Office Use Only: PP#

Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	Towson University

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No	Payment Type: (●) R*STARS # JC085038 ( ) Check # JC085038	Payment Amount: $850	Date Submitted: 4/1/2024

Department Proposing Program	Department of Physics, Astronomy & Geosciences
Degree Level and Degree Type	Bachelor of Science
Title of Proposed Program	Interdisciplinary Physics
Total Number of Credits	120
Suggested Codes	HEGIS: 1902.01 — CIP: 40.0801
Program Modality	(●) On-campus ( ) Distance Education (fully online) ( ) Both
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources
Projected Implementation Date (must be 60 days from proposal submisison as per COMAR 13B.02.03.03)	(●) Fall ( ) Spring ( ) Summer — Year: 2024
Provide Link to Most Recent Academic Catalog	URL: https://www.towson.edu/academics/undergraduate/catalog.html
Preferred Contact for this Proposal	Name: Rhodri Evans
	Title: Assistant Provost for Assessment, Accreditation & Compliance
	Phone: (410) 704-3312
	Email: rhodrievans@towson.edu
President/Chief Executive	Type Name: Mark R. Ginsberg
	Signature: [signature] — Date: 04/01/2024
	Date of Approval/Endorsement by Governing Board:

Revised 1/2021

TOWSON UNIVERSITY

Mark R. Ginsberg, Ph.D.
President

Office of the President
8000 York Road
Towson, MD 21252-0001

March 25, 2024

TOWSON.EDU

Sanjay Rai, Ph.D.
Acting Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Dear Dr. Rai:

In accordance with the Code of Maryland Regulation (COMAR) 13B.02.03.06, Towson University seeks your review and approval to offer a **Bachelor of Science in Interdisciplinary Physics** with three areas of concentration in Computational Physics, Physics Innovation and Entrepreneurship (PIE), and Planetary Science.

The proposed program will complement TU's existing Bachelor of Science in Physics major and will provide students with a strong foundation in fundamental physics along with the freedom to develop a coherent academic program of study across other disciplines.

Students will be required to enroll in an area of concentration within the major and pursue specialized coursework, ranging from computer science and mathematics (Computational Physics); to marketing, economics, and communications (PIE); to astronomy, geology, and geography (Planetary Science). TU has prepared separate proposals for each area of concentration embedded within the degree. Although students will not be able to earn the degree without enrolling in an area of concentration, TU has also prepared a separate proposal for a "standalone" Bachelor of Science in Interdisciplinary Physics.

If you have any questions or require additional information, please contact Rhodri Evans, Assistant Provost for Assessment, Accreditation and Compliance, at rhodrievans@towson.edu or by phone at 410-704-3312.

Thank you in advance for your review.

Sincerely,

Mark R. Ginsberg, Ph.D.
President

MG/rjme

cc: Dr. Candace Caraco, Associate Vice Chancellor for Academic Affairs, USM
Dr. Melanie L. Perreault, Provost and Executive Vice President for Academic Affairs
Dr. Clare N. Muhoro, Associate Provost for Academic Affairs
Dr. Matthew Nugent, Dean, Fisher College of Science and Mathematics

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Proposal for a Bachelor of Science in Interdisciplinary Physics at Towson University

Table of Contents

A. Centrality to Institutional Mission Statement and Planning Priorities

A1. Program Description and Alignment with Institutional Mission

Towson University (TU) proposes a new Bachelor of Science (B.S.) in Interdisciplinary Physics (IP) in the Department of Physics, Astronomy, and Geosciences (PAGS) with three associated areas of concentration: Computational Physics, Physics Innovation and Entrepreneurship (PIE), and Planetary Science. This IP major will provide students with a strong foundation in fundamental physics along with the freedom to develop a coherent academic program across other disciplines. Every student will be required to enroll in an area of concentration within the major. The concentrations are centered on subjects that will prepare students to contribute to scientific advancement and economic development in our region and nation.

Several Maryland institutions (See Table 2 in Section C.4), including TU, offer a traditional physics major as a standard subject in the core sciences. Some institutions offer programs that take an interdisciplinary approach to science more generally, e.g., Morgan State University's B.S. in Interdisciplinary Sciences and B.S. in Interdisciplinary Engineering, Information, and Computational Sciences and Salisbury University's B.S. in Integrated Science, but there are no interdisciplinary science programs that are specifically physics focused. No Maryland institution currently offers a program comparable to the proposed IP major, which is targeted at students who are interested in the applications of physics to other disciplines.

This new IP major is distinct from TU's current B.S. in Physics, as it requires 11 fewer credits in upper-level physics courses, affording students freedom to take courses in other disciplines. The General Physics, Applied Physics, and Astrophysics concentrations in TU's existing B.S. in Physics are heavily physics-focused, requiring over 30 credits of 300- or 400- level physics or astrophysics courses that emphasize theoretical concepts and mathematical rigor. In particular, the Applied Physics concentration is designed for students interested in engineering and physics subdisciplines such as materials science. Because of the number of upper-level physics requirements, the B.S. in Physics is not a suitable pathway for students who are interested in the applications of physics to other disciplines.

The IP curriculum consists of 33 credits in a core set of physics and mathematics courses. Depending on the concentration selected, students are required to take an additional 54-66 credits in a variety of other subjects ranging from computer science and mathematics (Computational Physics), to marketing, economics, and communications (PIE), to astronomy, geology, and geography (Planetary Science). Thus, the IP program will draw on TU faculty expertise from across the Fisher College of Science and Mathematics (FCSM), as well as from the College of Business and Economics and the College of Liberal Arts.

All concentrations in the proposed IP program are well-aligned with Towson University's mission of preparing students as leaders in high demand careers through interdisciplinary study and research. In particular, the PIE concentration will drive community engagement through entrepreneurial efforts.

A2. Strategic Goals Alignment and Affirmation of Institutional Priority

The proposed program in Interdisciplinary Physics aligns with Towson University's 2020-2030 Strategic Plan. Specifically, the program will:

- Educate with an "innovative student-centered curriculum emphasizing engaged learning, in-demand academic programs, and new approaches to instruction and learning."
- Innovate through research experiences with TU faculty, who are "leaders in scholarship and creative activities" or through creative approaches to technical entrepreneurship.

- Engage by "extending the talents of our students, faculty and staff beyond our campus boundaries" with entrepreneurship and experiential learning.
- Support students' intellectual growth with a "campus experience that reflects the educational values of Towson University and produces graduates prepared for careers or advanced education."

A3. Five-year Funding Plan

The proposed new bachelor's degree program will be funded with reallocated support from across the university, as this program is built on existing undergraduate courses and faculty expertise. One new faculty will be hired as part of the existing hiring plan for the PAGS department to support and enhance the program. TU's central administration has committed funds to assist program implementation. Resources and expenditures anticipated for the first five years are presented in Section L**, Tables 10** and **11**.

A4. Institutional Commitment

The proposed bachelor's degree program is aligned with the university's new research- and innovation-oriented mission and strategic plan.

Beyond the currently anticipated addition of a new faculty member, the IP program will require minimal financial commitment and no new funding allocations for administration or infrastructure (see Section L for further details). There are currently over 200 faculty from across three TU colleges who will contribute to this program as part of their existing instructional load (see Section I.1 and Appendix C for a detailed listing). See Section K for more details about physical facilities and infrastructure available to support the program.

TU's Office of Technology Services will provide support for general computing needs. More specialized technical support will come directly from the relevant colleges involved in the program, which have dedicated staff for computer technology needs, classroom support, and website development. This program will benefit from the laboratory and analytical facilities of TU's Science Complex, access to specialized software such as ArcGIS (through the College of Liberal Arts), and several software packages and utilities available to students through university, FCSM, or PAGS licenses: Capstone, DataStudio, Tracker, LabVIEW, MultiSim, Mathematica, Origin, SigmaPlot, MatLab, RSpecExplorer, OSLO EDU, and Acrobat Creative Cloud.

TU is committed to student success. All students in the IP program will receive academic advising from PAGS faculty who will assist them in designing degree completion plans, completing the degree requirements, choosing elective courses, and finding and applying for internship opportunities. The IP major requirements are designed to be completed in the four-year duration of an undergraduate degree. Required courses and typical four-year plans for each concentration are outlined in Appendix A and Appendix B.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan

B1. Program Demand and Need

Physics is a foundational science. Increasingly, the most interesting problems and exciting opportunities are at the intersections of physics and other fields. Many of these interdisciplinary fields are at the forefront of scientific advancement. Computational Physics provides an entry into quantum computing and modeling of complex systems and novel materials. Students who choose the PIE concentration will be prepared to enhance economic development in Maryland through technical sales, technical product development and marketing, and small business startups. Planetary science will prepare a student to participate in solar system exploration, exoplanet discoveries and characterizations and the search for life in the universe, and atmospheric science and the study of global climate change.

B2. Alignment with Maryland State Plan for Higher Education

The proposed B.S. in Interdisciplinary Physics aligns with the Student Success and Innovation goals in the 2022 Maryland State Plan for Higher Education. TU faculty are committed to high quality instruction (Priority 5). The proposed program will provide students with knowledge and training through integrated curricula that emphasize synthesis of ideas and provide opportunities to earn credit through real world experiences in research, internships, and business activities.

The IP degree is designed for students who wish to study physics as it is applied to other fields, in a less theoretical context than the existing B.S. in Physics offered at TU. The proposed Interdisciplinary Physics curriculum gives students flexibility to fulfill requirements and develop a course of study that allows them to explore interests within a well-defined structure. The degree will also provide students who matriculate at TU as physics or other science majors an alternative pathway for completing a bachelor's degree in a timely manner and, through articulation agreements with Maryland's community colleges, will facilitate enrollment and graduation of transfer students (Priority 6).

The nature of the IP degree will foster a culture of risk–taking (Priority 8) by encouraging students to take intellectual risks in exploring new and emerging fields. The PIE concentration will be especially appealing to students who wish to gain a background in foundational science while also engaging in creative problem solving, product development, and business planning.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State

C1. Pipeline and Employment Opportunities

Students with physics backgrounds are problem-solvers, and those with interdisciplinary backgrounds, including business knowledge and soft skills, are well situated for the job market.[1,2] Overall, physics bachelor's degree holders enter the workforce and postgraduate study at about the same rate and have low rates of unemployment one year after graduation (**Figure 1**).[3] About 60 percent of the graduates entering the workforce are in the private sector, and among these graduates in the private sector, over 90 percent are in STEM-related positions or positions in which they regularly solve technical problems (**Figure 2**).

[1] Educating Physicists for Impactful Careers APS Epic Report: https://epic.aps.org/.

[2] Phys-21 Preparing Students for 21st Century Careers. Joint Task Force on Undergraduate Physics Programs: https://www.compadre.org/JTUPP/docs/J-Tupp_Report.pdf.

[3] AIP Report, Initial Employment of Physics Bachelors and PhDs, Classes 2019 and 2020: https://www.aip.org/statistics/resources/initial-employment-physics-bachelors-and-phds-classes-2019-and-2020.

