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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 # JC085035 ○ Check # JC085035	Payment Amount: $250	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 with an Area of Concentration in Computational 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: Mark R. Ginsberg	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

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. Since students will not be able to earn the degree without enrolling in an area of concentration, TU has not prepared a separate proposal for a "standalone" Bachelor of Science in Interdisciplinary Physics; however, we have completed a cover sheet and have submitted an $850 payment to establish the overarching bachelor's degree within which each area of concentration will reside.

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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TOWSON UNIVERSITY

Proposal for a Bachelor of Science in Interdisciplinary Physics with an Area of Concentration in Computational 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 major in the Department of Physics, Astronomy, and Geosciences (PAGS): a Bachelor of Science (B.S.) in Interdisciplinary Physics (IP) with an area of concentration in Computational Physics. This IP major 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. The concentrations are centered on areas 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.

This new concentration within the 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 within 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, TU's existing B.S. in Physics is not a suitable pathway for students who are interested in the applications of physics to other disciplines, such as computational physics, which blends core physics with computer science and mathematics.

The Computational Physics concentration curriculum consists of 33 credits in a core set of physics and mathematics courses and 54 credits in computer science and mathematics. Thus, the concentration will draw on TU faculty expertise from across the Fisher College of Science and Mathematics (FCSM). The proposed concentration is well-aligned with Towson University's mission of preparing students as leaders in high demand careers through interdisciplinary study and research.

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 7** and **8**.

A4. Institutional Commitment

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

The new Computational Physics concentration in the proposed IP major will require minimal financial commitment and no new funding allocations for administration or infrastructure (see Section L for further details). There are currently over 40 faculty from across FCSM 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 concentration will benefit from the laboratory and analytical facilities of TU's Science Complex and access to several software packages and utilities available to students through university, FCSM, or PAGS licenses: Capstone, DataStudio, Tracker, LabVIEW, MultiSim, Mathematica, Origin, SigmaPlot, MatLab, 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 a typical four-year plan of study for the Computational Physics 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.

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 and internships.

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.

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**).

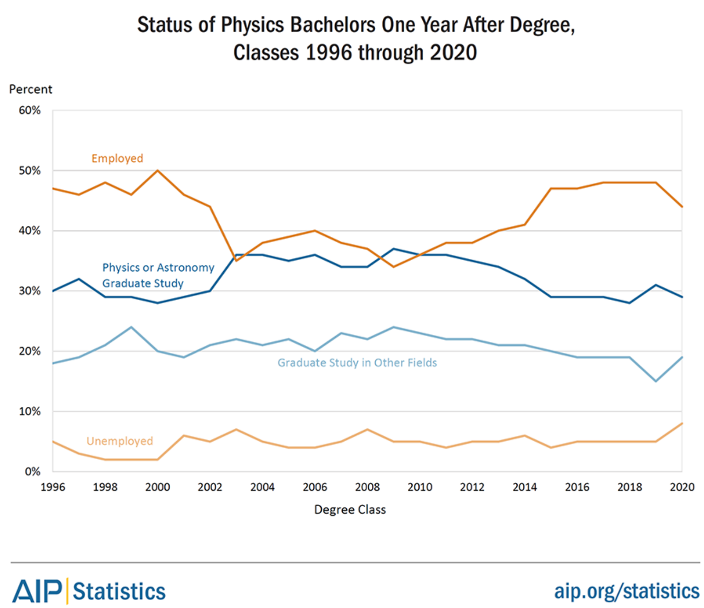

Figure 1. Physics Bachelors One Year After Degree

[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.

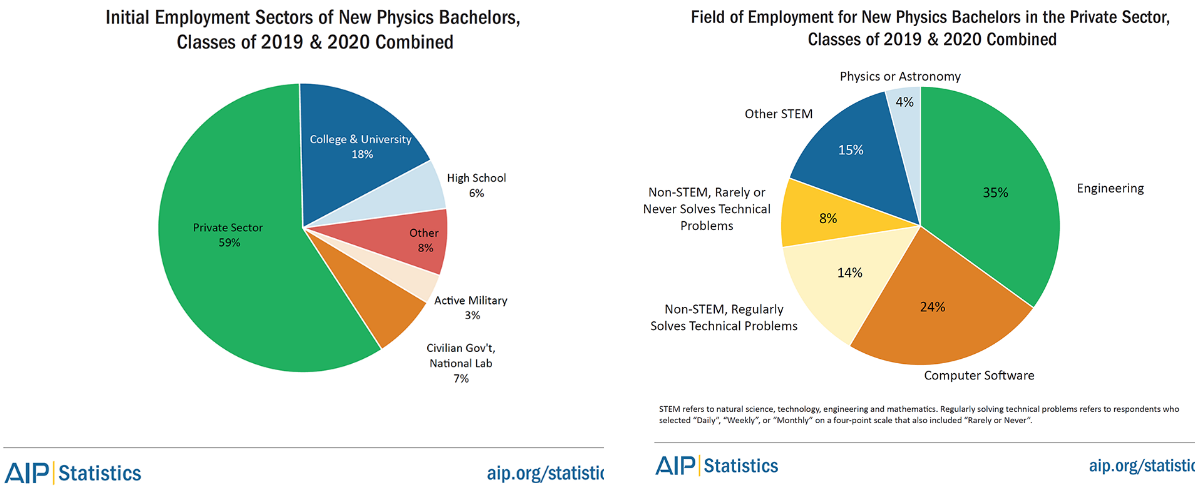

Figure 2. (a) Initial Employment Sectors of Physics Bachelors. (b) Fields of Employment for New Physics Bachelors in the Private Sector.

Computational skills are highly valued in the private and government sectors. Students focusing on computational physics are well-positioned for a wide variety of jobs that require data analysis or computational modeling. Students enrolled in the Computational Physics concentration will be able to pursue a 4+1 pathway to TU's master's in Computer Science. Computational physics and related fields are projected to show increased demand according to the Maryland Department of Labor (**Table 1**).

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.

