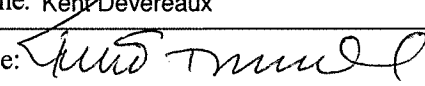


Institution Submitting Proposal	Goucher College
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Each action below requires a separate proposal and cover sheet.

- | | |
|---|---|
| <input checked="" type="radio"/> New Academic Program | <input type="radio"/> Substantial Change to a Degree Program |
| <input type="radio"/> New Area of Concentration | <input type="radio"/> Substantial Change to an Area of Concentration |
| <input type="radio"/> New Degree Level Approval | <input type="radio"/> Substantial Change to a Certificate Program |
| <input type="radio"/> New Stand-Alone Certificate | <input type="radio"/> Cooperative Degree Program |
| <input type="radio"/> Off Campus Program | <input type="radio"/> Offer Program at Regional Higher Education Center |

Payment <input checked="" type="radio"/> Yes	Payment <input type="radio"/> R*STARS	Payment \$850	Date
Submitted: <input type="radio"/> No	Type: <input type="radio"/> Check	Amount:	Submitted: 5/2019

Department Proposing Program	Physics (suspended with intent to discontinue)		
Degree Level and Degree Type	B.A.		
Title of Proposed Program	Engineering Science		
Total Number of Credits	120		
Suggested Codes	HEGIS:	CIP: 14.1301	
Program Modality	<input checked="" type="radio"/> On-campus	<input type="radio"/> Distance Education (<i>fully online</i>)	
Program Resources	<input checked="" type="radio"/> Using Existing Resources	<input type="radio"/> Requiring New Resources	
Projected Implementation Date	<input checked="" type="radio"/> Fall	<input type="radio"/> Spring	<input type="radio"/> Summer Year: 2019
Provide Link to Most Recent Academic Catalog	URL: https://catalog.goucher.edu/		
Preferred Contact for this Proposal	Name:	Scott Sibley	
	Title:	Interim Provost	
	Phone:	(410) 337-6288	
	Email:	ssibley@goucher.edu	
President/Chief Executive	Type Name:	Kent Devereaux	
	Signature:		Date: 7/1/19
	Date of Approval/Endorsement by Governing Board:		

Revised 3/2019

Academic Program Proposal
Goucher College
Engineering Science

A. Centrality to Institutional Mission and Planning Priorities:

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

The Engineering Science (EngSci) major is designed to prepare students for careers in today's technology, engineering, or research fields. It is a fully interdisciplinary program with a design emphasis, focusing on broad skills-based preparation for science- and engineering-related work. The curriculum is built around a 32-credit core, which covers fundamentals of physics, math, chemistry, and programming, as is typical for pre-engineering programs; however, these courses are designed specifically to emphasize applications and real-world problem-solving. Students then specialize by choosing from among three tracks of 12 credits each, in which they deepen their knowledge base in one of three science disciplines (Environmental Science, Chemistry, or Physics). As a senior capstone experience, all students will complete a collaborative design project.

The vision of the EngSci program is to prepare today's students for a future in technological innovation, by grounding them in skills—problem-solving, quantitative analysis, programming, designing experiments, building equipment—that are common to a range of careers and technologies, while also developing an interdisciplinary perspective and socio-cultural competency through Goucher's liberal-arts education. Our goal is for students to be able to identify and build practical and usable solutions to particular technological needs, but also to understand of the societal context and impacts of science/technology, and to navigate diverse perspectives and cultural communities while collaborating to solve problems.

At the same time, the EngSci program is committed to accessibility and to enabling success for all students. The student pathway through the program has been completely reimaged, in comparison to a traditional science or engineering degree, to remove barriers for underprepared students and to provide scaffolded support while students solidify their skills. Introductory courses are spread through the first four semesters, starting with calculus, rather than begun all at once. A cohort model, in which each year's entering class forms a learning community and takes many courses together, will provide students with peer learning and relationships, mutual support, and co-curricular enrichment.

