table>

As noted above, these four advanced labs will be replaced by two laboratory courses, Physics 398 and 399 (each 3 credit hours).

*Physics 103 and 104 may together be substituted for Physics 230.

It will be seen that the required courses account for 29 credit hours. The 300 and 400 level required courses shown in Table 2-4 do not count towards fulfilling another graduation requirement:

(a) “27 additional hours from physics, astronomy, chemistry, engineering, and mathematics at the 200 level or above or from geology and biology and other fields with prior approval of the department,” but they do count towards the minimum of

(b) “30 hours of physics and astronomy at the 300 and 400 level,” (as stated on p. 94, UTC 2005-06 Undergraduate Catalog).

Physics and Astronomy elective courses often comprise the bulk of requirement (a), in part because these electives are all 300 and 400 level courses, which have the effect of satisfying both requirements (a) and (b) simultaneously. In the case where a student would choose all courses for requirement (a) as coming from our department, it is seen that the credit hour ratio of
required courses to elective courses would be 29:30 — essentially half of the physics coursework for the B.S. would come from required courses.

The following electives are highly recommended for those wishing to pursue graduate study in physics or astronomy:

Phys 303 Basic Electronics (4)
Phys 307 Optics (4)
Phys 310 Introduction to Thermal Physics (4)
Phys 412 Nuclear Physics (3)
Phys 414r Advanced Modern Physics (3)

The faculty believes that these electives will provide an entering graduate student with a strong background for either experimental or theoretical work.

For students wishing to enter the teaching profession after graduation with a B.S. in Physics, currently Phys 425 Computer Based Materials Development in Science is recommended. However, the department is now considering the creation of courses that are suitable for physics majors with an option for becoming school teachers. Another idea currently under study is a physics degree with a concentration in applied physics. Students wishing to enter the job market immediately after graduation are encouraged to confer with faculty as to their best choices for electives.

Please see sections 9 and 10 for upcoming changes, which will affect the overall departmental curriculum offerings.

5. CURRENT APPROACHES AND CONTESTED ISSUES, METHODS OF INQUIRY.
Coursework at the 300 and 400 level often provides opportunities for faculty to give more in-depth analyses not only of their own research, but also of topics, which are currently “hot.” The (elective) course Physics 400r Physics Seminar allows students to explore, by giving oral and written reports of research/review articles in appropriate journals and periodicals, those areas, which are currently of interest to the physics community, as well as topics which they themselves find exciting. This course also insures that students will become acquainted with the use of Physics Abstracts in Lupton Library. The Internet has become a primary means to gather information about current events in science.

At the introductory level, Astronomy 102 never fails to raise questions concerning the nature and veracity of our knowledge when students encounter the chapters entitled “Cosmology: The Big Bang and the Fate of the Universe,” and “Life on Earth and Life Beyond: Are We Alone?” Instruction emphasizes the use of experimental evidence as the ultimate arbiter of theory, not only in astronomy but also in the introductory physics and general science courses.

The exposure of physics majors to “methods of inquiry commonly used in the field” is found throughout the curriculum, but is concentrated, for the most part, in upper level laboratory activities and independent research. For example, students are exposed to a variety of electronic apparatus (e.g., amplifiers, delay lines, counters for radiation dosimetry and correlation measurements) in Physics 482r Nuclear and Health Physics Laboratory. In Physics 303 Basic Electronics, oscilloscope techniques are taught, as well as analog and digital electronics.
Demonstration helium-neon lasers are used for holography by students in Physics 307 Optics, as well as for other experiments in the advanced laboratory courses. X-ray scattering is done in Physics 481r Atomic Physics Laboratory; this course also utilizes the department’s Jarrell-Ash Spectrograph, and the department’s dark room. In Astr 300r Advanced Astronomy Laboratory, a CCD (charge-coupled device) camera is used for astrophotography.

At the 100 and 200 level, students gain some initial familiarity with interferometers, diffraction gratings, lasers, oscilloscopes, digital multimeters, radiation counters, and multichannel analyzers, all of which are commonly used to obtain data about the physical environment.

We have begun to upgrade both our more advanced and introductory physics laboratories through the use of computer-assisted data taking and data analysis.

6. OPPORTUNITIES FOR STUDENT RESEARCH
Both the astronomy and physics curricula make provision for faculty-supervised student research. Common to each are the 199r Special Projects courses for 100 or 200 level research projects, and the 498r Individual Studies and 499r Group Studies for more advanced projects. All courses specifically set for student research are of variable credit (1-4 hours). In addition, the physics curriculum provides for 495r Departmental Honors, and 497r Research.