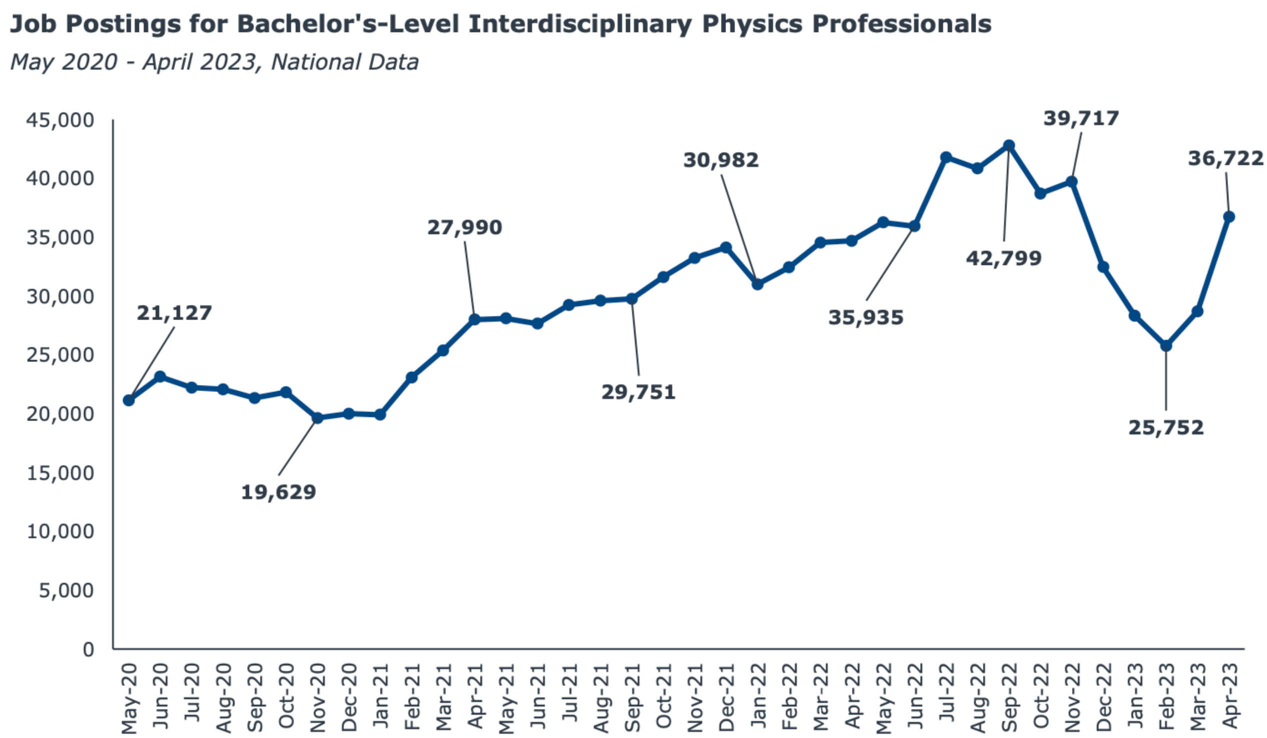

Figure 3. National Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

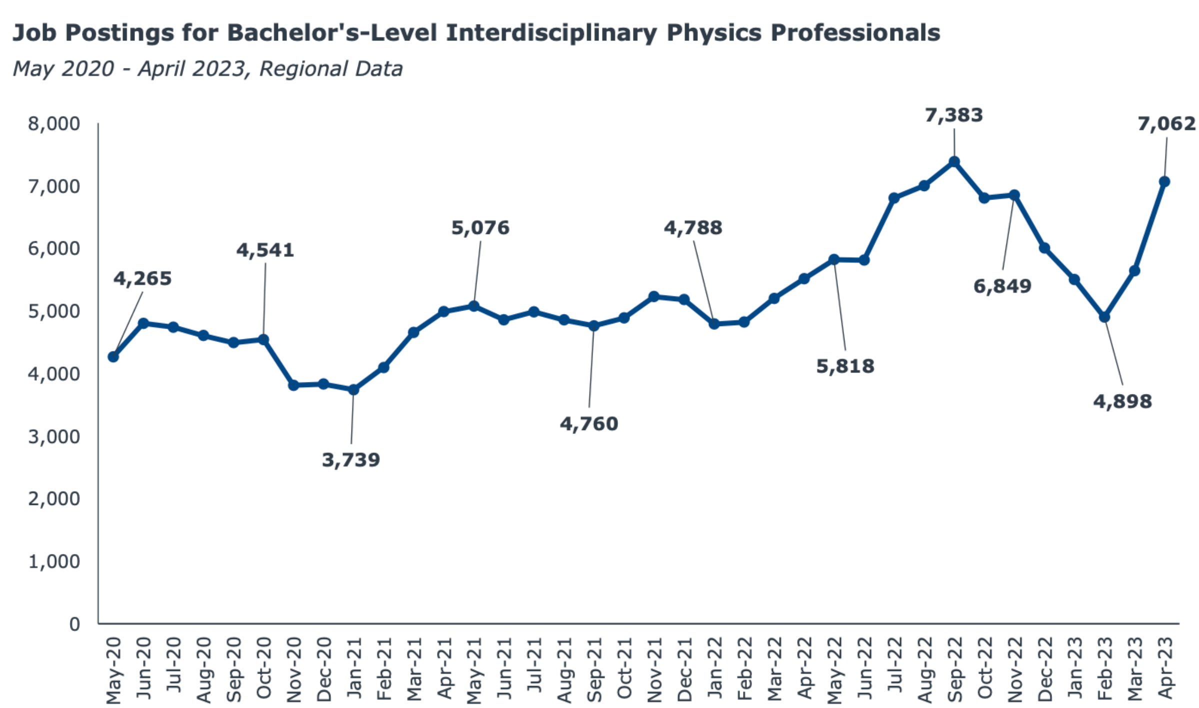

Figure 4. Regional Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

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 Computational Physics concentration (**Table 1**) is between 16.8 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
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

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

According to the EAB market study, commissioned to examine interdisciplinary physics overall, 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 in the Computational Physics concentration of the proposed program: computer programming and simulations, mathematics, etc. (**Figures 5** and **6**).