This vision aligns compellingly with the mission and vision of Goucher College. In our mission statement, Goucher "is dedicated to a liberal arts education that prepares students within a broad, humane perspective for a life of inquiry, creativity, and critical and analytical thinking;" this leads to a vision statement in which Goucher is a "model for accessible transformational education that integrates curricular and co-curricular learning to deliver graduates who can solve complex problems together with people who are not like themselves." Almost every element of the vision statement is reflected in the EngSci program: solving of complex real-world problems, working in diverse teams, a focus on accessibility, and integration of multiple perspectives.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

Central to Goucher's strategy plan is an emphasis on the relevance and primacy of the liberal-arts educational experience for tomorrow's careers. In the most recent strategy cascade, the goals of academics at Goucher include: "use innovative pedagogies to deepen student learning; foster independent creative thinkers through advising and mentoring; promote students' learning

through experiential opportunities in local and global communities; ensure student success through high quality services and programs.” The proposed EngSci major is an innovative and interdisciplinary program that aims to be highly relevant for students, is committed to their success, and includes pedagogies that lead to independence, creativity, and initiative. The EngSci program also aligns with the interests of a large group of college-bound students, including many who already apply to Goucher; we expect to enroll students who have high affinity for Goucher’s environment and would strongly benefit from the EngSci program’s accessible structure.

The faculty and administration have strongly supported the creation of program; it was approved by the faculty standing committee on Curriculum, and then by a vote of the full faculty on March 13, with the endorsement of academic leadership.

3. Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L.

The proposed program is intentionally cost-effective, as it makes heavy use of courses already taught for other programs. Because Goucher’s physics major and minor are in the process of being discontinued, the physics program’s staffing and other financial resources will be transferred to the EngSci program to enable dedicated courses to be offered. (Goucher College submitted a request to suspend the physics program on August 24, 2018, and that request was approved by MHEC on October 31, 2018. Students who matriculated in fall 2018 are the last group who will be able to declare a major or a minor in physics.) The existing physics faculty will receive support for professional development and training in the proposed program, and no new faculty are required.

By transferring existing resources to the proposed program, Goucher will be able to adequately fund the proposed program for the first five years of its implementation and beyond.

4. Provide a description of the institution’s commitment to ongoing administrative, financial, and technical support of the proposed program; and to continuation of the program for a period of time sufficient to allow enrolled students to complete the program.

The proposed program will be offered in place of the existing physics major. General education and service courses offered in physics will continue under the proposed program, but fewer program-specific courses will be offered. Hence the staffing needed for the proposed program is in fact less than that of the former physics program, making it possible to support the program adequately on currently available resources.

Goucher is strongly committed to continuing the proposed program for a period of time sufficient to allow enrolled students to complete the program. Due to the demonstrated need and demand for such a program (explained in the next section), Goucher College believes the EngSci major will attract numerous students via the market demand and the interdisciplinarity of the program, and thus, be more successful than the former physics major. In addition, the college is committed to any needed retraining of current faculty to plan for the long-term continuation and success of the proposed program. Goucher’s commitment to students is further demonstrated by fulfilling its commitment to the students majoring or minoring in programs that are currently being discontinued. All of the students in discontinued programs will be able to complete their intended major or minor in these programs while remaining at, and graduating from, Goucher.

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

1. Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:

- a) **The need for the advancement and evolution of knowledge**
- b) **Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education**

The growing prominence of STEM (science, technology, engineering, mathematics) career fields, and the parallel growth of STEM enrollment at the college level, have been massive in the last decade, as documented by IPEDS data,¹ and are poised to continue. Technological innovation at large and small scales drives many sectors of the economy—biotech, transportation, energy, medicine, communication, and information, to name a few—and is necessary to address critical world problems such as energy sufficiency, disease, and security. Demand for STEM graduates remains strong: in 2017, federal data showed 24% growth in STEM employment over the previous decade, with a further 9% growth predicted from 2014 to 2024.² Interest in STEM careers appears likewise to be growing still further among college applicants, with nearly half of high school seniors taking the ACT expressing interest in STEM or health science majors in 2017, with 23% planning to major in science or engineering.³ Nationwide, applicants to engineering programs still outpace the number of admitted and enrolled students. At Goucher, engineering is our third most popular inquiry area (just under 9%, after Biology and Business) even though we have never had an engineering major—which indicates the level of interest among students in joining STEM careers.

Goucher's location is particularly beneficial to Maryland and the Washington-Baltimore metro area in particular, which has a thriving STEM economy in both the government and private sectors. According to the US Bureau of Labor Statistics, the DC/MD/VA metro area has the highest proportion of STEM jobs in the country (8% in 2017). Our program's graduates will be prepared for entry-level jobs working with scientists and engineers in laboratories, private research firms, government agencies, and small businesses. Since our students also tend to remain in the local area after graduation, our graduates will directly contribute to a key driver of the local economy—in addition to the larger benefits of technological innovation for the nation and the world.