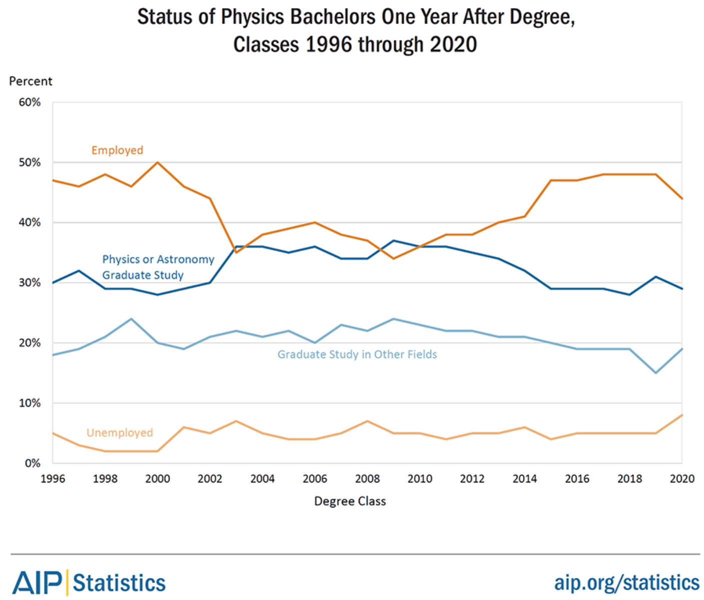

Figure 1. Physics Bachelors One Year After Degree

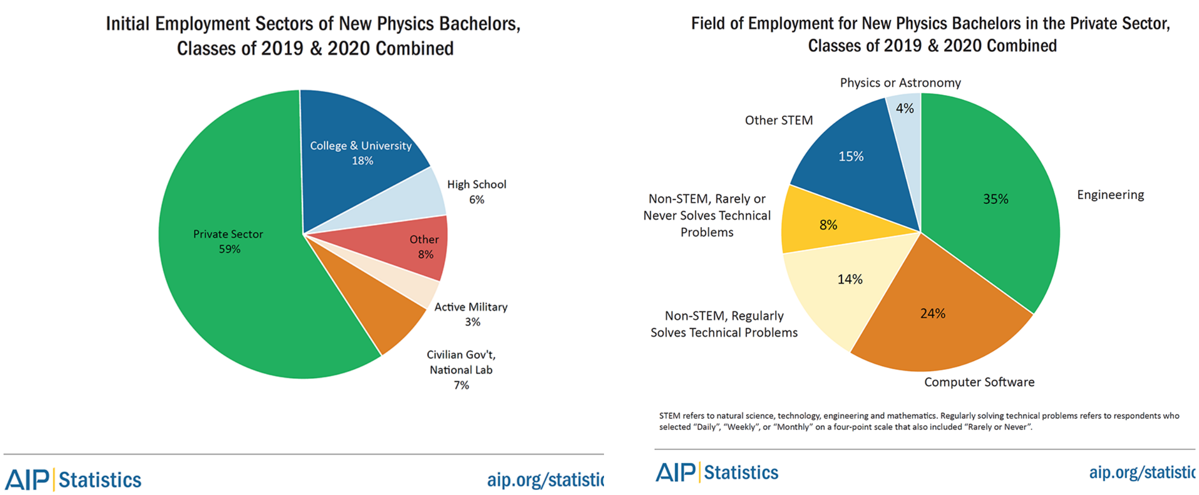

Figure 2. (a) Initial Employment Sectors of Physics Bachelors. (b) Fields of Employment for New Physics Bachelors in the Private Sector.

Specific career and postgraduate education options for students in the proposed IP concentrations are outlined below; these and related fields are projected to show increased demand according to the Maryland Department of Labor (**Table 1**).

Computational Physics: Computational skills are highly valued in the private and government sectors. Students focusing in this area of physics are well-positioned for a wide variety of jobs that require data analysis or computational modeling. Students enrolled in this concentration will be able to pursue a 4+1 pathway to TU's master's in Computer Science.

Physics Innovation and Entrepreneurship: The American Physical Society has recently emphasized the opportunities at the intersection of physics and entrepreneurship.[1,4,5] A program such as the one offered in the proposed IP major will prepare students for careers in the commercial sector, in which many of the highest paying positions are sales and marketing positions that require a combination of technical knowledge and soft skills in business and communications.

Planetary Science: Students pursuing this concentration will be well-prepared for postgraduate programs in the field or for research data analyst positions at local employment centers such as the Johns Hopkins Applied Physics Lab, NASA/Goddard, or one of the many Maryland businesses that contract with NASA. Stronger emphasis on geology would prepare a student for employment at government agencies such as the US Geological Survey. Geographic Information System (GIS) skills will be marketable for analyst positions, including in some areas of U.S. Intelligence.

C2. Market Demand

A market study commissioned by TU and conducted by EAB reports that according to the U.S. Bureau of Labor Statistics, in the past year, national and regional employers advertised a moderate total number of job postings for bachelor's-level interdisciplinary physics professionals (178,499 and 30,917 respectively). **Figures 3** and **4** show total monthly postings over the past three years. Average monthly employer demand for relevant professionals outpaced demand for all bachelor's-level professionals in both markets (1.97 percent vs. 1.79 percent nationally; and 1.80 percent vs. 1.45 percent regionally). Additionally, three of the top five most relevant occupations both regionally and nationwide are projected to grow faster than average. Together with Maryland Department of Labor projections reported in the following section, these trends indicate ample employment opportunities for graduates of an interdisciplinary physics program.

[4] Teaching physics for tomorrow: Equipping students to change the world (2019) Physics Today, 72, 10: https://physicstoday.scitation.org/doi/10.1063/PT.3.4318.
[5] Physics in the real world Careers2020, APS Careers & Physics World: https://reader.exacteditions.com/issues/84341/spread/16.

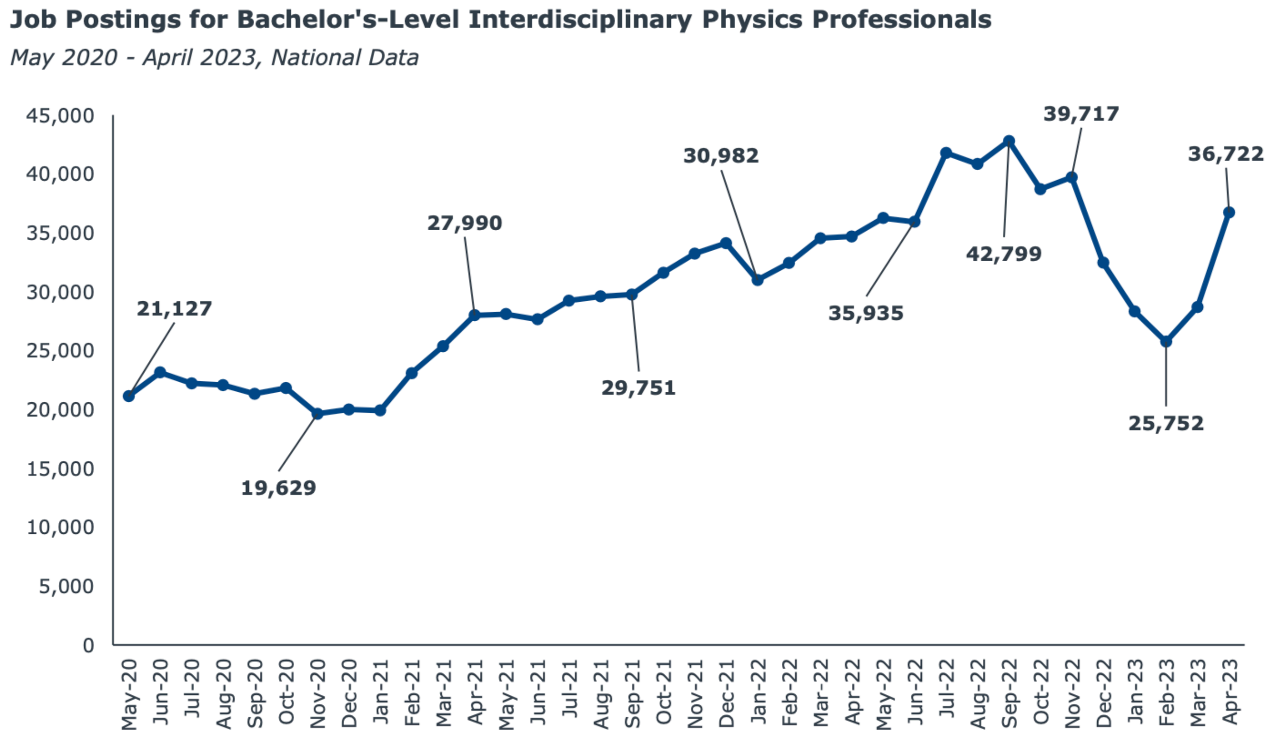

Figure 3. National Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

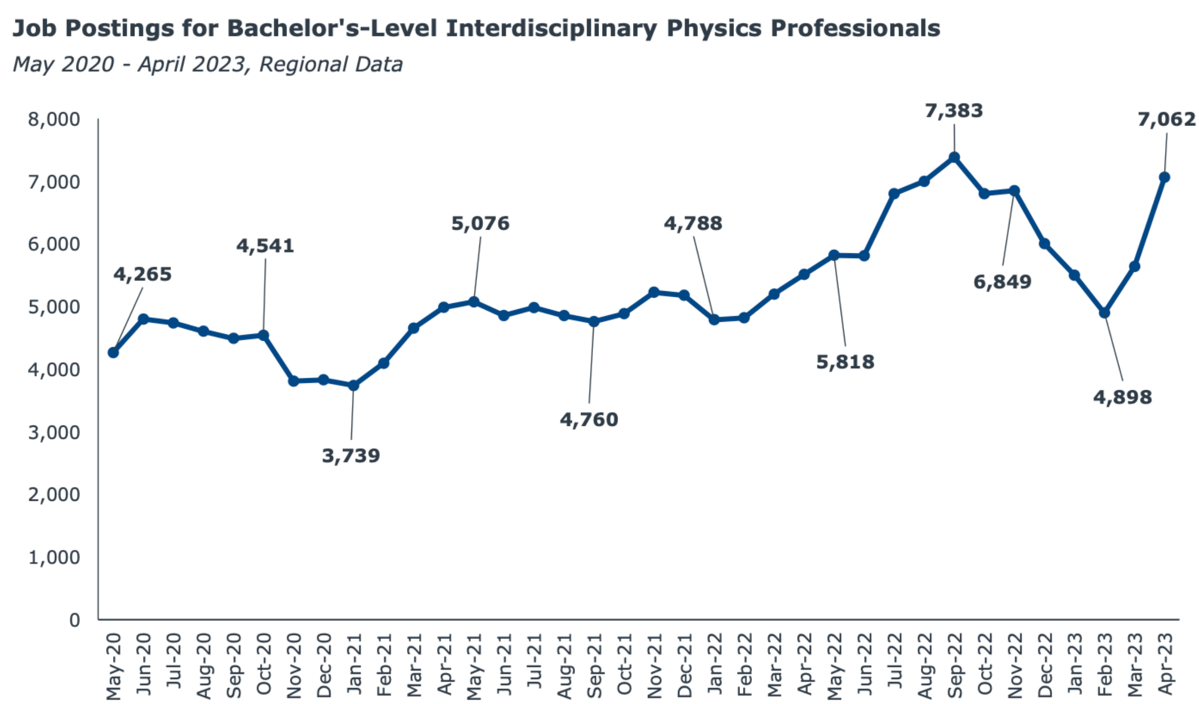

Figure 4. Regional Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

Note that the decline in job postings between September 2022 and February 2023 aligns with overall market trends during the same period. Both the regional and national market trends indicate a growing labor market for program graduates.

C3. Anticipated Vacancies and Training Needs
According to the Maryland Department of Labor, the occupational projections growth in job titles most closely related to the concentrations in the proposed program (**Table 1**) is between 3.3 percent and 30.5 percent for the period 2020-2030.

Table 1. Maryland Department of Labor Occupational Projections (2020-2030)

Title	Projected Change	Projected Annual Openings	Education Value
Computational Physics-related			
Computer and Information Research Scientists	16.8%	3,285	Master's
Data Scientists and Mathematical Science Occupations, All Other*	30.5%	3,045	Bachelor's
Innovation & Entrepreneurship-related			
Sales Engineers	9.5%	1,032	Bachelor's
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	6.2%	7,401	Bachelor's
Planetary Science-related			
Atmospheric and Space Scientists	5.4%	706	Bachelor's
Geoscientists except Hydrologists and Geographers	3.3%	433	Bachelor's

**Not Actuaries, Mathematicians, Operations Research Analysts, Statisticians*

According to the EAB market study, the projected growth during the period 2022-2033 in occupations for IP professionals such as Data Scientists, Software Developers, Electrical, Mechanical, and Industrial Engineers and Operations Research Analysts is 7.0 percent regionally and 8.8 percent nationally. Top skills in regional and national job postings encompass physics and additional disciplines included in the concentrations to be offered within the proposed IP program: computer programming and simulations, electronics, mathematics, product development, chemistry, data analysis, etc. (**Figures 5** and **6**).