Majors are encouraged to participate in collaborative research with faculty, to attend scientific meetings at both the state and regional level, and to present papers or talks at same. See Appendix 1.5 for a listing of recent student trips/presentations at these functions.

Grants have been obtained by the faculty for the purpose of providing students with summer stipends, allowing them to engage in collaborative research. Students can design a research project under faculty supervision, and submit a proposal for a “Provost Student Research Grant” to the Faculty Research Committee (see Appendix 1.5). In addition, summer research programs which are available at other universities or national laboratories (e.g., SERS program at Argonne) are beginning to be seen by students as an important step in getting a valuable head start in pursuing research goals.

One item which has been lacking in our research program is the presence of a regular colloquium series, which would allow physicists and astronomers from nearby institutions to present an hourly talk on their research. The last series like this held in our department was in the spring of 1990.

7. DEVELOPMENT OF APPROPRIATE SKILLS
Written language skills are fostered throughout the physics curriculum at all levels through the students’ preparation of laboratory reports. In Astronomy 102, most homework questions are designed to be answered descriptively, rather than through problem solving. Short papers have also been required in this course, as has been the class discussion of supplementary reading material. Students in Astr 102 are requested to prepare their homework using word processing software, giving them further practice in computer skills.
In Physics 307 Optics, students are required to present two written summaries of articles from *Scientific American.*
The course which may provide the most practice in both written and oral communication skills is Phys 400r Physics Seminar, in which students have prepared both oral and written summaries of articles from journals such as *Physics Today* and *Scientific American.*

Computer literacy skills are beginning to receive more attention: the Department has purchased 11 workstations for use in both introductory and advanced courses; the faculty have begun the process of designing lab exercises (primarily for 200 level courses) requiring the use of these stations in collecting and analyzing data.

Mathematics skills required for the B.S. in Physics consist of the following 17 credit hours as a minimum:

Mathematics 150 Calculus I with Analytic Geometry (4),  
Mathematics 160 Calculus II with Analytic Geometry (4)  
Mathematics 212 Elementary Linear Algebra (3)  
Mathematics 245 Introduction to Differential and Difference Equations (3)  
Mathematics 255 Multivariable Calculus (3)

Needless to say, homework sets and exams for the overwhelming majority of physics courses consist of setting up and mathematically solving problems! Those students who are not majors encounter problem solving in the introductory level courses which are appropriate for the specified math prerequisites.

Critical thinking skills are developed throughout the curriculum to the extent that “problem solving” can be viewed as a subset of “critical thinking.” Also, students are encouraged to ask and answer questions in class which may be initially unclear, but which can be refined so that other, better known concepts can be correlated with the question.

Physics majors are “encouraged” to learn a programming language (see UTC Catalog p.82 “Typical course of study;” second semester sophomore year); it is now considered a virtual necessity in order to pursue research in any environment. As mentioned in #5, computers are now being used in the 200 level and higher laboratories for the taking and analysis of data in some experiments. The Department is continuing to apply this technology to more experiments in courses at all levels.

8. INTERNSHIP / PRACTICAL FIELD EXPERIENCES
The Department has not, in the past, provided for internships for its physics majors. With the advent of the new Challenger Center on campus, the Department anticipates that some of its majors (particularly those interested in an academic career) may be able to work in this setting. In addition, the Department was responsible for loaning science apparatus to WTVC News Channel 9 for the initiation of its extremely popular Science Education Theater (for K-8 students of Hamilton and surrounding counties). We will pursue opportunities for students to gain practical experience in the design and presentation of science demonstrations in connection with this program.
9. CURRICULUM UPDATES
The Department has, within the last year, begun to revise its curriculum in these ways:

(a) new courses (Physics 190 Introduction to Physics and Physics 410 Mathematical Methods for Scientists) have been planned and should be submitted to the Curriculum Committee during the current academic year (see section 2(a));
(b) in this same proposal, the Department will seek to separate the introductory lectures and laboratories into individual courses. In addition, the prerequisites of some courses are being updated and other courses which have not been offered for several years will be deleted;
(c) new programs in (i) Applied Physics and (ii) Physics Education are being discussed as substitutes for the current minor in Health Physics;
(d) a re-write of our course catalog descriptions, identifying (i) recent changes made in the scheduling of courses, (ii) recommended courses for graduate school, and (iii) an update in the typical course of study, is being submitted to the Curriculum Committee.
(e) computerized laboratory experiments are beginning to be seen now in both advanced and elementary laboratories, allowing students to spend more time thinking about the physics concepts involved, and presenting a more current and realistic experience in gathering data.