The EngSci program is particularly focused on providing access to a STEM education and career prospects for underserved populations or those with disadvantaged educational background. As explained above, the use of a reimagined course pathway, a cohort teaching model, and embedded co-curricular support and are designed to allow a wide range of students to succeed in the major—and to benefit from the high-demand and well-paying careers to which it can lead. This is in stark contrast to traditional and intensely-paced science or engineering majors, in which strong preparation in high school is truly a pre-requisite for success, and in which underprepared students tend to drop out quickly.

¹ National Center for Education Statistics, Digest of Educational Statistics (https://nces.ed.gov/programs/digest/d17/tables/dt17_322.10.asp?current=yes). Engineering degrees awarded increased by 47% between 2010 and 2016, health professions by 77%, physical and biological sciences by 30%, and computer science by 63%. Over the same period, degrees in humanities and social sciences declined by 7% to 20%, and those in business, communication, and psychology increased by 10-20%.

² U.S. Dept of Commerce (Economics and Statistics Administration), "STEM Jobs: 2017 Update," <http://www.esa.doc.gov/sites/default/files/stem-jobs-2017-update.pdf>

³ ACT, Inc. (2017), "STEM Education in the US, 2017", <https://www.act.org/content/dam/act/unsecured/documents/STEM/2017/STEM-Education-in-the-US-2017.pdf>

2. Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education.

The Maryland State Plan for Postsecondary Education, in its preamble, points to the strength of employment in the sciences and technology in Maryland, including a high proportion of tech startups and a high ratio of female workers in the sciences. The EngSci program's outcomes will align intentionally with this regional strength and continued driver of employment, and prepare students for meaningful jobs in any of those sectors.

The state plan also discusses trying to ameliorate student debt; the career orientation of this program is ideal for minimizing debt, as students will be given the skills and the career mentoring needed to compete successfully for entry-level STEM jobs—typically well-paid in comparison to average salaries for bachelor's recipients.

Many of the goals of the plan are concerned with students who might struggle in higher education. Strategy 1 points to the need for remediation among many Maryland high school graduates, and to variable levels of college readiness; our program is designed to enable success for students who would not normally be considered “college ready” for an engineering major. Strategy 6 seeks to facilitate prompt degree completion; our cohort model is intended to boost retention and to smooth the pathway to four-year completion for all students. Strategy 7 focuses on helping students become career-ready by integration of career advising and planning. In addition to Goucher's Career Education Office, which is being integrated more formally into the educational experience for all students, we intend to develop a detailed career mentoring plan that will support senior students in developing marketable resumes, career prospects, and—if necessary—graduate education. The career focus of our program will be very helpful in allowing graduates to market themselves using skills that employers seek. Goucher's science programs already have a strong track record in placing students into internships or research experiences, which are a primary builder of marketability. On that same point, Strategy 8—partnerships between colleges and businesses, in this case around curricular choices and co-curricular opportunities for students—would be a natural fit for this program, and we intend to seek such partnerships.

Strategies 9 and 11 deal with faculty and pedagogical development, and with innovation and risk-taking generally. The EngSci program represents a new approach to science education and career preparation, one that is not represented elsewhere in Maryland. We believe it is clear that EngSci is a highly innovative program, including some untried and experimental strategies, which will certainly go hand in hand with faculty development as we retrain to teach with a different emphasis and with a design approach.

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

1. Describe potential industry or industries, employment opportunities, and expected level of entry (*ex: mid-level management*) for graduates of the proposed program.

Graduates of the Engineering Science major will be prepared for entry-level positions across the engineering, scientific, and technology sectors, as well as for the pursuit of master's degrees in engineering. In the Maryland Dept. of Labor statistics, these entry-level positions are often labeled “Technician”. A search on glassdoor.com in Baltimore alone yielded over 500 jobs using the keywords “engineering technician”, 183 using “research technician”, and 263 using “lab technician.” Employers listed include large universities and academic labs (the University of Maryland Medical School, Johns Hopkins Hospital and medical school, the Space Telescope Science Institute, Johns Hopkins Applied Physics Laboratory, Kennedy Krieger Institute), small private companies and startups, large technology companies (Northrop Grumman, General

Dynamics, Lockheed Martin), consulting firms (Booz Allen Hamilton, Accenture), government labs (NIH, NIST, NSA) and the military (army and navy).