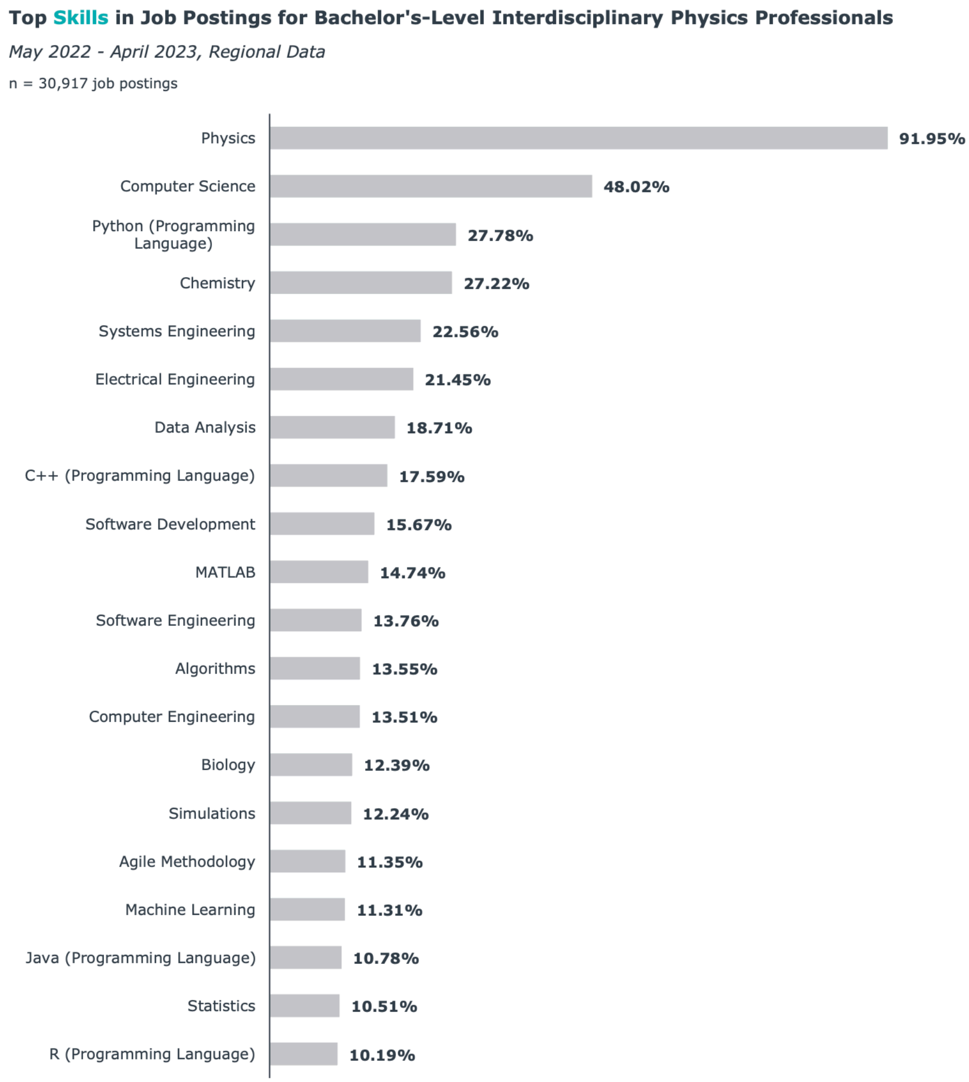

Figure 5. Top Skills in Regional Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

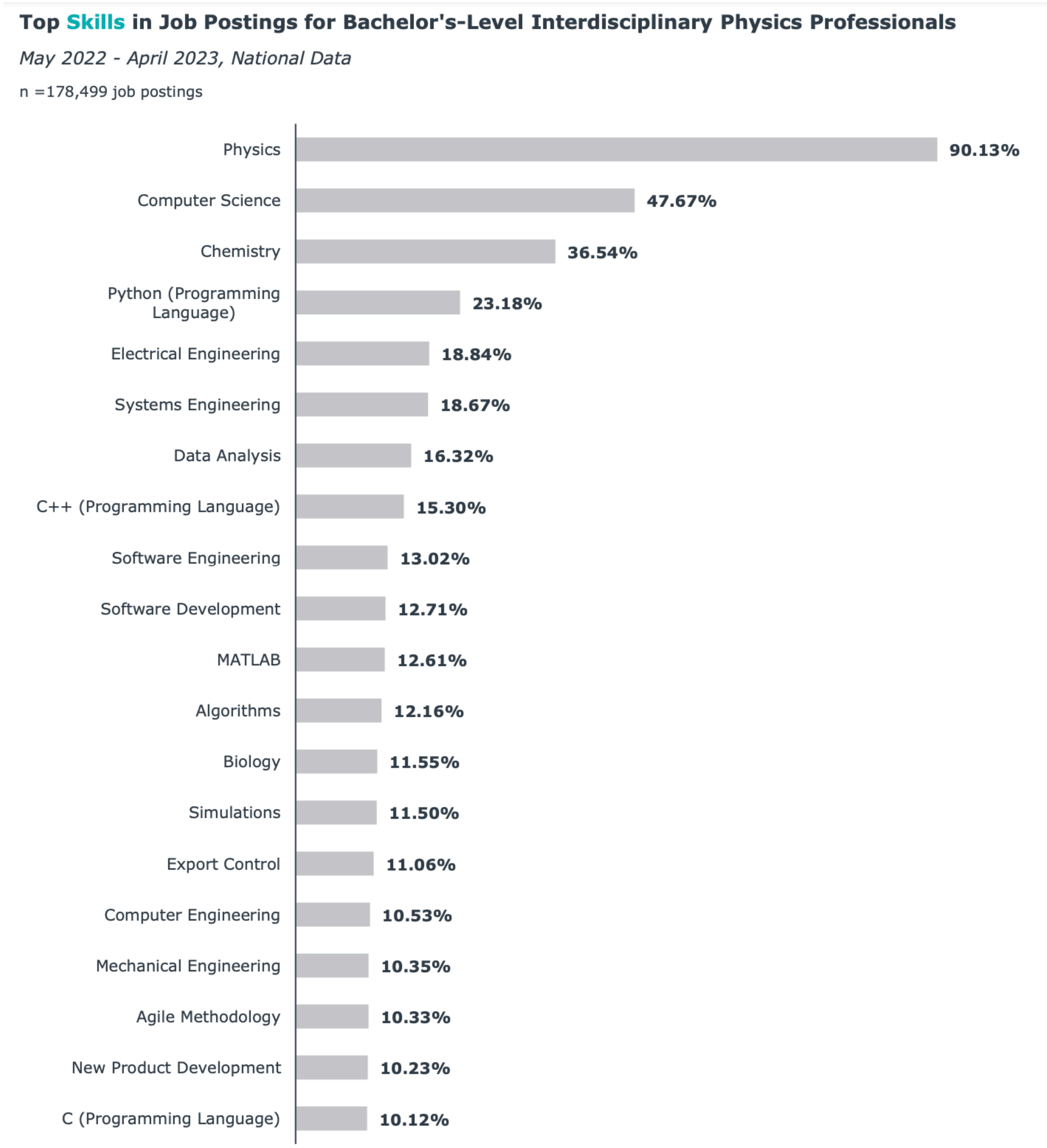

Figure 6. Top Skills in National Job Postings for Bachelor's Level Interdisciplinary Physics Professionals – EAB Report

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**.[4] 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 IP program

[4] 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.

is expected to attract students who would have majored in other STEM fields. Thus, for the Computational Physics concentration proposed here, **Table 2** also tabulates the number of TU degree completions in 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 computer science.