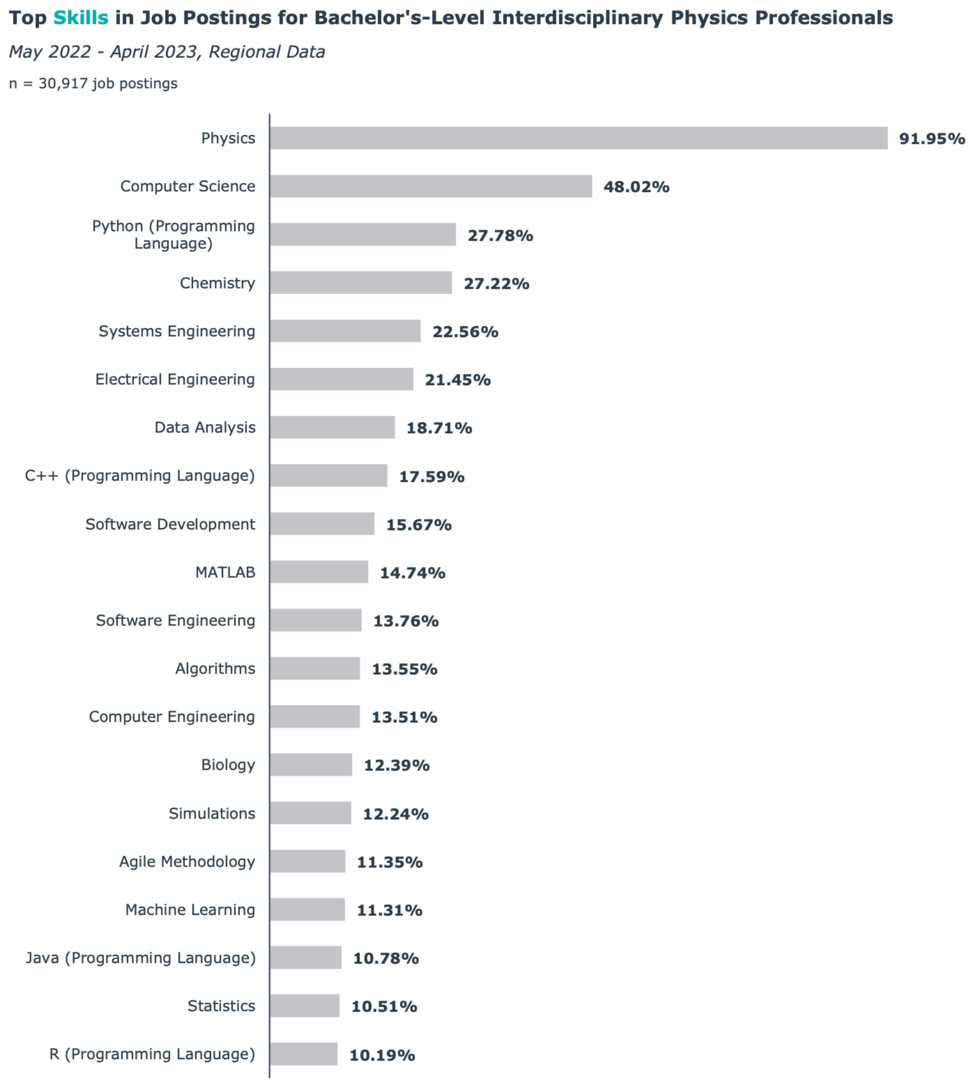

Figure 5. Top Skills in Regional Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

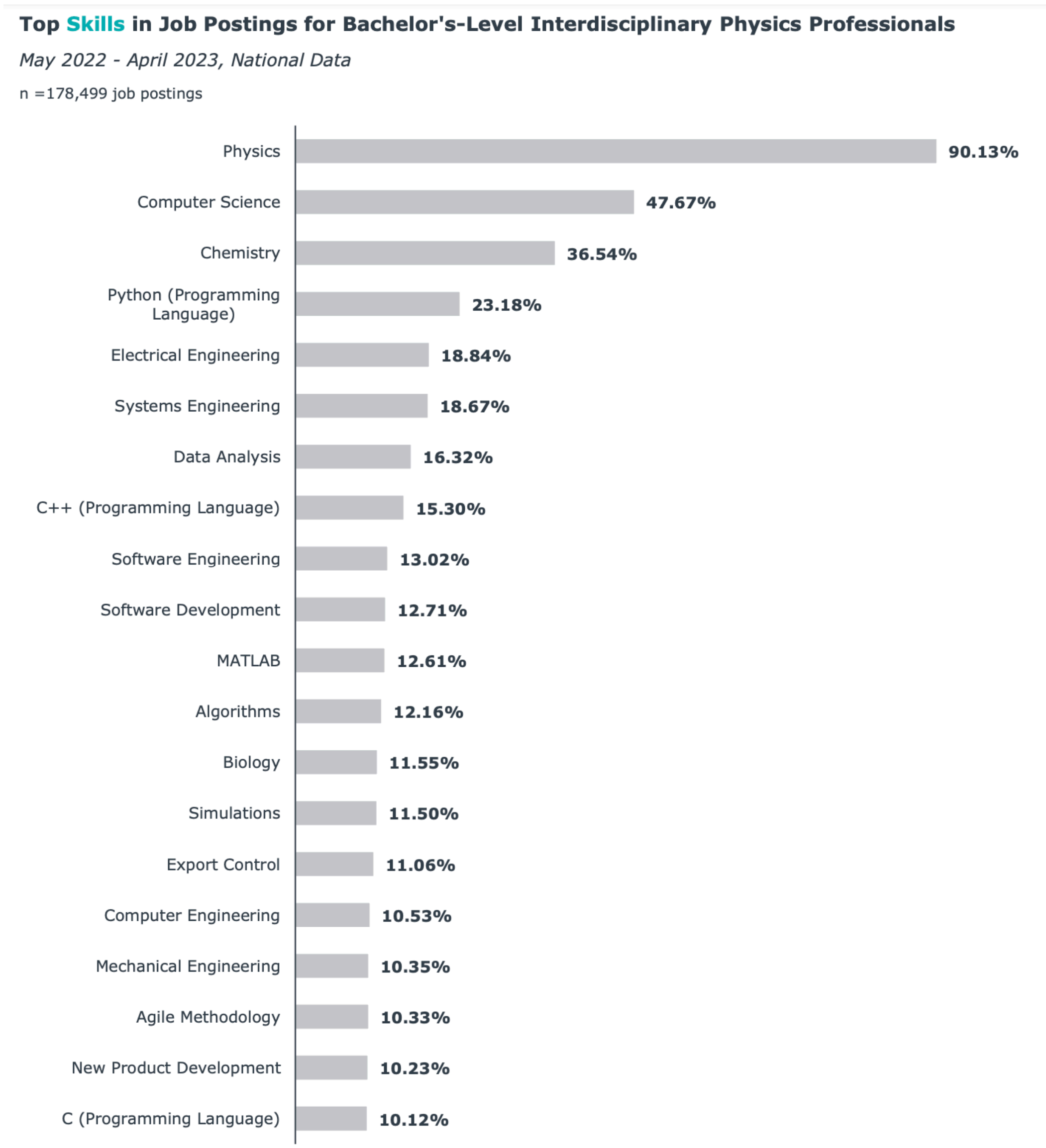

Figure 6. Top Skills in National Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

C4. Projected Supply of Prospective Graduates

TU's proposed program will complement existing physics-related programs, most of which follow the traditional physics curriculum and are similar to TU's existing physics major. The IP program will attract students from a variety of STEM backgrounds who want to pursue opportunities at the intersection of physics and other fields.

The number of students enrolled in these programs and the number of degree completions for the period 2018-2022 as reported by MHEC is summarized in **Table 2**.[6] The number of physics and physics-related degrees awarded statewide has remained relatively stable over the past five years, with fluctuations of about 10 percent. Because of its interdisciplinary nature, the proposed

[6] Maryland Higher Education Commission, Trends in Degrees and Certificates by Program, Maryland Higher Education Institutions 2014-2021, March 2022 https://mhec.maryland.gov/publications/Documents/Research/AnnualReports/2021DegreesByProgram.pdf.

IP program is expected to attract students who would have majored in other STEM fields. Thus, **Table 2** also tabulates the number of TU degree completions in subjects such as geology, earth space science, and computer science. Finally, **Table 2** includes the number of potential students who may be drawn to the program from two-year institutions, including those who complete associate's degrees in subjects such as geosciences and computer science.

Table 2. Enrollment Trends in Physics and Interdisciplinary Physics Related Programs at Two- and Four-Year institutions[7]

Comparable Programs in Maryland

Program	Institution	Enrollment				
		2018	2019	2020	2021	2022
Physics	Frostburg State University	10	7	8	4	7
Engineering Science	Goucher College	0	0	0	5	7
Physics	Johns Hopkins University	54	40	40	41	48
Earth and Planetary Sciences	Johns Hopkins University	6	8	3	5	4
Materials Science & Engineering	Johns Hopkins University	17	20	9	13	26
Physics	Loyola University	9	4	7	6	9
Physics (Engineering)	Loyola University	2	1	3	5	4
Physics	McDaniel College	7	4	8	11	8
Physics	Morgan State University	10	12	13	7	11
Engineering Physics	Morgan State University	28	27	23	23	19
Interdisciplinary Engineering, Information, & Computational Sciences	Morgan State University	N/A	N/A	N/A	N/A	5
Interdisciplinary Sciences	Morgan State University	N/A	N/A	N/A	N/A	3
Physics	Notre Dame of Maryland University	11	8	8	4	3
Physics	Salisbury University	84	80	60	44	56
Integrated Science	Salisbury University	N/A	N/A	N/A	3	11
Physics	St. Mary's College of Maryland	29	21	22	25	31
Physics	University of Maryland, Baltimore County	128	133	114	102	88
Physics	University of Maryland, College Park	324	301	321	288	269
Physical Sciences	University of Maryland, College Park	0	1	0	0	0
Materials Science & Engineering	University of Maryland, College Park	130	121	110	79	56
Physics	Washington College	29	28	16	13	8

[7] N/A indicates program was not yet operational for the year listed.

		Bachelor's Degree Completions				
		2018	2019	2020	2021	2022
Physics	Frostburg State University	2	4	2	2	1
Engineering Science	Goucher College	0	0	0	0	0
Physics	Johns Hopkins University	22	21	14	15	10
Earth and Planetary Sciences	Johns Hopkins University	7	4	4	2	1
Materials Science & Engineering	Johns Hopkins University	17	20	9	13	26
Physics	Loyola University	2	1	3	2	1
Physics	McDaniel College	7	4	1	1	3
Physics	Morgan State University	0	1	4	1	0
Engineering Physics	Morgan State University	1	2	2	0	2
Interdisciplinary Engineering, Information, & Computational Sciences	Morgan State University	N/A	N/A	N/A	N/A	N/A
Interdisciplinary Sciences	Morgan State University	N/A	N/A	N/A	N/A	N/A
Physics	Notre Dame of Maryland University	1	2	4	1	1
Physics	Salisbury University	30	12	20	14	9
Integrated Science	Salisbury University	N/A	N/A	N/A	1	1
Physics	St. Mary's College of Maryland	4	10	8	5	6
Physics	University of Maryland, Baltimore County	20	12	24	16	21
Physics	University of Maryland, College Park	62	73	71	76	66
Physical Sciences	University of Maryland, College Park	3	0	0	1	0
Materials Science & Engineering	University of Maryland, College Park	38	22	36	34	33
Physics	Washington College	4	8	11	7	8

Internal TU Student Migration						
TU Program (transfer from)		**Enrollment**				
		2018	**2019**	**2020**	**2021**	**2022**
Physics	Towson University	106	99	93	68	57
Earth-Space Science	Towson University	11	8	7	14	13
Geology	Towson University	45	37	38	34	35
Computer Science	Towson University	837	884	933	950	971

		Bachelor's Degree Completions				
		2018	2019	2020	2021	2022
Physics	Towson University	14	19	24	12	13
Earth-Space Science	Towson University	2	2	3	1	0
Geology	Towson University	9	17	10	12	11
Computer Science	Towson University	121	133	137	141	167

External Feeder or Transfer Programs						
Program	**Institution**	**Enrollment**				
Arts & Sciences Transfer	Baltimore City Community College	350	239	198	187	120
Mathematics & Science	College of Southern Maryland	179	144	150	153	125
Science	Community College of Baltimore County	575	555	484	428	382
Physical Science	Carroll Community College	2	12	8	9	18
Geosciences	Cecil Community College	0	1	1	3	3
Physics	Cecil Community College	1	4	3	2	3
Engineering Science	Hagerstown Community College	42	37	40	44	44
Arts & Sciences Transfer	Harford Community College	855	796	721	705	671
Computer Science	Harford Community College	129	110	94	94	111
Arts & Sciences Transfer	Howard Community College	1,334	1,411	1,391	1,258	1,151
Computer Science	Howard Community College	147	176	257	277	342
Science	Montgomery College	1,283	1,078	1,053	820	838
Engineering Science	Montgomery College	1,110	895	801	713	660
		Associate's Degree Completions				
		2018	**2019**	**2020**	**2021**	**2022**
Arts & Sciences Transfer	Baltimore City Community College	47	25	20	13	31
Mathematics & Science	College of Southern Maryland	6	6	3	7	5
Science	Community College of Baltimore County	55	65	48	40	40
Physical Science	Carroll Community College	0	1	3	2	2
Geosciences	Cecil Community College	0	0	0	0	0
Physics	Cecil Community College	2	4	4	1	1
Engineering Science	Hagerstown Community College	9	11	5	5	6
Arts & Sciences Transfer	Harford Community College	217	195	167	167	169
Computer Science	Harford Community College	18	9	19	15	12
Arts & Sciences Transfer	Howard Community College	238	225	221	203	188

Computer Science	Howard Community College	26	15	28	39	21
Science	Montgomery College	148	193	170	164	178
Engineering Science	Montgomery College	108	122	106	115	92

D. Reasonableness of Program Duplication

D1. Similar Programs

As detailed in **Table 2**, there are a number of institutions of higher education in Maryland that offer undergraduate degrees in physics and related fields. Most of these programs are "traditional" physics degrees, similar to TU's existing B.S. in Physics, or they have a specialized area of focus (such as engineering or materials science) that is wholly distinct from TU's IP degree. While TU believes that the combination of a strong physics foundation and three specialized areas of focus, with critical bridge courses that provide connections, makes this proposed program unique, a summary of existing programs at other Maryland institutions that are the most like TU's IP degree is provided:

<u>Computational Physics</u>
Computer science, computer engineering, and computer information systems are common majors in Maryland, but none has the distinct focus on application to physical problems offered by TU's Computational Physics concentration.