For graduates that continue to graduate study in engineering and become engineers, the field is even broader, with 2700 job openings for “electrical engineer” in Baltimore alone. It is common for entry-level technicians who become valued employees to continue advancing in their careers through training while remaining at a single employer.

2. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.

The Bureau of Labor Statistics lists “Architecture, Engineering, and Related Services” as one of the industries with the fastest growing projected output during 2016-2026,⁴ and notes that “Most of the projected job growth in this group is in the engineer occupations, as their services will be in demand in various areas such as rebuilding of infrastructure, renewable energy, oil and gas extraction, and robotics.”⁵ In the next 10-year period, according to BLS projections, there will be 126,000 annual openings for engineers of all types, but also 40,000 annual openings for engineering technicians, and 46,000 openings for “life, physical, and social science technicians.”⁶ Likewise, the BLS lists “Management, scientific, and technical consulting services” as among the industries with the fastest growing wage and salary employment,⁷ showing a projected increase in this category of 319,000 jobs in the next ten years.

Pay scales are higher than the national average across all categories, and particularly so in engineering itself. This table is restricted to **entry-level** salaries only:

<i>Job Title</i>	<i>Entry-level salary with Bachelor’s degree</i>
Engineering technician	\$36K-\$63K, average \$53K (payscale.com) \$30K-\$88K, average \$58K (glassdoor.com)
Research technician	\$24K-\$40K, average \$32K (glassdoor.com)
Engineer	\$30K-\$140K, average \$98K (glassdoor.com)

The following table shows salary data for 2014 graduates in physical science holding bachelor’s degrees who entered the workforce:

STEM professions, private sector	\$42K-\$64K, average not given (American Institute of Physics Statistical Research Center) ⁸
STEM employment in civilian government and national laboratories	\$35K-\$55K, average not given (American Institute of Physics Statistical Research Center)

⁴ <https://www.bls.gov/emp/tables/industries-fast-grow-decline-output.htm>

⁵ <https://www.bls.gov/ooh/architecture-and-engineering/home.htm>

⁶ <https://www.bls.gov/emp/tables/emp-by-detailed-occupation.htm>

⁷ <https://www.bls.gov/emp/tables/industries-fast-grow-decline-employment.htm>

⁸ American Institute of Physics, <https://www.aip.org/sites/default/files/statistics/employment/bachinitemp-p-14.1.pdf>

3. Provide data showing the current and projected supply of prospective graduates.

As described earlier, prospective college students have demonstrated high interest in STEM majors in general and engineering majors in particular.⁹ At Goucher, engineering as a career interest accounts for 9% of our initial student enquiries, and this program will appeal strongly to the career focus of students and parents. We anticipate enrolling an initial cohort of 10-15 students, but given applicant numbers we project growth to 20-25 graduates per year within two or three years.

D. Reasonableness of Program Duplication:

1. Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.

There are only a few programs nationally that are at all comparable to our proposal, in that they include broad STEM-career preparation in a choice of scientific disciplines. Research universities generally offer a variety of traditional science majors as well as undergraduate degrees in engineering—rigorous programs designed in part to enable students to pass professional licensing exams upon graduation—and, in some cases, Applied Physics as well. Small colleges can rarely support a true engineering program, and commonly advertise a 3+2 dual-degree program (sometimes called “pre-engineering”), in which traditional science majors transfer to a large university’s engineering program after three years.

As a response to demand, a few liberal-arts colleges now offer 4-year majors in “Engineering Physics,” “Engineering Studies,” or “Pre-Engineering,” which are intended to prepare students for further study in engineering science (or 3+2 transfer) rather than qualify them as professional engineers. These typically are physics majors that have been broadened with engineering-specific courses. In a few cases they are more distinct from the traditional physics curriculum.

Within Maryland, there are traditional engineering majors at Johns Hopkins, the University of Maryland—College Park, Loyola University, and Morgan State University. Washington College and Towson University offer standard physics majors with 3+2 engineering dual-degree options. St. Mary’s College of Maryland offers an Applied Physics concentration within the physics major; it adds several courses that would be helpful for engineering graduate programs, but is still primarily a physics degree. Salisbury University offers an Engineering Physics major track taught by the physics department but incorporating a separate course list (an engineering core plus 7 elective options and research experiences). Their program is not interdisciplinary, but resembles a streamlined version of a true engineering degree. Loyola also offers a number of applied science tracks based on the physics major; students may specialize in several engineering subdisciplines, math, or medical physics.