Table 2. Enrollment Trends in Physics and Interdisciplinary Physics Related Programs at Two- and Four-Year institutions[5]						
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
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

[5] 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
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
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
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
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
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 the Computational Physics concentration is provided:

Computational Physics
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.

Interdisciplinary Programs
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 its 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 the Computational Physics concentration 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." The data presented in sections C.2 and C.3 show the market demand and anticipated vacancies for students possessing skills conferred by the Computational Physics concentration within the proposed IP degree 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 Interdisciplinary Sciences) that have some curricular overlap with the Computational Physics concentration within 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 University System of Maryland (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 the master's in Integrated Sciences at Morgan State University, 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 Computational Physics concentration 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 concentration. 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 IP program concentrations.

G2. Educational Objectives and Learning Outcomes
The IP program has three 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 in the Computational Physics concentration will achieve a third learning outcome:

3. Demonstrate the ability to apply computational methods and computer controls to investigate experimental and theoretical scientific problems.

These SLOs address the Middle States Commission on Higher Education 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 shows the alignment of the core requirements of the IP curriculum with the program and concentration-specific SLOs. 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 Program of Study included in Appendix B.

Table 3. Curricular Alignment with Student Learning Outcomes			
Physics Core Requirements	**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		

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 in **Table 4**.

Table 4. Brief Descriptions of Measures		
	Measure 1	**Measure 2**
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.
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.

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. Because the concentrations within the IP major are tailored to specific projected advanced degree and career pathways, students must choose a 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. The curriculum includes courses that explicitly integrate physics with mathematics and computer science. All IP core courses and Computational Physics 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 **- 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.*

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**

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.

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. 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 Computational Physics concentration will be particularly important for helping students choose a set of elective courses within the 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 an articulation agreement for the Computational Physics concentration within the IP major with Cecil College (see Exhibit A attached) and will pursue articulation agreements with other community colleges once the program is approved.

I. Adequacy of Faculty Resources
I1. Quality of Program Faculty
All the concentrations in this new major 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.

Because the IP new major is truly interdisciplinary in nature, the proposed Computational Physics concentration will build ties between physics faculty and faculty within and outside the multidisciplinary PAGS department and, in particular, help strengthen relationships with FCSM's Departments of Computer & Information Sciences and Mathematics.
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.

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 the Computational Physics concentration will be taking courses already offered for physics majors within PAGS and in other TU undergraduate majors outside PAGS (e.g., Computer Science, Information Technology, and Mathematics); therefore, no expenditures are necessary to develop the program curriculum. Additionally, PAGS anticipates hiring a new faculty member in Year 2; this position would support teaching in the concentration (budgeted at a 0.13 FTE rate in **Table 8**). Other than this new faculty position, the Computational Physics concentration will be supported through existing faculty 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 with a Computational Physics concentration from programs such as Computer Science, Information Technology, or Mathematics. The types of marketing activities PAGS anticipates undertaking include website development, email and social media marketing, flyers, and 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 7. Programmatic Resources

Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	$0	$0	$0	$0	$0
a. Reallocated Funds-Faculty FTE[1]	$0	$0	$0	$0	$0
2. Tuition/Fee Revenue (c + g below)	$22,612	$58,225	$95,952	$135,894	$165,425
a. Number of F/T Students	2	5	8	11	13
b. Annual Tuition/Fee Rate (In State)[1,2]	$11,306	$11,645	$11,994	$12,354	$12,725
c. Total F/T Revenue (a x b)	$22,612	$58,225	$95,952	$135,894	$165,425
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)	$22,612	$58,225	$95,952	$135,894	$165,425

[1] Student enrollments are calculated at 100 percent in-state. It is anticipated that all students will enroll on a full-time basis.
[2] Tuition and fees increase by three percent annually.

Table 8. Programmatic Expenditures					
Expenditure Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Faculty (b + c below)	$0	$15,089	$15,541	$16,008	$16,489
a. Number of FTE	0	0.13	0.13	0.13	0.13
b. Total Salary[1]	$0	$10,701	$11,022	$11,353	$11,694
c. Total Benefits[1]	$0	$4,388	$4,519	$4,655	$4,795
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	$16,089	$16,541	$17,008	$17,489

[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,[6] 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.

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

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.[7,8] 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.[9] Since the Computational Physics concentration of TU's proposed IP degree will provide an additional pathway 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.

[7] U. S. Census Bureau, 2020: https://www.census.gov/quickfacts/fact/table/US/POP010220#POP010220.
[8] 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.
[9] 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)[10]
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)[10]
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)[11]
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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[10] Students may take either PHYS 211 or PHYS 241.
[11] Students may take either PHYS 385 or ASTR 385.

ASTR 385 ASTROPHYSICS SEMINAR (1)[11]
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.

Appendix B. Example Program 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**			

Appendix C. Faculty Supporting the Computational Physics Concentration in the Interdisciplinary Physics Major

Full-Time PAGS Program Faculty			
Name	**Terminal Degree**	**Field**	**Academic Title**
Bedard, Antoine	Ph.D.	Electrical Engineering	Lecturer
Ghavamian, Parviz	Ph.D.	Astrophysics	Professor
Ha, Phuoc	Ph.D.	Physics	Professor
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
Overduin, James	Ph.D.	Physics	Professor
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 in the Computational Physics concentration 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 Computational Physics concentration—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.