<u>Physics Innovation and Entrepreneurship</u>
None

<u>Planetary Science</u>
University of Maryland College Park (UMD): Minor in Planetary Science
Johns Hopkins University (JHU): Major in Earth and Planetary Sciences

TU's proposed Planetary Science concentration within the IP major is a combination of physics, astronomy, geology, and geography, while the curriculum for the UMD minor is primarily astronomy and geology, with no physics requirement. Similarly, the JHU undergraduate program in Earth and Planetary Sciences focuses on earth science, environmental science, geology, geography, with no physics or astronomy requirements other than one course in planetary atmospheres.

<u>Interdisciplinary Programs</u>
Morgan State University: Interdisciplinary Engineering, Information, and Computational Sciences
Morgan State University: Interdisciplinary Sciences
Salisbury University: Integrated Science

Morgan State University (MSU) programs were approved in 2021 and are two of eight interdisciplinary bachelor's degrees offered within the College of Interdisciplinary and Continuing Studies. These two programs have a much broader interdisciplinary scope than TU's proposed IP program, allowing students to take coursework in a wide range of subject areas (depending on the program) that are not available to TU students, such as psychology, sociology and anthropology, various engineering fields, transportation and urban infrastructure, education, public health, nursing, etc.

The Salisbury University Integrated Science degree is also a general interdisciplinary program that allows students to combine areas of study across disciplines. There are no options for Salisbury's Integrated Science program that correspond directly to concentrations in TU's proposed IP program.

D2. Program Justification

Approximately 9,000 physics bachelor's degrees are awarded each year in the U.S. About one half of those degree recipients will enter the workforce in a STEM-related field. Students expect their degrees to confer skills that will help them succeed in the modern economy, which is increasingly technical and interdisciplinary. Thus, it will be highly beneficial for students to obtain a degree with a strong physics foundation and with concentrations that span a variety of other scientific, technical, and business-related fields. The EAB market study found that "...projected growth in employer demand and rising student demand suggests a favorable outlook for the proposed bachelor's-level interdisciplinary physics program."

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

While Morgan State University does offer undergraduate degree programs (in Physics, Engineering Physics, Interdisciplinary Engineering, Information, and Computational Sciences, and Integrated Science) that have some curricular overlap with TU's proposed IP degree, Section D.1 highlights how TU's proposed IP program differs substantively from MSU's programs. The other three HBIs in the USM, Bowie State University, Coppin State University, and University of Maryland Eastern Shore, do not offer physics-related programs.

Interested and qualified students who graduate from TU with a bachelor's degree in Interdisciplinary Physics may pursue programs such as MSU's master's in Integrated Sciences, so this new bachelor's program may provide a pathway for Towson University undergraduate degree holders to pursue graduate education at a nearby HBI.

F. Relevance to the Identity of Historically Black Institutions (HBIs)

Given the specialized subject areas of the proposed degree, TU does not anticipate that its implementation will impact the uniqueness and institutional identities and missions of HBIs.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes

G1 Program Development and Faculty Oversight

The curriculum for the B.S. in Interdisciplinary Physics was developed primarily by faculty with expertise in physics and astronomy within the Department of Physics, Astronomy, and Geosciences, in consultation with TU faculty and staff from the variety of disciplines represented in the IP concentrations. Faculty members who will oversee the program are identified in Section I.1; they are tenured and tenure-track faculty with diverse research and pedagogical expertise in physics and all the related disciplines in the program concentrations.

G2. Educational Objectives and Learning Outcomes

The IP program has two overarching student learning outcomes (SLOs). Upon successful completion of the degree, students in all IP concentrations will be able to:

1. Demonstrate an understanding of fundamental principles of physics and major concepts in a student's chosen concentration and be able to apply these principles to solve quantitative problems.
2. Communicate scientific information effectively in both oral and written formats.

Additionally, students will achieve a third learning outcome, defined for each concentration:

Computational Physics	Demonstrate the ability to apply computational methods and computer controls to investigate experimental and theoretical scientific problems.
Physics Innovation and Entrepreneurship	Demonstrate an understanding of the interdisciplinary nature of scientific research and technology as they apply to the fields of business, entrepreneurship, and physics.
Planetary Science	Demonstrate an understanding of the interdisciplinary nature of scientific research and theory as they apply to the fields of astronomy, geology, and physics.

These SLOs address the Middle States Commission on Higher Education (MSCHE) requirement in the following ways:

SLO 1: Scientific and quantitative reasoning, critical analysis and reasoning, technical competency, and information literacy.

SLO 2: Oral and written communication, information literacy

SLO 3: Scientific and quantitative reasoning, critical analysis and reasoning, technical competency, and information literacy.

Table 3 below shows the alignment of the core requirements of the IP curriculum with the overarching program SLOs (#s 1 and 2) and the concentration specific SLO (#3). Yellow shading indicates courses used for SLO measures. Additional courses in each concentration are also used for SLO measures, which are summarized in the following section. All courses used for SLO measures are also shaded in Section G.4 Program Requirements and in the Example Programs of Study included in Appendix B.

Table 3. Curricular Alignment with Student Learning Outcomes			
Physics Core requirement	**SLO 1**	**SLO 2**	**SLO 3**
PHYS 185 Introductory Seminar in Physics	x	x	
PHYS 241 General Physics I Calculus-based or PHYS 211 General Physics I non Calculus-based	x	x	x
PHYS 242 General Physics II Calculus-based	x	x	x
PHYS 243 General Physics III	x	x	x
PHYS 305 Computers in Physics*	x	x	x
PHYS 311 Modern Physics I	x	x	
PHYS 341 Intermediate Physics Laboratory	x	x	x
PHYS 385 Physics Seminar or ASTR 385 Astrophysics Seminar	x	x	x
PHYS 486 Physics Seminar II	x	x	
MATH 273 Calculus I	x		
MATH 274 Calculus II	x		

**Used for SLO measure in Computational Physics and PIE Concentrations only.*

Descriptions of all required and concentration courses are included in Appendix A.

G3. Assessment and Documentation of Student Learning Outcomes
Each core SLO has two measures. Performance data are collected each time the courses are taught. Descriptions of the measures are summarized below in **Table 4**.

Table 4. Brief Descriptions of Measures		
	Measure 1	**Measure 2**
All Concentrations		
Outcome 1	The Force Concept Inventory will be administered to all PHYS 241 or PHYS 211 students as a pre/post exam. This exam, developed using physics education research, is a standard test used across the country and allows comparison of TU student results with other institutions.	The Concepts Survey in Electricity and Magnetism (CSEM) exam will be administered to all PHYS 242 students as a pre/post exam. This exam, developed using physics education research, is a standard test used across the country and allows comparison of TU student results with other institutions.
Outcome 2	Students are required to submit written reports for the experiments performed in PHYS 341. One report will be chosen to assess the ability of students to communicate in written form. The "Introduction" and "Conclusion" sections will be evaluated to assess this outcome.	Students will be assessed on oral presentations given in PHYS 385 or ASTR 385.
Computational Physics Concentration		
Outcome 3	A common assignment will be used in PHYS 305 which demonstrates the ability of students in the Computational Physics concentration to use technology to solve a theoretical physics problem. Students in the Computational Physics concentration will be expected to investigate two or more computational methods to solve the problem.	Students in the Computational Physics Concentration will be assessed on a final project in PHYS 460.
Physics Innovation and Entrepreneurship Concentration		
Outcome 3	A common assignment will be used in PHYS 305 which demonstrates the ability of students to use technology to solve a theoretical physics problem. Students in the PIE concentration will be expected to investigate applications or develop a marketing plan for their team's technological solution.	In PHYS 385 or ASTR 385, students in the PIE concentration will be required to give a presentation on a topic related to their concentration.

Planetary Science Concentration		
Outcome 3	The TU Core assessment instrument (pre/post exam) for ASTR 261 will be scored for students in the Planetary Science Concentration.	Students in the Planetary Science Concentration will be assessed on a data analysis assignment in ASTR 371.

G4. Program Requirements

The curricula of the concentrations within the Interdisciplinary Physics major provide students with a strong foundation in physics along with the freedom to develop an academic program across other fields of study. The IP major has a set of core physics requirements for all concentrations. Each concentration has its own set of requirements, in physics and in a wide variety of other disciplines, crafted as a coherent pathway for development of knowledge and skills sought by today's employers. The concentrations include courses that explicitly integrate physics with the other disciplines. Because the concentrations within the IP major are tailored to specific projected advanced degree and career pathways, students must choose a concentration.

All IP core courses and concentration requirements are listed in the tables below. Yellow shading indicates courses used for SLO measures described in the previous section. Descriptions of all core and concentration courses are included in Appendix A.

Table 5. Required Courses for B.S. in Interdisciplinary Physics (All Concentrations) - Required Physics Courses		
Course number	**Title**	**Credits**
PHYS 185	Introductory Seminar in Physics	1
PHYS 241 or PHYS 211*	General Physics I (Calculus or non-Calculus-based)	4
PHYS 242	General Physics II Calculus-based	4
PHYS 243	General Physics III	4
PHYS 305**	Computers in Physics	4
PHYS 311	Modern Physics I	3
PHYS 341	Intermediate Physics Laboratory I	3
PHYS 385 or ASTR 385	Physics or Astrophysics Seminar	1
PHYS 486	Physics Seminar II	1
Subtotal		**25**
- Required non-Physics Courses		
Course number	**Title**	**Credits**
MATH 273	Calculus I	4
MATH 274	Calculus II	4
Subtotal		**8**
TOTAL		**33**

**A grade of B or better in PHYS 211 is required to substitute for PHYS 241.*
***Used for SLO measure in Computational Physics and PIE Concentrations only.*

Computational Physics Concentration

The Computational Physics concentration blends physics with courses in mathematics and computer science appropriate for students interested in technical careers involving data analysis and modeling.

Table 6. Computational Physics Concentration Coursework - Required Physics Courses		
Course number	**Title**	**Credits**
PHYS 307	Introductory Mathematical Physics	3
PHYS 337	Digital Electronics	4
PHYS 460	Computational Methods in Physics	3
Subtotal		**10**
- Required non-Physics Courses*		
Course number	**Title**	**Credits**
COSC 236	Introduction to Computer Science I	4
COSC 237	Introduction to Computer Science II	4
COSC 290	Principles of Computer Organization	4
COSC 336	Data Structures and Algorithm Analysis	4
MATH 263	Discrete Mathematics	3
MATH 275	Calculus III	4
MATH 374	Differential Equations	3
Upper-level electives in PHYS, COSC or MATH		12
General Electives		6
Subtotal		**44**
TOTAL Concentration		**54**
TOTAL w/IP Core		**87**
TOTAL for B.S. Degree		**120**

Physics Innovation and Entrepreneurship
The PIE concentration combines physics with courses that build knowledge in business and soft skills in writing and communication. The coursework requirements will earn students a Minor either in Entrepreneurship or Marketing in addition to the B.S. in Interdisciplinary Physics.