We see our proposal’s interdisciplinary approach and design focus as very distinctive, not only in Maryland, but in the small-college landscape as a whole. It is uncommon for schools to explicitly prepare students for entry-level science and technology careers generally. As we see above, the more common phenomenon is a physics degree with an engineering specialization. Likewise, our program’s design-based approach combined with scaffolded and supported learning for a diverse population of students is unlike any traditional science degree program, whether in Maryland or elsewhere.

⁹ ACT, Inc. (2017), “STEM Education in the US, 2017”, <https://www.act.org/content/dam/act/unsecured/documents/STEM/2017/STEM-Education-in-the-US-2017.pdf>

2. Provide justification for the proposed program.

As described above, the proposed program serves both highly prepared students as well as a population that has not historically had access to traditional science and engineering programs. By taking an innovative and streamlined approach to organizing the content of the program, we can build skills that are common to a range of technological career paths while also supporting students with a variety of backgrounds. We believe this program will provide a new opportunity for Maryland students and for the region's economy.

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

1. Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBI's.

There is no comparable program at an HBI in Maryland. The engineering majors offered at Morgan State University are traditional, narrowly focused programs leading directly to qualification as a professional engineer. As such, the students who will enroll and succeed in those programs will have different backgrounds and career goals than those who choose the Engineering Science major.

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

1. Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.

We do not see any potential impact on the institutional identity of HBIs in Maryland.

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

1. Describe how the proposed program was established, and also describe the faculty who will oversee the program.

The proposed program was designed in a collaborative effort by faculty in Goucher's natural science departments (biology, chemistry, environmental science, and the now-discontinued physics program), with the former physics faculty taking a lead role. The curriculum was chosen after examining career outcomes for Goucher science alumni as well as recommendations from national scholarly associations such as the American Physical Society.¹⁰ Program oversight will be the purview of the core program faculty, under the supervision of the director of the Center for Natural Sciences. The program faculty members are listed individually in Section I below.

2. Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.

The proposed Engineering Science major will incorporate a broad base of subject content and the opportunity to specialize, but will be fundamentally oriented around underlying skills—problem-solving, quantitative analysis, programming, designing experiments, building equipment—that are widely transferable into a range of careers. An overall framework is the concept of “engineering design”—the ability to identify and build practical and usable solutions to particular technological needs. The proposed major's educational objectives are for students to develop:

- Facility in finding technological solutions to design problems
- Problem-solving ability, using methods from an appropriate scientific discipline

¹⁰ “Phys21: Preparing Physics Students for 21st Century Careers,” a report by the Joint Task Force on Undergraduate Physics Programs, APS/AAPT. <https://www.aps.org/programs/education/undergrad/jtupp.cfm>

- Knowledge of quantitative analysis tools, both analytical and numerical, including the use of software modeling and data manipulation
- Foundational skills in computer programming and an understanding of common characteristics of computer languages
- Laboratory skills, including an understanding of core protocols or methods for their chosen specialization
- Communication skills in a scientific/technical context
- Ability to work in teams to reach goals

These specific skills and capabilities are complementary to many goals of the Goucher Commons curriculum (i.e. Goucher College general education curriculum), all of which are relevant for STEM professionals: foundational skills in fluent writing and critical thinking, awareness of environmental and global issues and challenges, understanding of the societal context and impacts of science/technology, and ability to navigate diverse perspectives and cultural communities. All of these attributes are highly sought by employers—alongside or even in preference to technical knowhow—and are a necessary part of the skill set for technical workers today.