<u>**Interdisciplinary Physics Core**</u>

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

<u>Computational Physics Concentration</u>

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

Exhibit A: Articulation Agreement with Cecil College

Umbrella Program Transfer Agreement
between Towson University and Cecil College

This **UMBRELLA PROGRAM TRANSFER AGREEMENT** (this "Agreement"), effective as of the date of last signature below (the "Effective Date"), is hereby entered into by and between **TOWSON UNIVERSITY** ("TU"), an educational institution of the University System of Maryland, itself an agency of the State of Maryland, located in Towson, Maryland, and **CECIL COLLEGE** ("Cecil"), a community college located in North East, Maryland.

I. Purpose

The Agreement affirms the commencement of an initiative between Cecil and TU (each, a "Party" and collectively hereinafter referred to as the "Parties") to provide articulated transfer pathways for Cecil students (each, a "Pathway") where, after successful completion of Cecil coursework, admissible Cecil students will be able to transfer seamlessly to TU and enroll in programs leading to the Bachelor of Science, Bachelor of Arts, Bachelor of Fine Arts, or Bachelor of Technical and Professional Studies degrees.

The purpose of this Agreement is to: (i) define the responsibilities of each Party and the opportunities for students who choose to follow a Pathway, and (ii) to enhance and facilitate degree completion at the respective institutions. In addition, this Agreement contributes to the Maryland Higher Education Commission's completion initiative by increasing associate degree attainment and providing momentum for baccalaureate completion.

II. Guaranteed Admission

Subject to the terms and conditions of this Agreement, TU shall provide students graduating from Cecil with associate degrees the opportunity to seamlessly transfer to TU into any of the bachelor's degree programs offered by TU that do not have special admissions requirements. TU's Office of Undergraduate Admission will retain the final authority in all admission decisions.

III. Pathways; Admission to Special Programs

Each Pathway connecting departments, majors, or tracks between Cecil or TU shall be established and memorialized pursuant to a separate Program Transfer Addendum ("PTA Addendum"), which shall be incorporated to this Agreement. A template for the PTA Addendum is attached hereto as Exhibit A.

The PTA Addendum shall specify the department, major, or track at Cecil sending students to TU, the department, major, or track at TU awarding transfer credit, and any other relevant information.

When applicable, the PTA Addendum will outline specific requirements for admission into TU's screened major. Students must follow the admission requirements and application processes for those screened majors as outlined in the TU Undergraduate Catalog.

IV. Acceptance of Transfer Credit

Subject to the terms and conditions of this Agreement, TU shall accept transfer of Cecil credits up to a maximum of sixty-four (64) applicable semester credit hours. PTA Addendums hereto include Pathways detailing the requirements for credit transfer for specific degree programs/curricula.

A completed General Education program taken as part of an associate's degree (e.g., AA, AS, ASE, AAT) at Cecil will transfer to TU's Core Curriculum without the need for a course-by-course match. Students who have completed an associate's degree will be required to take TU's Advanced Writing Seminar (Core 9) and additional units (which is the term TU uses when referencing credits/credit hours) necessary to complete the minimum number of Core Curriculum units. The Towson Seminar (Core 1) course will be waived for all students transferring under this Agreement. Official transcripts from all higher education institutions from which students have earned academic credit must be submitted to TU as part of the application process. Credits transferred into Cecil from other colleges/universities will be reviewed individually to determine transferability and applicability.

TU itself does not grant academic credit for occupational competency/life experience. However, such credits, including institutional examination credits, will be accepted if awarded by Cecil and documented on an official transcript. TU will also accept a maximum of 30 credits in any combination from one of more of the following sources: acceptable Advanced Placement (AP) examination scores, acceptable College Level Examination Program (CLEP) scores, Defense Activity for Non-Traditional Education Support (DANTES) exam credits, Cambridge Advanced International Certificate of Education Diploma, successful completion of International Baccalaureate (IB) examinations, or acceptable transfer credit for prior learning.

V. Academic Planning

To facilitate a seamless transition, Cecil students should work closely with their academic advisor at Cecil to develop a comprehensive academic plan as early in their academic career as possible and prior to transfer. Students and advisors are encouraged to utilize a variety of advising resources including the PTA Addendum (Exhibit A), Cecil Catalog, TU Undergraduate Catalog, respective departmental websites, and ARTSYS (the USM online articulation database), to ascertain the transferability of coursework.

Pre-transfer advising is also available at TU for students to discuss their progress in the Pathways before transferring to TU.

VI. Academic Advising

Before matriculation at TU, a student's official transfer credit evaluation will be available on the student portal's Academic Requirements Report. The Academic Requirements Report details prior coursework transferability and applicability to the university, Core Curriculum, and major requirements at TU.

All new TU students are required to attend the New Student Orientation. During this orientation, students will meet with their academic advisors to review prior coursework, discuss academic interests and goals, and register for the upcoming semester.

TU students are assigned advisors in their area of study and are encouraged to meet with them periodically to assess their academic progress. Students with forty-five (45) or more earned credits must meet with their academic advisors to complete individualized Degree Completion plans for completion of all Core Curriculum, graduation, and major requirements, as outlined in the TU Undergraduate Catalog. These requirements include successfully completing at least 120 credits/units to earn the baccalaureate degree, of which at least thirty (30) must be earned at TU.

VII. Financial Aid and Transfer Scholarships

The Free Application for Federal Student Aid (FAFSA) is required for need-based aid. Students transferring from Cecil to TU must indicate TU's school code of 002099 when submitting the FAFSA. All students are encouraged to submit the FAFSA beginning October 1 but no later than the priority application deadline of January 15.

Students transferring from Cecil to TU who meet the transfer admissions priority deadline will be considered for TU's merit-based scholarship, the Transfer Achievement Award, for outstanding academic achievement.

Cecil students who transfer to TU are encouraged to apply for other TU scholarship opportunities as they become available. Students should consult with the Scholarship Seeker on the financial aid site at TU. TU transfer scholarships shall be promoted on both the TU and Cecil websites.

Students transferring to from Cecil to TU who have completed an associate's degree are encouraged to apply for the Maryland Higher Education Commission (MHEC) 2+2 Transfer Scholarship.

VIII. Reverse Transfer

TU encourages students to complete their associate's degree at Cecil before transferring. Additionally, TU will support former Cecil students who have transferred to TU without completing their associate's degrees through the "Reverse Transfer" process. TU will facilitate reverse transfers each spring and fall semester, identifying students who meet the reverse transfer criteria and will notify Cecil of eligible students. Cecil will review to determine eligibility for awarding of the associate's degree at Cecil. Students must meet the following qualifying criteria to be considered for reverse transfer: (1) be a current student at TU; (2) have not received any degree from TU; and (3) have earned at least 15 credits at Cecil (based on what TU transferred in) and have at least 60 total earned credits. Eligible students must indicate their interest in participating in Reverse Transfer at the time of application to TU or sign a FERPA (defined below) waiver to allow TU and Cecil advisors to exchange student academic records. Reverse Transfer data will be shared yearly amongst administrators, as set forth below.