10. CURRICULUM CHANGES NECESSARY FOR STUDENTS TO ACQUIRE APPROPRIATE EDUCATIONAL OUTCOMES
The Department seeks to provide its majors with:

- a solid undergraduate background in classical and modern physics
- an appreciation of -- and the ability to explain -- the importance of physics to other sciences and to technology
- a capacity to critically evaluate scientific approaches in answering questions concerning the physical universe
- the ability to carry out, at an appropriate level, investigative research using modern technology such as computers

A student who minors in Physics should be:

- knowledgeable in the discipline at the level of a secondary school instructor
- able to describe the impact of physics on our culture and history
- able to successfully integrate the concepts of physics with those of his/her major field of study

In order to bring these goals to fruition, the Department must continue to update and strengthen its curriculum. This may best be accomplished through planned new courses, an improvement in course scheduling, and new programs in tune with the needs of the recent job market (see section 9). We must offer more opportunities for student research with the present faculty, and through summer programs with other institutions and national laboratories. More attention must be given to the students’ ability to communicate, both verbally and in writing, clearly and concisely. In particular, faculty must devote more time in mentoring students, i.e., helping them to explore not only the information of physics textbooks and the laboratory activities of “doing physics,” but also the real world where physics is a profession.
PART 3: TEACHING AND LEARNING ENVIRONMENT

The mission of the Department of Physics, Geology and Astronomy at UTC is to prepare students majoring in physics to enter graduate schools or work force and to provide quality physics/science/astronomy education to pre-professional students.

3.1. THE CURRENT INSTRUCTIONAL PRACTICES include lectures, laboratories and seminars (Appendix 8, Figure 5), which are consistent with the standards of discipline. The courses are scheduled so that all majors may take the required courses during their four years of study. Students are consulted about course offerings, for both their requirements and their preferences.

UTC now requires students to complete 120 hours of credit for graduation, 8 hours less than in previous years. The university also has a general education core curriculum for all students that includes courses in 7 categories: Rhetoric and Composition, Mathematics and Statistics, Natural Sciences, Humanities and Fine Arts/Cultures and Civilizations, Behavioral and Social Sciences, Foreign Language, and American History.

The Physics degree requirements are as follows:

B.S. degree in physic core requirements
- Principles of physics-Electricity and magnetism: Phys 231/232-4 credits
- Principles of physics- Optics and Modern physics: Phys 232/282- 4 credits
- Classical mechanics: Phys 341- 4 credits
- Electricity and Magnetism: Phys 342- 4 credits
- Introduction to Quantum Mechanics: Phys 411- 3 credits

6 hours (essentially three 2 hr. courses) selected from the following laboratory courses:
- Methods of Experimental physics: Phys 381r- 2 credits
- Classical Physics laboratory: Phys 382r- 2 credits
- Atomic Physics laboratory: Phys 481r- 2 credits
- Nuclear and Health Physics laboratory: Phys 482r- 2 credits

Additional requirements are:
- 8 Credit hours in Chemistry
  - Math 245 (differential and difference equations)
  - Math 255 (Multivariable calculus) and its pre-requisites.
- 30 additional hours at the level of 200 or above in physics.
- Astronomy, chemistry, engineering, or mathematics

3.2. OPPORTUNITIES FOR STUDENTS TO INTERACT WITH EACH OTHER, WITH FACULTY, AND WITH PROFESSIONALS IN THE FIELD
- A student study room on the 3rd floor (shared between Physics and Chemistry students) is available essentially 24 hours a day or as long as the building is open.
• Over the last two semesters (Spring-Fall 2005) the department has offered a physics seminar course available for all majors. This seminar serves the following purposes: to give students and faculty members opportunity to learn about modern trends/accomplishments in physics from the experts in the field which we invite as speakers; to facilitate interaction between physics majors at freshman, sophomore, junior and senior levels, to allow faculty of the department to share the results of their research at the seminar.

• Faculty are available on a full time basis to handle student questions, advising, etc. -see section 3.3.

• Student research is supported and encouraged (Appendix 8.7).

Students are encouraged to look for summer internships in industry and at other schools where they can get real experience with working physicists. Each year the department receives many notices from other universities, observatories, and national laboratories specifically designed to inform students of summer research. These notices are first placed on the "Student Opportunities" bulletin board immediately outside the department office, and then maintained on file in the office for up to one semester. The head e-mails some of the information to the majors when appropriate.

Another opportunity that students have is to accompany faculty members to external research at other labs/universities. Dr. Lin Jun Wang used the National labs at Huntsville and Oak Ridge for such purposes. Dr. Allen has taken students with her to the Electrical and Computer Engineering Department, University of Toronto; Dr. Marlowe has taken students to the University of Toledo.