The Engineering Science program faculty have adopted these learning outcomes for students in the major. By graduation, an Engineering Science major will have acquired:

1. **Core Systems Mastery.** In each of the three tracks, chemical, environmental and physical systems, students will demonstrate mastery of core principles, including qualitative understanding, interconnections, and limitations.
2. **Problem Solving Proficiency.** Students will demonstrate the appropriate use of a variety of quantitative (e.g. mathematical, analytic) methods to solve complex problems in real-world contexts, model systems, and understand new or unfamiliar situations; and assess the reasonableness of the result.
3. **Instrumentation/Laboratory Competency.** Students will demonstrate the appropriate design, execution, and analysis of laboratory experiment, including familiarity with instrumentation, data collection, and statistical analysis techniques
4. **Design Creativity.** Students will acquire design and/or fabrication skills appropriate to the field, such as building electronic circuits, novel uses of standard equipment, coding, or numerical analysis, to solve problems or complete tasks when ready-made resources are unavailable.
5. **Independence.** Students will develop self-motivated study and research skills (in the context of the classroom and/or in independent projects).
6. **Communication Skills.** Students will demonstrate effective communication skills, both written and oral, including the ability to communicate to audiences of different cultures and scientific backgrounds and teach a complex idea or method to others.
7. **Team Work.** Students will demonstrate ability to work collegially and collaboratively in diverse and interdisciplinary teams

The learning outcomes for the proposed program also align with the recommendations of a national task force commissioned by the American Physical Society and American Association of Physics Teachers, “Phys21: Preparing Physics Students for 21st Century Careers,”¹¹ which gathered rich data from physical science undergraduate programs, alumni, and employers in order to identify the most important skills and knowledge degree-holders should possess for diverse careers.

¹¹ (2016). A report by the Joint Task Force on Undergraduate Physics Programs, APS/AAPT. <https://www.aps.org/programs/education/undergrad/jtupp.cfm>

3. Explain how the institution will provide for assessment of student achievement of learning outcomes in the program, and document student achievement of learning outcomes in the program

The program will be included in the Goucher College annual assessment process, the Goucher College program review process, and the annual course evaluation process. Goucher College has a comprehensive and sustained process for assessing student learning outcomes in all courses and programs that is overseen by the Institutional Assessment Team, and framed by the College Assessment Plan. All assessment at Goucher College is completed on a regular annual cycle, at both course and program levels, and considers both college-wide and program outcomes for students.

4,5. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements. Discuss how general education requirements will be met, if applicable.

The proposed major and other courses required for graduation totals 120 credits:

Engineering Science major requirements	44 credits
Goucher Commons (General Ed) Requirements	53 credits
Elective Credits	23 credits
TOTAL CREDITS	120

Every Goucher student must take at least 53 credits of general education courses, known as the Goucher Commons Curriculum. The Goucher Commons Requirements, or GCRs, were recently revised, with revisions approved by vote of the full faculty on 4/3/2019. A summary of these requirements can be found online at

<https://www.goucher.edu/learn/curriculum/>

In current form, the GCRs are as follows:

<i>Goucher Commons Requirements</i>	<i>Credits</i>
First-year Seminar (one course)	4
Data Analytics courses (two courses)*	8
Race Power and Perspective Course (one course, other)	4
Environmental Sustainability Course (one course)	4
Foreign Language courses (variable, upon placement)	8
Writing Requirement courses (three courses)**	12
Complex Problem Exploration courses (two courses)***	8
Study Abroad requirement (one course minimum)	3
<u>Capstone course (one course) 2-4</u>	
Total	53

*to satisfy the Mathematics requirement of 13B.02.02.16E(2)(a)

**to satisfy the English Composition requirement of 13B.02.02.16E(2)(a)

In addition, students must fulfill a disciplinary breadth requirement by taking at least 3 credits in each of the following 4 areas as designated by the Registrar: Arts, Humanities (with Interdisciplinary Studies), Social and Behavioral Sciences, and Biological and Physical Sciences. These disciplinary requirements can be fulfilled by a course in a major or a minor as well as by Complex Problem Exploration courses and/or additional designated courses throughout the curriculum. All students therefore satisfy the remaining three area requirements of COMAR 13B.02.02.16E(2)(a)).

***Goucher's Complex Problem Exploration (CPE) courses are a signature program that emphasizes the interdisciplinary character of learning and the application of the liberal arts to real-world problems. These courses are interdisciplinary, center around a contemporary issue, and require students to work in sustained collaborations in a student-directed research or creative project. The courses are classified with an area designation, corresponding to the four disciplinary areas of the college, as described in the table below. Thus, CPE courses are typically also used to fulfill two of the disciplinary breadth areas.