Table 7. Physics Innovation and Entrepreneurship Concentration Coursework - Required Physics Courses		
Course number	**Title**	**Credits**
PHYS 312	Modern Physics II	3
PHYS 335 or PHYS 337 or PHYS 361	Choice of Basic or Digital Electronics or Optics	4
Upper-level electives in PHYS		9
Subtotal		**16**
- Required non-Physics Courses*		
Course number	**Title**	**Credits**
COMM 131*	Public Speaking	3
ECON 201*	Microeconomic Principles	3
LEGL 225*	Legal Environment of Business	3
BUSX 301 or ENGL 317*	Business Communications or Writing for Business and Industry	3
MKTG 341	Principles of Marketing	3
MKTG 451	Personal Selling	3
Electives (Minor)	From one of two groups (in orange and green)	12
*Entrepreneurship Electives***		
ENTR 110	Creativity and Idea Development	3
ENTR 215	Start-up Basics for non-Business majors	3
ENTR 355	Entrepreneurship Foundations and Pathways	3
ENTR 410	Business Plan Competition	3
*Marketing Electives****		
MKTG 350	Entrepreneurial Marketing	3
MKTG 425	Consumer Behavior Analysis	3
MKTG 445	Global Marketing	3
MKTG Elective	From among list required for Marketing Minor	3
General Electives		20
Subtotal		**50**
TOTAL Concentration		**66**
TOTAL w/IP Core		**99**
TOTAL for B.S. Degree		**120**

**COMM 131 satisfies CORE 5, ECON 201 satisfies CORE 6, ENGL 317 or BUSX 301 satisfy CORE 9, and LEGL 225 satisfies CORE 11 requirements in the TU Core Curriculum.*

***Courses shaded in orange are required for the Entrepreneurship Minor. The Entrepreneurship Minor also requires two electives, which will be physics courses from the IP Core.*

****Courses shaded in green, in addition to the required non-physics courses ECON 201, COMM 131, MKTG 341, and MKTG 451, will satisfy the requirements for the Marketing Minor.*

The total number of credits for this concentration makes it feasible for students to obtain both an Entrepreneurship Minor and a Marketing Minor.

Planetary Science Concentration

The Planetary Science concentration combines physics with astronomy and astrophysics, as well as necessary background in geology, in preparation for employment or advanced degrees in the field. Course requirements in geography build skills in analysis of mapping and remote sensing data.

Table 8: Planetary Science Concentration Coursework - Required Physics/Astrophysics Courses		
Course number	**Title**	**Credits**
ASTR 261	Introduction to Astrophysics	4
ASTR 371	Planetary Astronomy	3
Subtotal		**7**
- Required non-Physics Courses		
Course number	**Title**	**Credits**
COSC 175	General Computer Science	4
CHEM 131/131L	General Chemistry I	4
GEOL 121	Physical Geology	4
GEOL 331	Mineralogy	4
GEOL 333	Petrology of Igneous & Metamorphic Rocks	4
GEOG 221	Introduction to Geospatial Technology	3
GEOG 321	Introduction to Remote Sensing and Photogrammetry	3
Upper-level electives in ASTR, CHEM, PHYS, or GEOL		15
General Electives		6
Subtotal		**47**
TOTAL Concentration		**54**
TOTAL w/IP Core		**87**
TOTAL for B.S. Degree		**120**

G5. General Education Requirements

TU's Core Curriculum, comprising fourteen categories within four themes (43-46 credits in total), satisfies the general education requirements mandated by the State of Maryland (COMAR 13B.06.01.03) and educational effectiveness standards held by the university's accrediting body, the Middle States Commission on Higher Education. To fulfill Towson University's Core Curriculum requirements, students must complete one course from each of the following categories (1-14).

Table 9. TU Core Curriculum Requirements	
Core Category	**Credits**
Fundamentals	
(1) Towson Seminar (*Must be completed with a minimum C grade; course not required for transfer students*)	3
(2) English Composition (*Must be completed with a minimum C grade*)	3
(3) Mathematics	3-4
(4) Creativity & Creative Development[1]	3
Ways of Knowing	
(5) Arts and Humanities[1]	3
(6) Social & Behavioral Sciences	3
(7) & (8) Biological & Physical Sciences	7-8
Writing in a Chosen Field	
(9) Advanced Writing Seminar (*Must be completed with a minimum C grade*)	3-4
Perspectives	
(10) Metropolitan Perspectives	3
(11) The United States as a Nation	3
(12) Global Perspectives	3
(13) Diversity & Difference	3
(14) Ethical Issues & Perspectives	3
Total Credits	43-46

[1]Courses fulfilling the Core 4 and Core 5 requirements must be from different subjects.

The IP Core will allow students to satisfy TU's Core Curriculum requirements in Mathematics (Core 3) and Biological & Physical Sciences (Core 7 and 8), while also completing the IP major requirements. The requirements for the PIE concentration also allow students to satisfy TU Core Curriculum requirements in the Arts & Humanities (Core 5), Social & Behavioral Sciences (Core 6), Advanced Writing (Core 9), and the United States as a Nation (Core 11).

All other TU Core Curriculum requirements will be fulfilled through additional credits as described in the tables above and in Appendix B. All concentrations in the proposed major allow students to fulfil major and TU Core Curriculum requirements in 120 total credits.

G6. Specialized Accreditation and Certification
Not applicable.

G7. Outside Contracts
Not applicable.

G8. Program Information Assurances
All TU undergraduate students are required to meet with an academic advisor each semester. In the first meeting with an advisee, the academic advisor develops a Four-Year Degree Completion Plan for the student, according to the academic requirements for the major and the schedule of course offerings. During subsequent advising meetings, the advisor reviews the student's progress towards their degree and helps the student plan courses for the next semester. The advisor may help the student modify the degree completion plan, if necessary. Advisors and students will also discuss the student's plans for employment or postgraduate education. Academic advisors often provide information about internships and other opportunities to help students achieve those goals.

Academic advising for students in the IP program will be particularly important for helping students choose a set of elective courses within their concentration that forms a coherent curriculum aligned with the student's interests. Faculty advisors will be assigned so that they are knowledgeable about their advisee's subfield within the IP program.

Students in the IP program will be expected to develop technical competencies throughout the duration of the program, but there are no specific requirements to enter the program other than admission to TU. IP students will have access to the same academic support that all TU students have, such as tutoring, coaching, and workshops available through the TU Tutoring and Learning Center.

IP students will pay regular TU undergraduate tuition and fees and will have the same opportunities for scholarships and research experiences as students in the existing physics program, including the Fisher Scholarship, the Maryland Space Grant Scholarship, and the Eddie L. Loh Scholarship.

Information that will help students be successful in the program, such as the IP's curriculum and degree requirements, learning management system support, financial aid, student support services, etc., will be posted on TU's website and in the undergraduate catalog published annually.

G9. Advertising, Recruiting, and Admissions Materials Assurances
TU regularly reviews its advertising, recruiting, and admissions materials to ensure that they clearly and accurately represent programs and services available, and that there is consistency across different modes of communication such as the TU website, the academic catalog, and other print and online promotional materials.

H. Adequacy of Articulation
TU has signed articulation agreements with Cecil College for each of the three concentrations offered within the IP degree (which are attached separately in the individual concentration proposals) and will pursue articulation agreements with other community colleges once the program is approved. Since students will not be able earn the B.S. in Interdisciplinary Physics without enrolling in a concentration, TU has not signed a separate articulation agreement specifically for the overarching bachelor's degree.

I. Adequacy of Faculty Resources
I1. Quality of Program Faculty
All the concentrations in the IP degree are built entirely from existing courses and will require few significant new outlays of resources to launch in the short term. Appendix C lists the faculty who could contribute to the successful execution of this new major. All tenure and tenure track faculty have terminal degrees in their disciplinary fields and bring expertise to the courses they teach and the research they conduct.

The PAGS department has recently hired a new faculty member with expertise in planetary science and in the next two years the PAGS department anticipates hiring a faculty member in biophysics. These new faculty members will allow TU to expand the current course offerings with which we propose to launch the IP program and strengthen it going forward.

Because all the concentrations in this new major are truly interdisciplinary in nature, the proposed IP program will build ties between faculty within the multidisciplinary PAGS department, as well as strengthening relationships with FCSM's Departments of Computer & Information Sciences and Mathematics, with the Departments of Economics and Marketing within the College of Business and Economics, and with the Department of Geography & Environmental Planning within the College of Liberal Arts, among others.

I2. Ongoing Faculty Training

The Faculty Academic Center of Excellence at Towson (FACET) is the faculty development center for Towson University. FACET's mission is to support an inclusive and collaborative faculty community and foster a culture of excellence in scholarship and teaching. FACET supports all campus faculty in their scholarship and teaching through a combination of programs, workshops, resources, funding, and communities of practice such as: Student Engagement, Emerging Technologies, Open Educational Resources, and High Impact Educational Practices. In collaboration with the TU Office of Technology Services, FACET also recommends, reviews, and provides programs to support advancement of faculty skills with Blackboard, TU's learning management system. FACET provides one-on-one or small group, virtual or face-to-face meetings with an instructional design team, who also perform course reviews. Faculty may attend open meetings as well as request consultation from FACET staff.

J. Adequacy of Library Resources

Resources available through TU's Cook Library (https://libraries.towson.edu) are sufficient to meet the needs of students and faculty in the proposed program. The library houses an extensive collection of materials, including more than 500,000 print and electronic volumes. In addition to a dedicated subject librarian, team of research librarians, and subject-specific research guides, the library provides access to 19 physics and astronomy subject-specific databases, such as Nature Portfolio, Scopus, ScienceDirect, JoVE Science Education Unlimited, JSTOR, and SpringerLink. Cook Library also houses computer workstations with specialty software for data analysis, data visualization and mapping.

In addition to Cook Library, faculty and students have access to materials through reciprocal agreements at nearby Baltimore institutions and across USM-affiliated institutions. Materials from other libraries across the country can be requested for loan through standard interlibrary loan (ILL) services. As part of this service, faculty and students have access to RAPID ILL, a service customary at high research activity institutions. The current turnaround time for article requests is typically less than 48 hours.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Equipment

K1. Assurance of Physical Facilities, Infrastructure and Equipment

TU's existing physical facilities, infrastructure and instructional equipment are sufficient to support the needs of the proposed program. The IP program will be administratively housed in the Department of Physics, Astronomy, and Geosciences in the Fisher College of Science and Mathematics. TU opened the 320,000 square foot Science Complex building in 2021. The Science Complex includes 50 new teaching laboratories and 30 research laboratory facilities with state-of-the-art instrumentation.

Faculty in other colleges associated with the program are also housed in facilities that are well suited for supporting its students. The College of Liberal Arts building was completed in 2012 and Stephens Hall, which houses the College of Business and Economics, includes special student labs for behavioral and business data analysis. Additionally, students in the PIE concentration will have access to TU's StarTUp at the Armory, a 26,000 square foot space for start-ups and collaborations with small businesses and the region's largest corporations. The Armory includes 6,000 square feet of free co-working space and meeting rooms where entrepreneurs and executives can connect.

K2. Assurance of Distance Learning Resources

The proposed program is designed to be delivered in-person via traditional modes of face-to-face instruction. If distance learning resources are required, whether in an individual course or at a broader scale, TU is well positioned to provide adequate support. The Faculty Academic Center of Excellence at Towson (FACET) offers training and certification programs for online and hybrid/blended instruction, Universal Design for Learning (UDL), and effective pedagogical approaches for enriching distance learning, including the Quality Matters Rubric. Students and faculty can enroll in training modules that provide instruction in university-sponsored distance learning technologies, including Blackboard, WebEx, Zoom, and Panopto. Technology support is available online, as well as via email, text, phone and on a walk-in basis at Student Computing Services and the Office of Technology Services.

L. Adequacy of Financial Resources with Documentation

The proposed IP program will be funded through existing resources from FCSM, the College of Business and Economics, and the College of Liberal Arts. Students in each concentration of the IP program will be taking courses already offered for physics majors within PAGS and in other TU undergraduate majors outside PAGS; therefore, no expenditures are necessary to develop the program curriculum.

A new faculty hire in astronomy, who began their appointment in fall 2023, will support the Planetary Science concentration at about 30 percent effort. This is included in the program resources listed in **Table 10**. A biophysicist hire, anticipated to begin in fall 2025, will also be available to teach lower-level physics courses that will support the new IP program and TU's other existing physics majors. This new faculty line (budgeted at a 0.4 FTE rate) is included in the expenditures listed in **Table 11**. Other than these two faculty positions, the proposed IP program will be supported through existing faculty and staff budget lines, and therefore no additional funding is required.