Another opportunity for students is to be involved in summer research with faculty members at UTC. This opportunity was established in the summer of 2004. Students David Welch and Marian Axente have collaborated with Drs. Allen and Marlowe.

• Honors in physics are offered to all students who are interested and meet the requirements.

3.3 Effective advising is provided by well-informed faculty and/or professional staff
Each physics major is assigned to an individual physics faculty member for advising and career planning. We know what each advisee has taken, what is being taken, and what needs to be taken in order to graduate on time. Also, notes about student interests and preferences are kept for future course planning.

Each faculty member is available and willing to help students find jobs, assists them in applying to graduate schools, writes letters of recommendations, etc.

3.4 Currency and adequacy of library holdings are currency and adequacy to meet student’s needs
Overview of library holdings for Physics Program is summarized in Appendix 8.16. The number of books appropriate to study of physics is 3,323 (out of 383,000 titles, 0.87%). Most of those books are old. Library support for physics program, $1000 per year (out of $126,100 total
allocation, 0.8%), is thought to be equivalent to that given to similar programs. The serials budget for Physics and Astronomy has been reduced since year 2000 by 4.67 times and in 2005 is $10,905 for both, Physics and Geology programs. Out of this budget Physics subscribes to 11 serials for the total of $4993 in 2005. We wish the library could have more funds to purchase additional serials. Access to any paid subscription to electronic databases such as Web of Science require spending departmental funds.

3.5 The program seeks to include the perspectives and experiences of underrepresented groups through curricular and extracurricular activities.

Physics tends to be a male dominated field. Our department is a lucky exception: we have 50/50 ratio between male/female faculty, and do everything to attract more female majors. Currently we have 3 female majors (20%), which is higher than average number in discipline. We have majors of Asian and Caucasian origin (Figure 8.14)

- The Department offers need-based and merit-based scholarships to the majors.
- The Physics Program faculty members give various demonstrations and exhibits at Engineers' Day, Freshman Orientation, Visitors' Day, and other occasions open to the public.
- The department members identify the students in lower level physics courses who have interest and ability to become a physics major/minor and advise them on individual basis.
- UTC Physics WWW home page is maintained and available to UTC students and general public.
- The Physics Program is cooperating with Creative Discovery Museum to offer public presentations to local school students.
- We are beginning to advertise departmental activities and services, particularly in the area of Astronomy, through UTC relations' office. Jones Observatory is open to the public on every Sunday throughout the academic year, and the each presentation/viewing attracts hundreds of people.

3.6 Students have the opportunity to regularly evaluate the quality of faculty teaching effectiveness.

Student evaluations are made each semester in each course in the program. The results are used to advise the faculty of their instructional strengths and weaknesses. Faculty who teach upper level physics courses having low enrollments must be especially vigilant in requesting the university's Office of Planning, Evaluation and Institutional Research to send evaluation forms: ordinarily, forms are not sent to classes having fewer than 5 students.

The results of evaluations are summarized in Appendix 8.8. The students' evaluations of physics faculty being “effective teacher” and “presents material clearly” are lower than UTC/college average. There are a combination of explanations for this condition. Firstly many non-physics majors seem to penalize physics faculty for the students' inability in the application of mathematical relations (often algebra in algebra-based physics). Secondly, some faculty receive exceptionally law ratings, which then lowers the overall average of the physics program. We anticipate that the latter case will be improved in the future, and the faculty will attempt to be rated as effective teachers, as the cliché goes: as we continue "to teach students and not courses."

We will also utilize the Walker Teaching and Learning Center to help us in this area. Other evaluation questions in (Appendix 8.8) return responses comparable to UTC/college average.
PART 4: PHYSICS FACULTY

OVERVIEW
The department of Physics, Geology, and Astronomy has two degree-granting programs in the areas of Physics and Geology, with the latter offering degrees in classic Geology and Environmental Geology. Both programs offer minors and are run with a small number of faculty, each consisting of 4 tenure-track faculty and 2 to 4 adjuncts in Physics, and 1 adjunct in Geology. The faculty have different specialties (Appendix 7) so that broad spectra of sub-disciplines are covered in both programs.