IX. Reports and Data Sharing

TU shall provide annual transfer reports to Cecil. Transfer reports will include data on Cecil transfer students who are currently enrolled at TU. Transfer reports should include: student demographics, number of credits transferred, program of study, scholarship awardees, number of conferred bachelor's degrees, number of Reverse Transfer students, and other pertinent information.

Cecil will provide student data and reports to TU annually, including student enrollment information, enrollment breakdown based on programs at Cecil, student demographic data, and other pertinent information.

The Parties will comply with all provisions of the Federal Family Educational Rights and Privacy Act ("FERPA") in all disclosures of FERPA-protected information between Cecil and TU. For example, the Parties may share personally identifiable information from a student's record for purposes related to a student's enrollment or transfer, per 34 C.F.R §§ 99.3 l (a)(2) and 99.34. In addition, pursuant to 34 C.F.R § 99.31 (a)(6)(i), the Parties may share with each other personally identifiable information from student's educational records without consent for the sole purpose of conducting studies to develop, validate, or administer predictive tests; administer student aid programs; or improve instruction. Also consistent with FERPA, the Parties shall use reasonable methods to assure that they provide only those education records necessary to this Agreement through secure delivery methods. Nothing in this Agreement shall be construed to allow the Parties to maintain, use, disclose, or share student record information in a manner prohibited under applicable laws or regulations.

X. Publicity, Promotion, and Intellectual Property

During the term of this Agreement, TU and Cecil shall develop and agree upon a mutually acceptable marketing and student recruitment plan to promote this Agreement and the Pathways to students. Any and all marketing, promotional, or publication materials developed pursuant to this Agreement that is prepared or developed by one Party must be reviewed and approved in writing by the other Party prior to the use of any such materials. Cecil agrees to promote Pathways to Cecil students by allowing TU to place marketing materials in student service-centered departments on campus and on the Cecil Transfer Agreements website.

Upon the request of TU, Cecil agrees to send outreach biannually (fall and spring) on behalf of TU to current Cecil students with 45 credits or more who are in articulated or parallel programs with TU.

Each Party reserves all rights to their respective trade names, trademarks, service marks, logos, or other commercial symbols (collectively, "Marks"), copyrights, patents, and other intellectual property rights and no rights to the Marks or copyrights, patent or other intellectual property rights are transferred or licensed pursuant to this Agreement. Each Party shall retain all intellectual property rights in their respective course materials offered to students while enrolled at their institution.

XI. Agreement Term and Review

The Agreement shall commence on the Effective Date and remain in force for an initial term of five (5) years unless sooner terminated by either Party as set forth below. The Agreement will automatically renew for an additional five (5) year term unless either Party gives ninety (90) days prior written notice to the other Party of its intent not to renew the Agreement.

Either Party may terminate this Agreement by providing ninety (90) days' written notice to the other Party. During the notice period, the Parties may discuss the continuation of a formal relationship. If the Agreement is terminated, TU will honor transfer students from Cecil under the expiring Agreement terms.

If there are changes in curriculum, programs, and credential requirements, the designated program administrators will meet on behalf of the Parties to determine if the Agreement should be amended. Any adjustments made during the Agreement's term will require a written amendment, modification, or addendum signed by authorized representatives of the Parties.

XII. Program Administrators

The individuals listed below have been designated to serve as program administrators of the Parties under this Agreement:

Cecil College Program Administrator	TU Program Administrator
Gladys Ramirez-Wrease, Ed.D. Associate Dean for Academic and Community Collaboration 443-674-1991 gramirezwrease@cecil.edu	Jennifer Mercer Associate Director University Admissions 410-704-6004 jmercer@towson.edu

If a Party replaces their respective program administrator for any reason, that Party shall promptly notify the other Party's program administrator in writing.

Any notice required to be given under this Agreement shall be given in writing and delivered: (1) in person with documentation of receipt; (2) by facsimile or via email of scanned document with documentation of delivery; or (3) by first class mail, postage prepaid and addressed to each Party's designated contact (program administrator), or such other person a Party may subsequently designate in writing as the program administrator. A notice shall be deemed effective when received.

XIII. Relationships of the Parties

Nothing contained in this Agreement shall be deemed or construed to create a relationship of employment, principal and agent, partnership, co- or joint employer, or joint venture. Neither Party shall, by virtue of this Agreement, have any right, power, or authority to act or create any obligation, express or implied, on behalf of the other Party, nor shall this Agreement be construed to create rights or obligations, express or implied, on behalf of or for the use of any parties other than the Parties hereto; and the Parties shall not be obligated, separately or jointly, to any third parties by virtue of this Agreement.

XIV. Waiver

Failure on the part of either Party, in any or more than one instance, to insist upon the performance of any of the terms, covenants, or conditions of this Agreement or to exercise any right or privilege contained within this Agreement, or the waiver by any Party of any breach of any of the terms, covenants, or conditions of this Agreement shall not be construed as thereafter waiving any such terms, covenants, conditions, rights or privileges, but the same shall continue and remain in full force and effect, as if no such forbearance of waiver had occurred.

XV. Governing Law

The Parties agree to comply with all federal, state, and local laws and regulations, and all Cecil and TU policies or procedures applicable to the activities under this Agreement. This Agreement, and all claims arising out of or relating to this Agreement, whether sounding in contract, tort, or otherwise, shall be governed in all respects by the laws of the State of Maryland, without reference to its conflicts of laws rules.

XVI. Counterparts

This Agreement may be executed in multiple counterparts, each of which is deemed an original and all of which constitute one and the same agreement. This Agreement is effective upon delivery of one executed counterpart from each Party to the other Parties, including by facsimile or PDF delivery. The signatures of all Parties need not appear on the same counterpart.

XVII. Severability

Each provision of this Agreement shall be deemed a separate, severable, and independently enforceable provision. The invalidity of breach of any provisions shall not cause the invalidity or breach of the remaining provisions hereof.

XVIII. Assignments

Neither Party may assign this Agreement nor assign any of its rights under this Agreement, except with the prior written consent of the other Party. Any purported assignment of rights in violation of this provision shall be void.