TU's new IP program will require some modest marketing resources to attract prospective, new, and transfer students, as well as to advertise the new opportunity to current TU students who may be interested in changing their major to Interdisciplinary Physics. The types of marketing activities PAGS anticipates undertaking include website development, email and social media marketing, flyers, giveaway items for TU Open House/TU4U events, and a small travel budget for student club outreach to area high schools. TU has budgeted approximately $1,000 per year for these efforts.

Table 10. Programmatic Resources					
Resource Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Reallocated Funds	$32,994	$33,984	$35,004	$36,054	$37,136
a. Reallocated Funds- Faculty FTE[1]	$32,994	$33,984	$35,004	$36,054	$37,136
2. Tuition/Fee Revenue (c + g below)	$90,448	$197,968	$287,869	$420,049	$509,000
a. Number of F/T Students	8	17	25	34	40
b. Annual Tuition/Fee Rate (In State)[2,3]	$11,306	$11,645	$11,994	$12,354	$12,725
c. Total F/T Revenue (a x b)	$90,448	$197,965	$299,850	$420,036	$509,000
d. Number of P/T Students	0	0	0	0	0
e. Credit Hour Rate	$0	$0	$0	$0	$0
f. Annual Credit Hour Rate	$0	$0	$0	$0	$0
g. Total P/T Revenue (d x e x f)	$0	$0	$0	$0	$0
3. Grants, Contracts & Other External Sources	$0	$0	$0	$0	$0
4. Other Sources	$0	$0	$0	$0	$0
TOTAL (Add 1-4)	$123,442	$231,949	$334,854	$456,090	$546,136

[1] Re-allocated funds are based on the incumbent astronomy faculty member at 30% FTE dedicated to the proposed program with salary and fringe rates. Salary and fringe rates increase by three percent annually.
[2] Student enrollments are calculated at 100 percent in-state. It is anticipated that all students will enroll on a full-time basis.
[3] Tuition and fees increase by three percent annually.

Table 11. Programmatic Expenditures					
Expenditure Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Faculty (b + c below)	$0	$45,267	$46,623	$48,024	$49,467
a. Number of FTE	0	0.4	0.4	0.4	0.4
b. Total Salary[1]	$0	$32,103	$33,066	$34,059	$35,082
c. Total Benefits[1]	$0	$13,164	$13,557	$13,965	$14,385
2. Admin. Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
3. Support Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
4. Technical Support & Equipment	$0	$0	$0	$0	$0
5. Library	$0	$0	$0	$0	$0
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses	$1,000	$1,000	$1,000	$1,000	$1,000
TOTAL (Add 1-7)	$1,000	$46,267	$47,623	$49,024	$50,467

[1] Salary and fringe benefit rates increase by three percent annually.

M. Adequacy of Provisions for Evaluation of Program

M1. Procedures for Evaluating Courses, Faculty and Student Learning Outcomes

The proposed program will be built from existing courses. Nevertheless, future course development will follow the regular Towson University procedures for approval, first at the program and PAGS department level, through the FCSM Curriculum Committee, and finally the University Curriculum Committee.

The course approval process evaluates new courses for appropriate rigor, effective assessment and grading, and adherence of the course syllabus to best practices. Evaluation at the program level ensures course content accuracy and program alignment, while the college and university level reviews facilitate the production of quality course proposals.

Existing courses are evaluated through regular review by program faculty and by student evaluations. Faculty regularly review courses to determine if the course meets overall program objectives. Additionally, instructors are observed by peers on a routine basis, with more frequent observations if faculty are new to a course or the university. If a course review indicates concerns or problems with a course, faculty develop strategies for addressing problems. Student course evaluation takes place at the end of every semester. Using a tool developed by TU faculty that allows for quantitative and qualitative feedback, students give feedback on instructors (e.g., ability to communicate clearly; quality of student-instructor interaction; preparedness) and suggest improvements for a course.

Evaluation of faculty follows policies and procedures established by TU's policies for faculty annual merit review and for faculty reappointment, tenure, and promotion. These evaluations occur at the department, college, and university level. The main areas of evaluation include teaching, scholarship, and service. Tools used as part of the annual evaluation process include review of the individual's portfolio that includes, but is not limited to, the following:

- Evidence of scholarship (e.g., articles in scholarly journals; presentations at scholarly meetings).
- Service work.
- A synopsis of teaching related activities (e.g., courses taught; new instructional procedures; interdisciplinary, diversity, international, and technology-related projects).
- Review of course syllabi.
- Peer teaching observation reports.
- Quantitative and qualitative student evaluation of instruction.

Section G.3 outlines the program assessment measures and shows their alignment with specific student learning outcomes. On an annual basis, specific learning outcomes are identified for assessment purposes. The program director, with the support of TU's Office of Assessment, will oversee the processes involved in the assessment of student learning outcomes, including collection and analysis of data, and creation of action plans, as necessary.

M2. Evaluation of Program Educational Effectiveness

The assessment of this program will be guided by TU's Office of Assessment, following established TU policies and procedures, including review of the program's assessment plan to ensure that learning outcomes remain appropriate, and that students are meeting expectations.

The program will work with TU entities such as the Office of the Provost, Enrollment Services and Student Services to review data on a regular basis and improve the program when needed.

Effectiveness will be assessed by student retention, progress toward degree completion, career outcomes for graduates, student and faculty satisfaction, cost-effectiveness, and other key performance indicators.

Additionally, TU will conduct a comprehensive evaluation of the program every seven years as part of the USM-mandated Periodic Review of Academic Programs process. The purpose of the review is to promote continuous program improvement and ensure that the needs of students are being met. Each program will prepare a self-study, engage an external reviewer to evaluate the program and identify strengths and areas for improvement, and submit a final report to the USM Board of Regents for review and approval.

N. Consistency with the State's Minority Student Achievement Goals

TU has a strong commitment to diversity, equity, and inclusion. With over 56 percent of the students identifying as a racial or ethnic minority[8], TU is nearly as diverse as the state of Maryland. It is only one of a few universities in the country to have no achievement gap, meaning that underrepresented student groups achieve the same or better academic success as the entire student population. In 2020, the university introduced its inaugural Diversity Strategic Plan. The plan, "*A More Inclusive TU: Advancing Equity and Diversity (2020–25)*," is firmly grounded in the premise that TU's ongoing success is dependent on the university's capacity to shift perspectives and approaches and strategically place diversity, equity, and inclusion at the core of its mission.

Diverse faculty recruitment is a TU institutional goal and faculty recruitment at the University is designed to reach and attract a diverse pool of candidates. Through diverse faculty recruitment, TU strives to foster a learning community that reflects the population of our campus, region, and state, and supports recruitment and retention of a diverse student population along with academic achievement of students from minority and underrepresented backgrounds.

In physics at TU, as with physics programs elsewhere in the U.S., racial minority groups are underrepresented. In 2019-2020, African Americans comprised 13.6 percent of the U.S. population but earned only three percent of the physics bachelor's degrees. Similarly, Hispanic/Latinx people comprised 19 percent of the U.S. population, but earned 11 percent of physics bachelor's degrees.[9,10] The 2020 report of the American Institute of Physics National Task Force to Elevate African American Representation in Undergraduate Physics and Astronomy advocates the use of multiple curricular options to retain African American physics majors.[11] Since TU's proposed IP degree will provide additional pathways to a physics degree, we anticipate that this program will enhance the overall racial diversity of PAGS students.

O. Relationship to Low Productivity Programs Identified by the Commission

Not applicable.

P. Adequacy of Distance Education Programs

Not applicable. The majority of courses in the program will be delivered on the main TU campus via face- to-face instruction.

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[8] Fall 2023 numbers according to TU Office of Institutional Research: https://www.towson.edu/ir/documents/f_hdct_car_coll_eth.pdf

[9] U. S. Census Bureau, 2020: https://www.census.gov/quickfacts/fact/table/US/POP010220#POP010220.

[10] American Institute of Physics Statistical Research Center, Engineering and Physical Science Degrees Earned by Members of Underrepresented Groups: https://www.aip.org/statistics/stats-degrees.

[11] American Institute of Physics National Task Force to Elevate African American Representation in Undergraduate Physics and Astronomy, 2020. The Time is Now: Systemic Changes to Increase African Americans with Bachelors Degrees in Physics and Astronomy: https://www.aip.org/sites/default/files/aipcorp/files/teamup-full-report.pdf.

Appendix A. Descriptions of Course Options in Program Outline

INTERDISCIPLINARY PHYSICS CORE COURSE DESCRIPTIONS

PHYS 185 INTRODUCTORY SEMINAR IN PHYSICS (1)
This seminar is intended for freshmen and sophomores who have demonstrated exceptional ability in the sciences and will involve them directly with current ideas and research in physics. Classical physics, quantum physics, relativity, and the new astronomy will be covered.

PHYS 211 GENERAL PHYSICS I NON-CALCULUS-BASED (4)[12]
For Arts and Sciences, Biology and Geosciences majors: mechanics, heat, light, electricity, magnetism, and a brief introduction to modern physics. Three lecture units and one three-unit laboratory period. Prerequisite: MATH 115 or good standing in high school algebra and trigonometry. Core: Biological & Physical Sciences. Lab/Class fee will be assessed.

PHYS 241 GENERAL PHYSICS I CALCULUS-BASED (4)[12]
Calculus-based physics for science and engineering majors. Mechanics and the conservation laws, gravitation, simple harmonic motion. Prerequisite: MATH 273 (may be taken concurrently). Core: Biological & Physical Sciences. Lab/Class fee will be assessed.

PHYS 242 GENERAL PHYSICS II CALCULUS-BASED (4)
Continuation of PHYS 241. Electricity, magnetism, DC and AC currents, geometric optics. Prerequisites: PHYS 241, MATH 274 (may be taken concurrently). Core: Biological & Physical Sciences. Lab/Class fee will be assessed.

PHYS 243 GENERAL PHYSICS III (4)
Special relativity, fluid kinematics and dynamics, waves, thermodynamics. Prerequisite: PHYS 242.

PHYS 305 COMPUTERS IN PHYSICS (4)
Introduction to hardware and software applications of computers in physics, including computer interfacing to experiments, computer aided design, LabView programming, data analysis, simulation, and modeling techniques. Prerequisite: PHYS 241. Lab/Class fee will be assessed.

PHYS 311 MODERN PHYSICS I (3)
A description of special relativity, quantum theory, atomic structure, and spectra. Three lecture hours. Prerequisites: MATH 274, PHYS 242 or PHYS 252; or PHYS 212 with consent of instructor).

PHYS 341 INTERMEDIATE PHYSICS LABORATORY I (3)
Experiments which defined modern physics. Exploration of classical and modern research methods: data acquisition and analysis, optical and nuclear spectroscopy. Six laboratory hours. Prerequisites: PHYS 305; PHYS 311 (may be taken concurrently). Lab/Class fee will be assessed.

PHYS 385 PHYSICS SEMINAR (1)[13]
Students participate in colloquia on topics of current interest in physics research under guidance of instructor. One lecture hour. Prerequisite: at least junior standing.

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[12] Students may take either PHYS 211 or PHYS 241.
[13] Students may take either PHYS 385 or ASTR 385.

ASTR 385 ASTROPHYSICS SEMINAR (1)[13]
Students learn to present technical material orally by attending and discussing presentations given by others and by giving presentations themselves on topics of current interest in astrophysics. Prerequisite: junior/senior standing as a Physics Major or Astronomy Minor.

PHYS 486 PHYSICS SEMINAR II (1)
Students participate in colloquia on topics of current interests in physics research under guidance of instructor. One lecture hour. Prerequisite: senior standing or consent of instructor.

MATH 273 CALCULUS I (4)
Functions, limits, and continuity; differentiation of algebraic and trigonometric functions; mean value theorem; differentials; introduction to integration; applications. Four lecture hours and one laboratory hour per week. Prerequisite: qualifying score on Math Placement exam or MATH 117 or MATH 119. Core: Mathematics.

MATH 274 CALCULUS II (4)
Differentiation and integration of exponential, logarithmic, and inverse trigonometric functions; techniques of integration and applications; indeterminate forms; improper integrals; sequences and series of numbers; power series. Prerequisite: MATH 273. Core: Mathematics.