To provide quality instruction in the areas of physics and astronomy, and to satisfy the requirements of the majors, minors, and concentrations that are identified in Part II and in the catalogue, the Department should have the following specialties:

a) Condensed matter physics
b) Optics
c) Nuclear physics and elementary particles
d) Theoretical Physics
e) Astronomy

FACULTY QUALIFICATIONS / COMPETENCIES
The program currently has four tenure-track faculty members with the following qualifications (see also vitae, Appendix 7)

a) Dr. Allen's specialty is in experimental and theoretical condensed matter.
b) Dr. Ling Jun Wang's specialty is in experimental surface physics. In addition, he is responsible for teaching General Science to non-physics majors.
c) Dr. Jin Wang's specialty is in theoretical physics. In addition, she has experience in experimental physics.
d) Dr. Marlowe's specialization is in experimental condensed matter physics (laser light scattering and biophysics). He also has an M.Ed. in secondary science teaching with a physics concentration. In addition to teaching in areas of physics, Dr. Marlowe is responsible for the Astronomy program.

Our adjunct faculty provide further important qualifications.

a) Mr. Climer, BS physics, and BA in education.
b) Dr. Gimmick, PhD in Physics
c) Mrs. Huang, BS physics education.
d) Mr. Kleiner, MS in Engineering

The faculty are diverse in gender (Appendix 8.14), ethnicity, and educational competencies. In the period 2000 to 2005 each tenured faculty member had a sabbatical leave, and a senior faculty member, Professor Eric Lane, retired. Dr. Jim Gummnick was hired as a full-time non-tenure faculty in order to cover the sabbatical leave of absence taken by the tenured faculty. Dr. Jin Wang has been hired to replace Dr. Peter Groves, who served for one year as a replacement faculty for the retired Professor Eric Lane. One of the most dedicated adjunct faculty, Mrs. Chantana Lane, retired along with her husband. Her retirement placed a huge strain on the course offering of the program. Initial help to cover the scheduled courses was obtained from the
College of Engineering, and Dr. Jim Cunningham taught Introductory Physics courses and Laboratories as Mr. Kleiner taught laboratory courses. Another adjunct faculty member, Dr. Larry Akers, who taught nuclear physics course and served as Radiation Safety Officer, also retired. Mr. Jack Pitkin, the departmental laboratory manager, has taken the additional task of being a Radiation Safety Officer. The physics program has essentially lost a twelve credit hour's worth of teaching, lecture and laboratory courses, by the retirement of Mrs. Chantana Lane and Dr. Akers.

QUALITY OF TEACHING
Up to date and current materials are used in the instruction of physics and faculty members periodically review the books to select for their classes. They integrate computer-based instruction in both lectures and laboratories. In the laboratories computers are used not only to manipulate data but also to collect data. Sabbatical leaves taken by faculty have invigorated their dedication to teaching, and may have contributed to the recent increase of majors in physics (Appendix 8.1).

The quality of teaching is an elusive aspect that offers difficulty for quantification and assessment. Some of the measures include student rating instruments (SRI), Student outcomes assessment (SOA), evaluation by development objects (EDO), Cumulative Performance Report (CPR), Five year self study (FYSS), and Faculty awards and recognition (FAR) rewards received by faculty.

Student Rating Instrument (SRI).
Our faculty receive good student ratings particularly in upper division physics courses. However, the rating at introductory levels dominated by non-physics majors is quite low compared to the ratings obtained by faculty in other science areas (Appendix 8.8). Most students have not had pre-college physics prior to attending physics courses at UTC, and they seem to blame their difficulties in following college level physics on poor teaching. Regardless, faculty are eager to improve their teaching methodologies to help the students. The approach the faculty have taken and are taking to address this concern include:

1) participating in teaching excellence awards (Appendix 7).
2) attending teaching enhancement programs organized by UTC. Typically, this involves attending a two-day retreat at Watts Bar, some 60 miles from the campus in the month of May. E.g., Dr. Allen has participated in this activity -Appendix 7).
3) Using the facilities, and discussing with the staff of UTC's Walker Teaching Resource Center. The faculty consult with the office to find ways of more effectively teaching the non-major students, and retaining majors who may not have had strong backgrounds in physics.

Student Outcomes' Assessment (SOA).
The department has agreed to implementing a set of means of assessing the results of the teaching the faculty performed by the learning the physics majors acquired (Part II). Unfortunately we had few majors and even fewer graduates Appendix 8.1 and 8.2) in the last five years that implementation of assessment by this means was not effected.
Evaluation Development by Objective (EDO).
The department has a set of guidelines by which it wishes to be evaluated yearly (Appendix 6-3). Faculty confer with the department head about their goals before the beginning of the academic year, usually by April of the spring semester. That is the time when the head writes comments indicating the emphasis the faculty should place among their goals. The process offers opportunities for the faculty to develop plans for conducting research, developing new courses, improving teaching, et cetera. The faculty are then evaluated at the end of the year, by March. When done properly the EDO system works well. Recently, exceptional merits that were identified in the EDO process were rewarded with salary raises, which were satisfying to the recipients. Each of the current tenured faculty had received at least one exceptional merit in the last five years.