XIX. Non-Discrimination

Each party agrees to subscribe to the principle of equal opportunity and shall not discriminate on the basis of race, color, religion, creed, age, sex, gender identity, sexual orientation, genetic information, marital status, national origin, ancestry, physical or mental handicap, or any other protected class in the selection of students and any other actions taken pursuant to this Agreement.

XX. Force Majeure

Neither Party will be responsible for or liable to the other party for non-performance or delay in performance of any terms or conditions of this Agreement due to acts or occurrences beyond the reasonable control of the nonperforming or delayed Party. Such causes include but are not limited to, acts of God, acts of government, pandemics, epidemics, embargoes, terrorism, wars, riots, strikes or other labor disputes, shortages of labor or materials, hurricanes, fires, and floods, or any other circumstances of like character. The Party whose performance is delayed or prevented shall promptly provide to the other Party written notice of the existence of and the reason for such nonperformance or delay and shall endeavor to mitigate its effects and make best efforts to resume performance as soon as practicable.

XIX. Entire Agreement and Amendments

Any exhibits, attachments, and documents referenced herein, whether physically attached hereto, are incorporated into and made part of this Agreement, which constitutes the final Agreement between the two Parties. It is the complete and exclusive expression of the Parties' agreement on the matters contained in this Agreement. All prior and contemporaneous negotiations and agreements between the Parties on the matters contained in this Agreement are expressly merged into and superseded by this Agreement. In entering this Agreement, neither Party has relied on any statement, representation, warranty, or agreement of the other Party except for those expressly contained in it. There are no conditions precedent to the effectiveness of this Agreement other than those expressly stated in this Agreement. No amendment, modification, or addition to this Agreement will be binding upon the Parties hereto unless reduced to writing and signed by the respective authorized representatives of each Party.

IN WITNESS WHEROF, the Parties hereby have caused this Agreement to be executed by their duly authorized representatives.

CECIL COLLEGE

By: Christy Dryer

Dr. Christy Dryer
Vice President
Academic Programs

Date: 4/2/2024

TOWSON UNIVERSITY

By: [signature]

Dr. Melanie Perreault
Provost and Executive Vice President
for Academic Affairs

Date: 3/20/24

2+2 Articulation Agreement for Cecil College and Towson University

Associate's Degree: A.S. in Physics
Bachelor's Degree: B.S. in Interdisciplinary Physics, Computational Physics Concentration
Effective Term: Fall 2024

Section 1: Course Completion Plan for Cecil College

This section outlines the courses to satisfy Cecil College (Cecil) general education and program requirements in order to complete both Cecil and Towson University (TU) degrees within a total of four years and earn the minimum required 120 units/credits.[1] The following tables do not include any nontransferable or prerequisite coursework outside of the curriculum.

Table 1: Cecil General Education Courses Applied to TU Core Curriculum

Cecil Requirement	Cecil Course to Take	Credits	TU Equivalent Course
English Composition	EGL 101 College Composition (E)	3	ENGL 102 Writing for a Liberal Education
Mathematics	MAT 191 Precalculus (M) (see advisor)	4	MATH 119 Precalculus
Arts & Humanities	EGL 102 Composition & Literature (H)	3	ENGL TLL English Lower-Level Elective
Arts & Humanities	Choose one of the following: ▪ PHI 201 Contemporary Moral Issues (H) ▪ PHI 270 Ethical Issues in Healthcare (H)	3	▪ PHIL 253 Contemporary Ethical Problems ▪ PHIL TLL Philosophy Lower-Level Elective
Social & Behavioral Sciences	Social Science Elective (SS)	3	Equivalency will vary by course
Social & Behavioral Sciences	Social Science Elective (SS)	3	Equivalency will vary by course
Biological & Physical Sciences	PHY 217 General Calculus Physics I with Lab (SL)	4	PHYS 241 General Physics I Calculus-Based
Biological & Physical Sciences	PHY 218 General Calculus Physics II with Lab (SL)	4	PHYS 242 General Physics II Calculus-Based

Cecil general education credits: 27

[1] Note that Cecil College awards academic "credit" for its courses, whereas Towson University uses the term "unit" in reference to the credit hour weighting assigned to its undergraduate courses. For the purposes of this articulation agreement, the terms "credit" and "unit" are interchangeable.

Completing the courses above will satisfy the general education program at Cecil. TU will transfer these courses without a course-by-course match to the Core Curriculum requirements. See section 2 for details.

Table 2: Cecil Program Requirements and Electives Applied to TU Degree

Cecil Requirement	Cecil Course to Take	Credits	TU Equivalent Course
Program Requirement	MAT 201 Calculus I with Analytic Geometry (M)	4	MATH 273 Calculus I
Program Requirement	MAT 202 Calculus II with Analytic Geometry (M)	4	MATH 274 Calculus II
Program Requirement	MAT 203 Multivariable Calculus (M)	4	MATH 275 Calculus III
Program Requirement	MAT 240 Introduction to Linear Algebra (M)	4	MATH 265 Elementary Linear Algebra
Program Requirement	MAT 246 Introduction to Differential Equations (M)	3	MATH T74 Differential Equations
Program Requirement	PHY 219 General Calculus Physics III with Lab (SL)	4	PHYS 243 General Physics III
Program Requirement	CHM 103 General Chemistry I (S)	3	CHEM 131 General Chemistry I Lecture
Program Requirement	CHM 113 General Chemistry I Lab	1	CHEM 131L General Chemistry I Lab
Program Elective	Choose one: ▪ CSC 109 Introduction to Programming ▪ CSC 104 Computer Science	3	COSC 175 General Computer Science
Program Elective	MAT 236 Discrete Structures	3	MATH 263 Discrete Mathematics

- **Cecil program requirements and elective credits applied to the TU degree: 33 credits**
- **Total Cecil credits applied to the TU Core Curriculum to fulfill TU general education requirements: 37 credits (includes courses taken at Cecil to meet general education requirements [see Table 1] and program requirements [see Table 2] for the A.S. degree)**
- **Maximum number of Cecil credits transferable to TU: 64**

While Cecil's A.S. degree in Physics is 60 credits, Cecil students may transfer a maximum of 64 credits toward TU's B.S. degree in Interdisciplinary Physics, Computational Physics Concentration. The application of these additional credits beyond the 60-credit standard will be determined by TU on an individual case-by-case basis. If students do not adhere to the courses outlined above in Tables 1 and 2, they are not guaranteed completion of the bachelor's degree in two years. Refer to section 2 for specific course details and transfer planning information.