COMPUTATIONAL PHYSICS CONCENTRATION COURSE DESCRIPTIONS

PHYS 307 INTRODUCTORY MATHEMATICAL PHYSICS (3)
Mathematical expressions for selected topics, such as forces and potentials, vector analysis, applications of Fourier series and complex variables, and solutions of the harmonic oscillator and wave equations. Prerequisites: PHYS 212 or PHYS 242; MATH 274; and consent of department.

PHYS 337 DIGITAL ELECTRONICS (4)
Subjects covered will be basic concepts of digital electronics such as gates, logic modules, truth tables, digital codes, sequential systems, semi-conductor memories, decade counters, etc. The laboratory program is designed to give students first-hand experience on the material covered in lecture using integrated circuits and LED display systems. Two hours lecture, three hours laboratory. Lab/Class fee will be assessed. Prerequisite: PHYS 242.

PHYS 460 COMPUTATIONAL METHODS IN PHYSICS (3)
Introduction to the basic concepts and programming skills of computational physics. Students will develop their own computer programs to solve problems in mechanics, electromagnetism, quantum mechanics, chaos, nonlinear dynamics, and other areas. No previous computer programming experience is required. Prerequisites: MATH 374 and PHYS 307 or consent of the instructor.

COSC 236 INTRODUCTION TO COMPUTER SCIENCE I (4)
Introduction to structured problem-solving, algorithm development and computer programming. Three lecture hours and two laboratory hours. Prerequisites: COSC 175 and at least one of [MATH 117, MATH 119, MATH 211, (MATH 231 or ECON 205), MATH 273, MATH 274, MATH 275, or a qualifying score on the Math Placement Exam].

COSC 237 INTRODUCTION TO COMPUTER SCIENCE II (4)
Development of programming and problem-solving skills, with a focus on object-oriented programming and design. Students will design and develop programs using encapsulation and information hiding, inheritance, polymorphism, and generics. Introduction to data structures and their implementations (lists, stacks, queues, and trees), recursion, and searching and sorting

algorithms. Includes two laboratory hours per week. Prerequisites: COSC 236; MATH 211 or MATH 273.

COSC 290 PRINCIPLES OF COMPUTER ORGANIZATION (4)
Computer organization and architecture including computer arithmetic, digital logic, principles of assembly language, memory system organization, computer interfacing, CISC and RISC architecture. Three hours per week of laboratory work required. Prerequisites: COSC 236 and (MATH 263 or MATH 267).

COSC 336 DATA STRUCTURES AND ALGORITHM ANALYSIS (4)
Fundamental data structures used in programming and the basic techniques used to design and analyze algorithms. Topics include: complexity analysis of elementary algorithms, linear data structures, trees, heaps, graphs, search algorithms (balanced binary trees, B-trees, hashing), sorting algorithms, basic graph algorithms (graph traversal, topological sorting, shortest path, minimum spanning trees), and paradigms in the design of algorithms (divide and conquer, dynamic programming, greedy). Prerequisites: COSC 237 and MATH 274.

MATH 263 DISCRETE MATHEMATICS (3)
Sets, logic, induction, functions, relations, sequences, recursion, combinatorics, graphs and trees, matrices with an emphasis on applications in computer science. Prerequisite: COSC 236.

MATH 275 CALCULUS III (4)
Vectors in two and three dimensions, differential and integral calculus of functions of several variables. Four lecture hours and one laboratory hours per week. Prerequisite: MATH 274.

MATH 374 DIFFERENTIAL EQUATIONS (3)
Theory and application of linear ordinary differential equations: homogeneous and nonhomogeneous linear equations, initial and boundary value problems, exact equations, variation of parameters, Euler equations; solutions of non-linear ordinary differential equations of the first order and second order; power series solutions; system of linear equations. Prerequisite: MATH 274.

PHYSICS INNOVATION AND ENTREPRENEURSHIP CONCENTRATION COURSE DESCRIPTIONS

PHYS 312 MODERN PHYSICS II (3)
Required course for the Applied and General tracks of the Physics major. Applications of special relativity and quantum theory to the various disciplines in physics, including solid state, nuclear, elementary particles, and cosmology. Prerequisite: PHYS 311.

PHYS 335 BASIC ELECTRONICS (4)[14]
Circuit components, characteristics of semi-conductors, electrical measurements, method of circuit analysis, electronic devices. Three lecture hours and one three-hour laboratory period. Prerequisites: PHYS 212 or PHYS 242 or consent of the instructor. Lab/Class fee will be assessed.

PHYS 337 DIGITAL ELECTRONICS (4)[14]
See COMPUTATIONAL PHYSICS CONCENTRATION COURSE DESCRIPTIONS above.

[14] Students may take either PHYS 335, PHYS 337, or PHYS 361.

PHYS 361 OPTICS FUNDAMENTALS (4)[14]
Geometric, wave and quantum optics; lenses and mirrors, lens aberrations and design, optical instruments, interference diffraction, polarization, absorption and scattering, lasers, holography, and the dual nature of light. Three lecture hours and one three-hour laboratory each week. Prerequisites: PHYS 243 and PHYS 341 (may be taken concurrently) or consent of the instructor. Lab/Class fee will be assessed.

COMM 131 PUBLIC SPEAKING (3)
Perspectives of rhetoric and public speaking, investigating contemporary American experiences, delivering, and critiquing speeches. Core: Arts & Humanities.

ECON 201 MICROECONOMIC PRINCIPLES (3)
Economic reasoning of individual choice in household and market decisions. Behavior of firms in competitive and noncompetitive markets, functioning of labor and capital markets, role of the entrepreneur and effects of government policies. Core: Social & Behavioral Sciences.

LEGL 225 LEGAL ENVIRONMENT OF BUSINESS (3)
Examines the nature and sources of law, the U.S. legal system with emphasis on court jurisdiction, procedure, constitutional law, torts, criminal law, and contracts in general and as they relate to business. Core: The United States as a Nation.

BUSX 301 BUSINESS COMMUNICATIONS (4)[15]
Seminar designed to enable students to gain the written and oral communication skills needed in professional business situations and to develop and practice important skills for workplace success. Requires grade of C or better to fulfill Core requirement. Prerequisites: a grade of C (2.0) or higher in ENGL 102 or ENGL 190, or equivalent; ECON 202; junior/senior status. Core: Advanced Writing Seminar.

ENGL 317 WRITING FOR BUSINESS AND INDUSTRY (3)[15]
Standard written formats used in business and industry, including correspondence, memoranda, and reports. Projects individualized to meet student needs and career interests. Requires grade of C or better to fulfill Core requirement. Prerequisite: ENGL 102 or ENGL 190 or equivalent. Core: Advanced Writing Seminar.

MKTG 341 PRINCIPLES OF MARKETING (3)
Design, distribution, pricing and promotion of goods, services, places, people and causes of both national and international markets. Included is an introduction to strategic and tactical applications of marketing. Not open to students who have completed MKTG T41. Prerequisites: ECON 201; sophomore standing (subject to availability); majors and eligible pre-major, BUAD, MKTG or MUID minor.

MKTG 451 PERSONAL SELLING (3)
The role and principles of personal selling as it relates to an organization's marketing strategy, specific techniques for uncovering customer needs and delivering effective sales presentations, and the critical nature of building interpersonal relationships throughout a sales cycle. Prerequisites: MKTG 341; major in BUAD or minor in MKTG; junior/senior standing.

[15] Students may take either BUSX 301 or ENGL 317.

ENTREPRENEURSHIP MINOR ELECTIVES

ENTR 110 CREATIVITY AND IDEA DEVELOPMENT (3)

Focuses on creativity and thinking creatively. Topics include developing creative abilities, opportunity recognition, creating a new product/service, and pitches for the new product/service. Prerequisites: BUAD major or ENTR minor.

ENTR 215 START-UP BASICS FOR NON-BUSINESS MAJORS (3)

Introduces students to important business concepts that will help them to run a business. Helps to prepare non-business major students with knowledge and skills needed for upper-level courses in entrepreneurship. Topics covered include economics, understanding business financial measures, types of financing available to entrepreneurs and data analyses. Prerequisite: ENTR Minor.

ENTR 355 ENTREPRENEURSHIP FOUNDATIONS AND PATHWAYS (3)

Introduces the entrepreneurial process including a focus on the identification and evaluation of opportunities. Discusses the importance of innovation, creating a business concept and business models. Develop business ideas and evaluate them for potential formation of a new venture.

ENTR 410 BUSINESS PLAN COMPETITION (3)

Focuses on developing a business plan for a successful new venture. Topics include opportunity evaluation, feasibility analysis, creating persuasive pitches for the business idea, competitive analysis, profiling the target market, developing financial forecasts and presentation of a business plan in a competitive style format. Prerequisites: ENTR 355; and BUAD major, ENTR minor or Certificate in Entrepreneurship.

MARKETING MINOR ELECTIVES

MKTG 350 ENTREPRENEURIAL MARKETING (3)

Examines how start-up and small/medium-sized companies identify and critically evaluate opportunities that exist within new and established market niches and develop marketing plans to take advantage of those opportunities based on the creative use of scarce resources. Prerequisites: MKTG 341, junior / senior and major standing.

MKTG 425 CONSUMER BEHAVIOR ANALYSIS (3)

An examination of the buying behavior of individual and organizational buyers with regards to the decision process utilized when purchasing goods and services and the resulting consequences in the development of marketing strategies by business firms, and other organizations. Prerequisites: MKTG 341; major in BUAD or minor in MKTG; junior/senior standing.

MKTG 445 GLOBAL MARKETING (3)

Impact of globalization, inter-country trade agreements, and national culture on country marketing environments and their influence on strategic marketing decisions related to pricing, product, channels of distribution, and marketing communications. Problems and obstacles related to acquiring information to guide market entry decisions and development of country marketing plans and policies. Prerequisites: MKTG 425; major in ACCT, BUAD, INST-BA or minor in MKTG; junior/senior standing.

PLANETARY SCIENCE CONCENTRATION COURSE DESCRIPTIONS

ASTR 261 INTRODUCTION TO ASTROPHYSICS (4)

Students will develop an understanding of the physical processes governing motions of celestial objects; the electromagnetic spectrum and the interaction of light and matter; star and planet formation and evolution; the extragalactic distance scale; and the early universe. Prerequisites:

PHYS 211 or PHYS 241; not open to students who have successfully completed ASTR 161 and ASTR 181.

ASTR 371 PLANETARY ASTRONOMY (3)
Planetary formation both around our Sun and around other stars, planetary interiors and surface processes, and atmospheres. Primitive surfaces, cratering, volcanism, tectonism, origin and evolution of planetary atmospheres. The course may include an observational segment (e.g., sketching the planets through a telescope) and field trips to local sites of geological interest. Prerequisites: ASTR 161 or ASTR 261 or GEOL 121 and PHYS 211 or PHYS 241.

COSC 175 GENERAL COMPUTER SCIENCE (4)
Computer systems overview, algorithm development, data representation, software design and testing methodologies, and brief overview of advanced topics.

CHEM 131 GENERAL CHEMISTRY I (3)
Atomic and molecular structure; theories of bonding, stoichiometry; chemical reactions; gases; solutions. Open to science/math majors/minors only. Not open to those who successfully completed CHEM 110. CHEM 131 is a quantitative course and students are expected to be proficient in algebraic manipulations and graphical interpretation. Corequisite: CHEM 131L. Core: Biological & Physical Sciences. Lab/Class fee will be assessed.

CHEM 131L GENERAL CHEMISTRY I LABORATORY (3)
Laboratory experiments to support concepts of General Chemistry I Lecture. Not open to those who successfully completed CHEM 110. Corequisite: CHEM 131. Core: Biological & Physical Sciences. Lab/class fee will be assessed.

GEOL 121 PHYSICAL GEOLOGY (4)
Composition and structure of the earth, the internal and external forces acting upon it, and the surface features resulting. Laboratory studies of common rocks and minerals, geologic and topographic maps, and aerial photographs. Field trips required. Three lecture hours and three laboratory hours per week. Core: Biological & Physical Sciences. Lab/Class fee will be assessed.

GEOL 331 MINERALOGY (4)
The study of minerals with emphasis on crystallography, crystal chemistry, and chemical-structural classification. Laboratory identification of minerals in hand specimen, in thin section by application of principles of optical mineralogy, by chemical analysis, and by X-ray diffraction analysis. Three lecture hours and three laboratory hours. Prerequisites: GEOL 121 and CHEM 131/ CHEM 131L. Lab/Class fee will be assessed.