Area Designation	Area	Academic Centers typically offering these courses
CPEA	Arts	Center for Art and Media Center for Dance, Music, and Theatre
CPEB	Social and Behavioral Sciences	Center for Education, Business Professional Studies Center for People, Politics, and Markets Center for Psychology
CPEC	Humanities with Interdisciplinary Studies	Center for Geographies of Justice and Cultures Center for Humanities
CPED	Biological and Physical Sciences	Center for Natural Science Center for Psychology

Engineering Science majors will satisfy both stages of the Data Analytics requirement (Foundation and Across the Curriculum), and the Biological/Physical Sciences area requirement within the major, thus satisfying MHEC requirements in Mathematics and Biological and Physical Sciences. Engineering Science majors will also take two Complex Problem Exploration courses in different areas (chosen from CPEA [Arts], CPEB [Social Sciences] or CPEC [Humanities]), thereby satisfying the additional MHEC area requirements in Arts and Humanities and Social and Behavioral Sciences. Finally, like all Goucher students, Engineering Science majors will complete a series of three writing courses that will satisfy the MHEC area requirement in English Composition. To satisfy Goucher's graduation requirements, a student must earn at least 120 credits. The Engineering Science major is 44 credits, and the total Goucher Commons curriculum is at least 53 credits, which leaves at least 23 elective credits.

Engineering Science Major Requirements: The proposed Engineering Science major consists of eight four-credit foundation & core courses followed by three four-credit courses specific to each of the three tracks: Environmental Systems, Chemical Systems and Physical Systems. The major's required core courses are chosen to provide foundational competency in physical and chemical problem-solving and mathematical analysis, but also to develop facility in design thinking, computation and programming, lab and experiment skills, and teamwork. The specialized track courses are chosen from the existing curriculum and comprise further coursework and deeper knowledge in mechanical/electrical, chemical, or environmental systems. The program requirements below include the course title, the course prefix and number for an existing course or the course level (followed by XX) for a new course, followed by the number of credits and a general education requirement designation, if applicable. The Goucher general education curriculum, known as the Goucher Commons Requirements or GCRs, includes required proficiencies and exploration courses, some of which can be fulfilled within majors. In this case, courses within the EngSci major will fulfill GCRs in Data Analytics (both foundational level, DA-F, and across the curriculum, DA-AC), and the GCR in Environmental Sustainability (ES). In addition, all Goucher students must take courses from within the four curricular areas of Arts, Humanities/Interdisciplinary, Behavioral & Social Sciences, and Biological & Physical Sciences, and several courses in the major satisfy the Biological & Physical Sciences (BPS) breadth requirement. Course descriptions follow these program requirements.

<i>Foundation & Major Core Courses</i>	<i>Credits</i>	<i>GCR</i>
MA 172: Calculus I	4	DA-F
CS 116: Intro Computer Science	4	
CHE 111: General Chemistry I with lab	4	BPS
PHY 125: General Physics I (revised with calculus topics)	4	BPS
PHY 126: General Physics II (revised with calculus topics)	4	BPS
PHY 3XX: Classical & Quantum Waves (new course)	4	
MA 416: Scientific Computation	4	
<u>PHY 497: Capstone: Design project</u>	<u>4</u>	
Total	32	
 <i>Environmental Systems track</i>		
ES 100: Introduction to Environmental Science	4	ES
One 200-level course from the following list:		
ES 200: Environmental Geology		
ES 206: Agriculture and the Environment		
ES 238: Ecology	4	
<u>ES 311: Environmental Analysis and Statistics</u>	<u>4</u>	DA-AC
Total	12	
 <i>Chemical Systems track</i>		
CHE 151: General Chemistry II	4	BPS, DA-F
CHE 230: Organic Chemistry I	4	
One course from the following list:	4	
CHE 340: Biophysical Chemistry with Lab		
CHE 355: Modern Methods of Chemical Analysis w/Lab		DA-AC
CHE 370: Environmental and Green Chemistry w/Lab		ES
CHE 372: Inorganic Chemistry		
<u>CHE 465: Quantum Chemistry & Spectroscopy w/Lab</u>	<u>4</u>	
Total	12	

Physical Systems track

PHY 2XX: Analytical Mechanics/Statics (new course)	4	
PHY310: Electronics	4	DA-AC
<u>PHY 3XX: Advanced Laboratory (new course)</u>	<u>4</u>	
Total	12	

Thus, the Engineering Science major requires 32 + 12 = 44 credits.