Cumulative Performance Report (CPR)
The college has a set of guidelines by which faculty may be reviewed every six years. We have started on this, though not all of our faculty have gone through it. Here, a committee of tenured faculty reviews the work of a colleague, and evaluates the overall effort of the faculty. Only one faculty member had received a "needs-improvement" evaluation on the CPR over the last five years. However, the CPR is no longer required by the college.

Five Year Self Study (FYSS).
Another evaluation process is the self-study document that we prepare every five years. This effort is particularly useful in showing the faculty the strengths and weakness of the program in terms of course offerings, staffing needs, space needs, equipment needs, and overall productivity. It is also the method by which the department receives feedback both from upper administrators and from reviewers outside of UTC. In the last FSS our program received a high rating.

Faculty Awards and Recognition (FAR)
There are many awards that UTC offers (Appendix 1.9) in the form of scholarships and grants. The faculty have benefited by competing and receiving awards in Faculty Research, Summer Fellowships (Appendix 8.11) and Sabbatical Leaves of absence. Some of our faculty serve as reviewers of journal articles, are chairs of societal meetings and Dr Lin Jun Wang was invited speech maker at plenary session of a societal meeting (See Appendix 1.4)

The head supervises new and temporary faculty, and other faculty are consulted in matters of discipline-based concerns, if such is deemed appropriate by the head.

Faculty Service
The faculty provide services to the university, the community and professional organizations. Faculty service to the university includes service in Faculty Council, Curriculum Committee, Library Committee, etc. (Appendix 7). The department offers four general education courses, thereby ensuring that our faculty are engaged in interdisciplinary activities that involve teaching to satisfy the needs of other departments. Also, one of the faculty, Dr. Marlowe, taught a course (the Development of Scientific Thought) in the University Honors Program during 1994-2003.

The faculty present their research work at scientific societies (Appendix 7). They interact with the scientific community via the Internet. They seek and obtain grants (Appendix 8.11) to
further their own research goals and those of the department. To help realize UTC's mission as a metropolitan institution, our faculty spares no effort. The faculty interact with area schoolteachers. For example, Dr. Marlowe presented demonstrations and discussions about black holes to both teachers and students of middle and high schools at the Creative Discovery Museum. Of course, all faculty provide answers to the many questions asked of them from the general public area schools. Perhaps the department's greatest contribution to our community comes from the Clarence T. Jones Observatory and the Planetarium annex. The department is extremely fortunate to have a budding amateur astronomer, Mr. Jack Pitkin, as a Laboratory coordinator in our department. Mr. Pitkin is very active in providing information concerning astronomy to WUTC and other radio and television stations; the local media for comments on current scientific events often contact the physics faculty. Such outreach will help the department increase its visibility in future years.

Overall Evaluation
The department endeavors to maintain a history of the departmental self-evaluation so that we may learn from experiences of the past.

1) In 1991, we designed a table that shows our course offering over a period of four years and distributed it to engineering, mathematics, and chemistry faculty members. We wished to provide a clear schedule of our courses so that they might advise students to enroll in our courses. However, there is no evidence that would support that our scheduling has helped to increase the number of our majors. Yet, it has clarified to us, in a concrete way, how our schedule appears over a span of time. We revise the schedule to meet ambient needs. For instance in 2005, low enrollment in calculus-based courses, particularly Physics 230 mechanics, and physics 232 quantum, has resulted in the faculty determination to offer these courses every year instead of every semester.

2) We have held several meetings on the issue of low enrollment including attending daylong retreats to hammer out issues. We focused on our course offerings, the number of chapters covered in a course, the meaning of student rating, and how to adjust to internal pressures. We had assembled data over a month as we prepared for the retreat. One significant point raised in our 1993 retreat has been implemented, and it concerns the use of computers, even in our introductory courses. The computer use is going to modernize our laboratory activities.

Another point raised in the 1993 retreat was the difficulty posed to a small department that is charged with increasing enrollment of majors, increasing non-major student enrollment, retaining a high level of student credit-hour (SCH) production, and maintaining quality of teaching. As a result of our determination at that retreat we decouple lectures from laboratories with the hope that this will help us increase overall student enrollment. We have no positive evidence to prove this conjecture. The high level SCH (>270) places a strain on productivity of faculty and the low number of majors continues to haunt us.

In a 2003 retreat we decided to discontinue offering radiation physics as a concentration for we did not have faculty with expertise to teach radiation physics.
3) As a result of our last five-year Self Study we determined that combining 4 upper division laboratory courses (381, 281, 481 and 482) into two laboratory courses would increase upper class enrollment and permit students to graduate in time. We plan to submit such a course by December 2005.