Section 2: Cecil Course Selection & Transfer Details

This section explains any specific course selections made in section 1 and provides transfer planning guidance specific to this degree plan. Students must follow the course selections outlined in this document. If students do not complete any or all of the courses outlined in this agreement, they will be required to complete the outstanding requirements at TU.

GENERAL EDUCATION

Students must take the following courses for their general education requirements. Students must earn a minimum grade of C in the following courses to satisfy TU major requirements**.**

- **Biological & Physical Sciences: PHY 217 General Calculus Physics I with Lab (SL)** to satisfy the major requirement of **PHYS 241 General Physics I Calculus-Based.**
- **Biological & Physical Sciences: PHY 218 General Calculus Physics II with Lab (SL)** to satisfy the major requirement of **PHYS 242 General Physics II Calculus-Based.**

The following information explains the transfer of students' general education courses:

- TU will recognize the courses in Table 1 (see section 1) as a completed general education program. Students will receive a core package that satisfies most of the TU Core Curriculum without the need for course-by-course placement in specific TU Core Curriculum requirements.
- Students entering into this agreement will need to complete one Core Curriculum requirement at TU: Advanced Writing Seminar (Core 9). Students not completing the courses listed in Tables 1 and 2 above will be required to complete additional Core Curriculum requirements at TU.

PROGRAM REQUIREMENTS

Students must take the following courses in order to also satisfy required courses in the major at TU. Students must earn a minimum grade of C in the following courses.

- **MAT 201 Calculus I with Analytic Geometry (M)** to satisfy the major requirement of **MATH 273 Calculus I**.
- **MAT 202 Calculus II with Analytic Geometry (M)** to satisfy the major requirement of **MATH 274 Calculus II**.
- **MAT 203 Multivariable Calculus (M)** to satisfy the major requirement of **MATH 275 Calculus III.**
- **MAT 240 Introduction to Linear Algebra (M)** to satisfy the major requirement of **MATH 265 Elementary Linear Algebra.**
- **MAT 246 Introduction to Differential Equations (M)** to satisfy the major requirement of **MATH 374 Differential Equations**.
- **PHY 219 General Calculus Physics III with Lab (SL)** to satisfy the major requirement of **PHYS 243 General Physics III.**

PROGRAM ELECTIVES

Students must take the following courses in order to also satisfy required courses in the major at TU. Students must earn a minimum grade of C in each of the following courses.

- **CSC 109 Introduction to Programming** or **CSC 104 Computer Science to** satisfy a required major prerequisite course of **COSC 175 General Computer Science**. For this agreement only. Students who do not complete CSC 109 or CSC 104 at Cecil must complete COSC 175 at TU.
- **MAT 236 Discrete Structures** to satisfy the major requirement of **MATH 263 Discrete Mathematics**.

LOWER-LEVEL EQUIVALENTS OF UPPER-LEVEL COURSES

A course number beginning with T or F indicates that it is a lower-level equivalent of an upper-level TU course. **MATH T74 Differential Equations** will satisfy a major requirement but will not count toward the TU degree requirement for 32 upper-level units.

Section 3: Degree Requirements to be Completed at TU

This section outlines the degree requirements for students transferring into the B.S. in Interdisciplinary Physics, Computational Physics Concentration. Refer to section 4 for additional major requirements, recommendations, and university-wide degree requirements.

CORE CURRICULUM REQUIREMENTS: 3 UNITS

Core 9 Advanced Writing Seminar (3 units)

INTERDISCIPLINARY PHYSICS MAJOR REQUIRED COURSES: 12 UNITS

PHYS 185 Introductory Seminar in Physics (1 unit)
PHYS 305 Computers in Physics (4 units)
PHYS 311 Modern Physics (3 units)
PHYS 341 Intermediate Physics Laboratory I (3 units)
Select one of the following for 1 unit:

- PHYS 385 Physics Seminar
- ASTR 385 Astrophysics Seminar

COMPUTATIONAL PHYSICS CONCENTRATION REQUIRED COURSES: 27 UNITS

PHYS 307 Introductory Mathematical Physics (3 units)
PHYS 337 Digital Electronics (4 units)
PHYS 460 Computational Methods in Physics (3 units)
PHYS 486 Physics Seminar II (1 unit)
COSC 236 Introduction to Computer Science I (4 units)
COSC 237 Introduction to Computer Science II (4 units)

COSC 290 Principles of Computer Organization (4 units)
COSC 336 Data Structures and Algorithm Analysis (4 units)

COMPUTATIONAL PHYSICS CONCENTRATION ELECTIVE COURSES: 12 UNITS
Students must complete 12 units of upper-level (300 or 400 level courses) coursework in PHYS, COSC, or MATH disciplines.

GENERAL ELECTIVES: 6 UNITS
The total number of elective units required will be determined by the total units completed within the major. Electives can be additional major electives or courses for personal interests.

Section 4: Additional Requirements & Recommendations for TU Degree Completion

ADDITIONAL REQUIREMENTS FOR INTERDISCIPLINARY PHYSICS, COMPUTATIONAL PHYSICS CONCENTRATION

- Physics majors are required to complete 16 of the required upper-division units in physics at TU.
- Students should be aware that most advanced physics courses (300 or 400 level) may be offered in either the first or second term, but not in both terms. Some physics electives are only offered every other year.

BACHELOR'S DEGREE REQUIREMENTS FOR ALL STUDENTS

- A grade of C (2.0 GPA) or higher is required in all major courses and prerequisites.
- A cumulative GPA of 2.0 is required.
- 32 units of the bachelor's degree must be completed at the upper level (courses numbered 300 or above).
- Certain majors may have additional requirements for graduation. Students should follow the specific requirements outlined in the catalog for the major.

Degree Completion Summary

Total Units Required for TU B.S. in Interdisciplinary Physics, Computational Physics Concentration	**120 UNITS**
Cecil A.S. Degree in Physics	**60**
Completion of Core Curriculum at TU	**3**
Interdisciplinary Physics Major Required Coursework at TU	**12**
Computational Physics Concentration Required Coursework at TU	**27**
Computational Physics Concentration Elective Coursework at TU	**12**
General Electives Taken at TU	**6**