GEOL 333 PETROLOGY OF IGNEOUS AND METAMORPHIC ROCKS (4)
Study of the properties and genesis of two major rock groups. Megascopic and microscopic techniques in rock classification. Environments of formation. Case studies from the Maryland Piedmont. Field trips required. Three lecture hours and three laboratory hours. Prerequisite: GEOL 331. Lab/Class fee will be assessed.

GEOG 221 INTRODUCTION TO GEOSPATIAL TECHNOLOGY (3)
Introduction to most effective ways to record and communicate spatial information. Emphasizes geotechniques including digital cartography, remote sensing, GIS, and GPS. Includes georeference systems, cartographic representation, and basic skills needed to use and understand geospatial data.

GEOG 321 INTRODUCTION TO REMOTE SENSING AND PHOTOGRAMMETRY (3)
Fundamentals and the development of remote sensing, the nature of the electromagnetic radiation and its interaction with the atmosphere and surface objects, photographic systems, aerial photography, and photogrammetry basics. Prerequisites: GEOG 101 and GEOG 221.

Appendix B. Example Programs of Study
Courses used for measures of Student Learning Outcomes are shaded in yellow.

Computational Physics Concentration: Four-Year Plan				
Year 1				
Fall			*Spring*	
PHYS 185	1		PHYS 241 (=CORE 7)	4
MATH 273 (=CORE 3)	4		COSC 237	4
COSC 236	4		CORE 4	3
CORE 1	3		CORE 5	3
CORE 2	3			
Total	15		Total	14
Year 2				
Fall			*Spring*	
PHYS 242 (=CORE 8)	4		PHYS 243	4
PHYS 305	4		MATH 275	4
MATH 263	3		MATH 374	3
MATH 274	4		CORE 6	3
Total	15		Total	14
Year 3				
Fall			*Spring*	
PHYS 311	3		PHYS 307	3
PHYS 341	3		PHYS 385	1
COSC 290	4		COSC 336	4
ELECTIVE	3		ELECTIVE	3
CORE 9	3		CORE 10	3
			CORE 11	3
Total	16		Total	17
Year 4				
Fall			*Spring*	
PHYS 337	4		ELECTIVE	3
PHYS 460	3		ELECTIVE	3
PHYS 486	1		ELECTIVE	3
ELECTIVE	3		CORE 13	3
CORE 12	3		CORE 14	3
Total	14		Total	15
Credit Grand Total	**120**			

Physics Innovation and Entrepreneurship Concentration with Entrepreneurship Minor: Four-Year Plan				
Year 1				
Fall			*Spring*	
PHYS 185	1		MATH 273 (=CORE 3)	4
CORE 1	3		PHYS 211 (=CORE 7)	4
CORE 2	3		CORE 10	3
ELECTIVE	3		ELECTIVE	4
ELECTIVE	4			
Total	14		Total	15
Year 2				
Fall			*Spring*	
CORE 4	3		PHYS 242 (=CORE 8)	4
MATH 274	4		ENTR 215	3
ENTR 110	3		ECON 201 (=CORE 6)	3
COMM 131 (=CORE 5)	3		MKTG 341	3
ELECTIVE	3		ELECTIVE	3
Total	16		Total	16
Year 3				
Fall			*Spring*	
PHYS xxx	3		PHYS 243	4
PHYS 305	4		PHYS 385	1
MKTG 451	3		LEGL 225 (=CORE 11)	3
BUSX 301 or ENGL 317 (=CORE 9)	3		ENTR 355	3
			ELECTIVE	3
Total	13		Total	14
Year 4				
Fall			*Spring*	
PHYS 311	3		ENTR 410	3
PHYS 341	3		CORE 14	3
PHYS 486	1		PHYS xxx	3
PHYS xxx	3		PHYS 312	3
CORE 12	3		PHYS 335/337/361	4
CORE 13	3			
Total	16		Total	16
Credit Grand Total	**120**			

Physics Innovation and Entrepreneurship Concentration with Marketing Minor: Four-Year Plan				
Year 1				
Fall			*Spring*	
PHYS 185	1		MATH 273 (=CORE 3)	4
CORE 1	3		PHYS 211 (=CORE 7)	4
CORE 2	3		CORE 10	3
ELECTIVE	3		ELECTIVE	4
ELECTIVE	4			
Total	14		Total	15
Year 2				
Fall			*Spring*	
CORE 4	3		PHYS 242 (=CORE 8)	4
MATH 274	4		MKTG 425	3
MKTG 350	3		ECON 201 (=CORE 6)	3
COMM 131 (=CORE 5)	3		MKTG 341	3
ELECTIVE	3		ELECTIVE	3
Total	16		Total	16
Year 3				
Fall			*Spring*	
PHYS xxx	3		PHYS 243	4
PHYS 305	4		PHYS 385	1
MKTG 451	3		LEGL 225 (=CORE 11)	3
BUSX 301 or ENGL 317 (=CORE 9)	3		MKTG 445	3
			ELECTIVE	3
Total	13		Total	14
Year 4				
Fall			*Spring*	
PHYS 311	3		MKTG xxx	3
PHYS 341	3		CORE 14	3
PHYS 486	1		PHYS xxx	3
PHYS xxx	3		PHYS 312	3
CORE 12	3		PHYS 335/337/361	4
CORE 13	3			
Total	16		Total	16
Credit Grand Total	**120**			

Planetary Science Concentration: Four-Year Plan				
Year 1				
Fall			*Spring*	
PHYS 185	1		GEOL 121	4
CHEM 131/131L	4		MATH 273 (=CORE 3)	4
CORE 1	3		CORE 4	3
CORE 2	3		ELECTIVE	3
ELECTIVE	3			
Total	14		Total	14
Year 2				
Fall			*Spring*	
PHYS 241 (=CORE 7)	4		PHYS 242 (=CORE 8)	4
MATH 274	4		GEOG 221	3
COSC 175	4		ELECTIVE	3
GEOL 331	4		CORE 5	3
			CORE 6	3
Total	16		Total	16
Year 3				
Fall			*Spring*	
ASTR 261	4		ASTR 385	1
PHYS 305	4		PHYS 243	4
ELECTIVE	3		GEOG 321	3
CORE 9	3		CORE 10	3
			CORE 11	3
Total	14		Total	14
Year 4				
Fall			*Spring*	
ASTR 371	3		GEOL 333	4
PHYS 311	3		CORE 13	3
PHYS 341	3		CORE 14	3
PHYS 486	1		ELECTIVE	3
ELECTIVE	3		ELECTIVE	3
CORE 12	3			
Total	16		Total	16
Credit Grand Total	**120**			

Appendix C: Faculty Supporting the Interdisciplinary Physics Major

Full-Time PAGS Program Faculty			
Name	**Terminal Degree**	**Field**	**Academic Title**
Bedard, Antoine	Ph.D.	Electrical Engineering	Lecturer
Casey, Michelle	Ph.D.	Geosciences	Associate Professor
Ghavamian, Parviz	Ph.D.	Astrophysics	Professor
Guice, George	Ph.D.	Geosciences	Visiting Assistant Professor
Ha, Phuoc	Ph.D.	Physics	Professor
Hasse, Tobias	Ph.D.	Geosciences	Lecturer
Hawkins, Andrew	Ph.D.	Geosciences	Lecturer
Hilligoss, Dylan	M.S.	Physics	Lecturer
Jackson, Alan	Ph.D.	Astrophysics	Assistant Professor
Kolagani, Rajeswari	Ph.D.	Physics	Professor
Krause, Thomas	Ph.D.	Physics	Associate Professor
Kudsieh, Nicholas	Ph.D.	Physics	Lecturer
Lising, Laura	Ph.D.	Physics	Lecturer
Moore, Joel	Ph.D.	Geosciences	Professor
Nelson, Wendy	Ph.D.	Geosciences	Associate Professor
Overduin, James	Ph.D.	Physics	Professor
Perkons, Eriks	M.S.	Geosciences	Lecturer
Ready, Christian	B.S.	Astrophysics	Lecturer
Requena Torres, Miguel	Ph.D.	Astrophysics	Lecturer
Schaefer, David	Ph.D.	Physics	Professor
Scott, Jennifer	Ph.D.	Astrophysics	Professor
Simpson, Jeffrey	Ph.D.	Physics	Professor
Smolyaninova, Vera	Ph.D.	Physics	Professor
Tsai, Tevis	B.S.	Mathematics	Lecturer
Yan, Jia-An	Ph.D.	Physics	Professor

Full-time PAGS faculty who are available to teach specific courses in the IP program's core curriculum and concentrations are listed below.

There is a sizable pool of full-time and adjunct faculty drawn from other colleges across TU who are available to teach in the IP program—approximate numbers of non-PAGS faculty qualified to teach each non-physics course are listed below. TU will determine which non-PAGS faculty will teach in the program, based on faculty availability, on a semester-by-semester basis.

Interdisciplinary Physics Core

PAGS Faculty	**PHYS**									
	185	211	241	242	243	305	311	341	385	486
Bedard, Antoine		X	X	X						
Ghavamian, Parviz	X	X	X	X	X		X		X	X
Ha, Phuoc	X	X	X	X	X		X		X	X
Jackson, Alan	X	X	X	X	X	X				
Kolagani, Rajeswari	X	X	X	X	X		X	X	X	X
Krause, Thomas	X	X	X	X	X			X	X	X
Kudsieh, Nicholas		X	X	X						X
Lising, Laura		X	X	X						
Overduin, James	X	X	X	X	X		X		X	X
Schaefer, David	X	X	X	X	X	X	X	X	X	X
Scott, Jennifer	X	X	X	X	X		X		X	X
Simpson, Jeffrey	X	X	X	X	X	X	X	X	X	X
Smolyaninova, Vera	X	X	X	X	X		X	X	X	X
Tsai, Tevis		X	X	X						
Yan, Jia-An	X	X	X	X	X	X	X		X	X

Non-PAGS Faculty		
Requirement	**TU Department**	**Number of Faculty**
MATH 273	Mathematics	10
MATH 274	Mathematics	10

Computational Physics Concentration

PAGS Faculty	**PHYS**		
	307	337	460
Ghavamian, Parviz	X		
Ha, Phuoc	X	X	X
Krause, Thomas	X		
Overduin, James	X		
Schaefer, David		X	X
Simpson, Jeffrey	X	X	X
Yan, Jia-An	X		X

Non-PAGS Faculty		
Requirement	**TU Department**	**Number of Faculty**
COSC 236	Computer and Information Sciences	8
COSC 237	Computer and Information Sciences	3
COSC 290	Computer and Information Sciences	3
COSC 336	Computer and Information Sciences	2
MATH 263	Mathematics	6
MATH 265	Mathematics	3
MATH 374	Mathematics	4

Physics Innovation and Entrepreneurship Concentration

PAGS Faculty	PHYS			
	312	335	337	361
Ha, Phuoc	X	X	X	
Kolagani, Rajeswari	X			
Schaefer, David				X
Simpson, Jeffrey		X		X
Smolyaninova, Vera				X
Yan, Jia-An			X	

Non-PAGS Faculty		
Requirement	**TU Department**	**Number of Faculty**
MKTG 341	Marketing	10
MKTG 451	Marketing	3
COMM 131	Communications	16
BUSX 301	Economics, Finance, Business Excellence Program	10
ENGL 317	English	13
ECON 201	Economics	10
LEGL 225	Marketing	8
Entrepreneurship Minor		
ENTR 110	Marketing	1
ENTR 215	Marketing	2
ENTR 355	Marketing	1
ENTR 410	Marketing	3
Marketing Minor		
MKTG 350	Marketing	1
MKTG 425	Marketing	2
MKTG 445	Marketing	1

Planetary Science Concentration

PAGS Faculty	ASTR		GEOL		
	261	371	121	331	333
Casey, Michelle			X	X	
Ghavamian, Parviz	X	X			
Guice, George			X	X	X
Hasse, Tobias			X	X	
Hawkins, Andrew			X		
Hilligoss, Dylan	X				
Jackson, Alan	X	X			
Krause, Thomas	X				
Moore, Joel			X	X	X
Nelson, Wendy			X	X	X
Perkons, Eriks			X		
Ready, Christian	X	X			
Requena Torres, Miguel	X	X			
Scott, Jennifer	X	X			

Non-PAGS Faculty		
Requirement	**TU Department**	**Number of Faculty**
COSC 175	Computer and Information Sciences	10
CHEM 131	Chemistry	12
CHEM 131L	Chemistry	12
GEOG 221	Geography	5
GEOG 232	Geography	1
GEOG 321	Geography	1