4) Implementation of the Cumulative Performance Report (CPR) helped the faculty to observe their contributions over a six-year span, and had a transformative effect on the department. The ambience of the program was invigorated by the retirement of a senior faculty member, and his replacement by younger ones, and by the taking of sabbatical leaves of absence by all tenured faculty over a span of three consecutive years has invigorated the department. The period also corresponded to an increase in the number of physics majors.

In conclusion, there can be no doubt that the quality of teaching in the program is quite adequate to enable students to develop appropriate skills and attain appropriate educational outcomes. The following summary shows our strengths.

1. We have qualified and well trained faculty that have PhDs.
2. We have faculty who have degrees in physics education, e.g., Dr. Marlowe and Mrs. Li Huang.
3. We have faculty who are active in research.
4. Our faculty strive to incorporate new technology in their instruction. Some laboratory experiments in the introductory courses are conducted by utilizing computers. More experiments will be computerized in the future.
5. We have faculty that use demonstration kits to enhance physics education. Dr. Jin Wang takes the lead role in this.
6. We have faculty that seek and receive both internal and external grants.
7. Our faculty perform research work at other institutions and try to develop research laboratories at UTC.
8. Our proximity to TVA nuclear facilities has in the past allowed us to provide service, training their staff, to them. In the middle and late 80's our student enrollment was greatly increased as the department offered degrees for TVA employees. While we currently don't have this interaction, our proximity to it has potential for future interactions.
9. The UTC Clarence T. Jones Observatory and associated planetarium is used for instruction and student research. The planetarium serves as one of our most successful outreach programs to the community. Over 1500 local area students visit the observatory every year.
PART 5: SUPPORT

The Department of Physics, Geology and Astronomy are housed in two separate buildings and have two separate budgets for its Physics & Astronomy part and its Geology part. Since 1968, the physics program has occupied the 3rd floor of Grote Hall in rooms that were furnished and fitted for physics instruction and laboratory work. Recently 3 rooms in the 2nd floor are also occupied by physics (Appendix 5.1). After the renovation of Grote Hall, the physics department is going to occupy parts of the 2nd floor and the 1st floors of Grote Hall (Appendix 5.1).

The operating budget of the Physics & Astronomy (P&A) program is given in Appendix 1.3. Because state revenues were limited, as of July 2000 a reduction in biweekly funds of about 23% was been implemented across the university in order to defray costs for faculty salary increases. The travel allotment of the operating budget have been a favorite target for suspension and/or reductions as appropriate to the exigencies in financial woes of the campus. About 59% of the travel allotment prior to 2003 has been reassigned to departments by 2005. Travel for presentation of research work by faculty was supported by seeking grants from the campus, from Dean Herbert Burhenn as well as from Departmental Gift Funds. The budgets for the last five years are given in Appendix 1.3. Equipment funds are not included in departmental operating budget. However, the department has received funds for equipment in the form of budget revisions (see the budget revision for supplies). Also, a start up fund for Dr. Jin Wang of $50,000.00 was given in the form of budget revision (Appendix 1.3 - see budget revision in other services, last row for 2005). The last row in Appendix 1.3 also contains indirect costs apportioned to the department from external funds that physics faculty had received. A total of $125,524.00 was used to purchase equipment and supplies in the last five years. This is in addition to equipment purchased through grant funds received by the faculty. In general, not having a budget for departmental equipment purchases, and the inability of the department to carry over funds across fiscal years have made it very difficult to plan for and satisfy the equipment needs of the department.

If all the funds in the departmental operating budget were used to teach majors only, our operating budget per student would range from $1573 to $ 2412 per Student (Appendix 8.18). However, less than 30% of faculty teaching effort is used to train majors. In fact, by a judicious and well-planned distribution of faculty teaching effort to meet the needs of both majors and service courses, the department has managed to be cost-effective and the operating budget ranges from $10.62 to $12.20 per SCH (student credit hour -- Appendix 8.19). Compared to other sciences, for example the chemistry department, our department is more cost effective (Appendix 8.20).

The department’s budgetary need is augmented by the effort of the faculty who actively seek internal and external funds (Appendix 1.4). Over the five years, the physics faculty had received about $124,000 from internal sources and about $70,000 from external sources. In the same five-year period, geology faculty have received about $3,700 from internal sources and about $106,000 from external sources. The faculty have obtained over $343,000 ($203, 882 in Physics, and $109,769 in Geology), which is more than double (a total of $272,000) the amount of the previous five years. Beyond the grant activity that help faculty teach and do research, the Physics and Astronomy program has scholarship funds and other endowments (Appendix 1.5)
that are placed in the UC Foundation fund pool. The interest from these monies is used to provide partial scholarship support for astronomy and physics students, and to augment the operating needs of the physics and astronomy program. The geology program has the Hoover-Nofsinger scholarship fund that provides about $700/year to an outstanding geology student.

INSTRUCTIONAL EQUIPMENT, LABORATORIES AND FACILITIES
The department has been able to maintain 10 sets of equipment (for 20 students) for each experiment taught in 100- and 200-level labs. We also have 20 computers (now about 5 years old) for lab teaching purposes. These computers were purchased from funds allocated by a previous Dean, Paul Graston, and also from grants received by the faculty. Currently, the University Help Desk is managing the proper functioning of the software in the computers and it has the responsibility for updating the hardware. The department inventory of instructional equipment (see also list of major equipment of Physics and Astronomy - Appendix 5.3) is quite adequate for undergraduate Physics instruction. Instruments that need repairs are repaired while those that need replacement are placed in a running list of equipment for Physics and Astronomy that the department head presents to the dean, when calls for equipment needs are announced. Dean Herbert Burhenn has provided some funds for the purchase of instructional equipment (see budget revision in Appendix 1.3). Occasionally, the department purchases equipment by using departmental gift funds.

As of 2005 the program has converted room 318 (Appendix 1.1) to a teaching room. It was intended to serve as a laboratory room but was not fitted or equipped for such yet. When the program moves to the 2nd floor, after the renovation of Grote Hall, we have anticipated the need of three introductory laboratories, one of which would be replacing the current room 318. We would need laboratory furnishings and computers for all the three introductory laboratories. The three introductory laboratories will go a long way in providing us with the capability to offer double sections proctored by one faculty and student helpers.

LIBRARY SUPPORT
The library holdings of the Physics Program are summarized in Appendix 8.16. As of July 2004, out of 383,000 titles, 0.87% (i.e. 3,323 books) are appropriate to the study of physics. Most of those books are old. Library support for physics program, $1000 per year (out of $126,100 total allocation, 0.8%), is thought to be comparable to that of similar units. The serials budget for P&A has been reduced since 2000 by 4.67 times and in 2005 is $10,905 for both the physics and geology programs. Out of this budget physics subscribes to 11 serials for the total of $4993 in 2005. The program will benefit if more funds are allotted for library book holding in the library for accessing electronic data bases, such as Web Science.

Library of videotapes in Astronomy is quite large, but library of videotapes in Physics is quite small (only 6 tapes). When time permits we may meet the challenge of having adequate video demonstration in Physics and to enlarge our video library by submitting proposals for Instructional Excellence Grants.
OFFICE SPACE
The Physics and Astronomy part of the department occupies adequate space at the third and second floors of the Grote Hall (Appendix 1.1). Each faculty member has his/her office space. The research laboratory space is also sufficient. We will begin to experience space problems when the second and first floors are renovated and we have to move the facilities from the second floor to the third floor. We anticipate that after the renovation the physics program will once again have adequate space. We also believe that our current concerns of offices without windows, inadequate teaching space specially suited for physics will be addressed after the renovation.

SECRETARIAL SUPPORT
At the moment the Physics and Astronomy department has employed a secretary for 30 hours per week, which is adequate.

TECHNICAL SUPPORT
We employ a full time lab manager/technical assistant who takes care of lab equipment and other minor repairs at the department.

PROFESSIONAL DEVELOPMENT OF THE FACULTY
Over the last five years each tenured faculty member of the department has taken a sabbatical leave of absence. During these times the faculty participated in experimental work at other institutions, which helped them develop in their professions. Before, during, and after securing sabbaticals the faculty had presented papers at professional societies despite the inadequacy of travel funds in the departmental operating budget. Dean Herbert Burhenn has been quite supportive of faculty research by providing partial funding for travel of faculty. Also, faculty apply to internal sources for additional travel funding.

OTHER RESOURCES
The recourse that is used often by faculty and students is the UTC Faculty Development Opportunities Fund (Appendix 1.9). For this, faculty compete to obtain faculty development grants, faculty research, summer fellowship, sabbatical leave, study leave, faculty research associate, CECA grants, travel funds, and instructional excellence grants. From the same fund, students compete for Provost Student Awards. Over last 5 years faculty members were pretty successful in obtaining both internal and external support for teaching and research purposes (Appendix 1.4)

The department has a Physics Astronomy Fund (Appendix 1.5) that it partially used to attract majors and establish summer research experience for students.

The Department offers several Awards to Physics majors (Appendix 1.5). Efforts by the department must be made to increase gifts, donations and availability of scholarships to physics students.