All students in the major will automatically fulfill the GCR requirement in Data Analytics (both foundational and across-the-curriculum) and the breadth requirement in biological and physical sciences. Furthermore, the major requires at least 12 credits at the junior (300-level) or senior (400-level) levels, satisfying COMAR 13B.02.02.16I(2).

Course Descriptions:

MA 172-Calculus Through Data and Modeling, 4 credits: This course provides an introduction to topics in single and multivariable calculus, and focuses on using calculus to address questions in the natural and social sciences. Students will learn to use the tools of calculus to process, analyze, and interpret data, and to communicate meaningful results, using scientific computing and mathematical modeling. Topics include functions as models of data, differential and integral calculus of functions of one and several variables, differential equations, and estimation techniques.

MA 416-Scientific Computation, 4 credits: Mathematical modeling is the process of transforming a problem into a mathematical framework in order to analyze and solve it. Modeling is essential to understand patterns, make predictions, and determine outcomes in applications as varied as disease outbreak, the interaction of species in ecosystems, the spread of an oil spill, the pricing scheme of a product, or the transportation of a drug through the bloodstream. This project-based class will use datasets and computer software such as Excel and MATLAB to model and solve problems using differential equations, graphs, dimensional analysis, parameter estimation, and sensitivity analysis.

CS 116-Introduction to Computer Science, 4 credits: Introduction to the discipline of computer science and algorithmic thinking through the study of a programming language. Students will master writing small computer programs to solve computational problems. Object oriented programming is introduced.

PHY 125-General Physics I, 4 credits: A calculus-based course where lecture and laboratory are combined and taught using an interactive teaching method employing computers and guided inquiry through hands-on experiments. The method is designed to increase problem-solving and analytical-thinking skills and to guide students toward a coherent and logical approach to understanding the world. Topics include kinematics and dynamics of linear and angular motions, universal gravitation, conservation of energy and momentum, simple harmonic motion, wave motion, and fluids. Six hours per week, integrated lecture/laboratory. Pre-requisite: MA 172.

PHY 126- General Physics II, 4 credits: A continuation of PHY 125, including integral calculus. Topics include thermal physics, electricity and magnetism, and physical and geometrical optics. Six hours per week integrated lecture/laboratory. Pre-requisite PHY125

PHY 2XX: Analytical Mechanics/Statics, 4 credits: This course will cover Newtonian Mechanics (including position and velocity dependent forces, and systems with variable mass), Lagrangian

Mechanics, oscillation, statics and dynamics of a rigid object. Mathematical topics covered will include ordinary and partial differential equations.

PHY 310-Electronics/Instrumentation, 4 credits: A project-based introduction to principles of electronic instrumentation and microprocessors that trains students to identify appropriate methods and techniques for physical measurements or experimental control. Students learn to automate processes using the Arduino platform. Topics include: DC and AC circuits, diodes, transistors, operational amplifiers, digital logic and sensing, using specialized chips, and data acquisition. The course also includes an introduction to related mathematical topics in Fourier analysis and complex variables. Four hours integrated lecture/laboratory. Prerequisites: PHY 126.

PHY 3XX: Classical & Quantum Waves, 4 credits: Classical waves and the wave equation, Fourier series and integrals, normal modes, wave-particle duality, the uncertainty principle, basic principles of quantum mechanics, energy levels, reflection and transmission coefficients, applications to atomic physics.

PHY 3XX: Advanced Laboratory, 4 credits: In this course, students will work in groups to plan, carry out, and analyze a series of sophisticated experimental measurements or demonstrations of an engineering principle. Each experiment or demonstration will include formulation of a clear and testable question, appropriate modeling and/or theoretical analysis, and communication or presentation of results. The course will focus on developing real-world problem-solving skills and instrumentation/analysis choices and relating them to fundamental theoretical principles. Prerequisite: Analytical Mechanics.

CHE 111: Principles of Chemistry I with Lab, 4 credits: Introduction to chemistry including atomic structure, molecular structure, bonding, chemical reactions, and states of matter. Taught in studio format with integrated classroom and lab. Fall semester, repeated spring semester.

CHE 151: Principles of Chemistry II with Lab, 4 credits: Second Semester of introduction to chemistry sequence including kinetics, thermodynamics, equilibrium, acid-base chemistry, redox reactions and electrochemistry. Taught in studio format with integrated classroom and lab. Prerequisite: CHE 111

CHE 230: Organic Chemistry I, 4 credits: Chemistry of the compounds of carbon with emphasis on the relation of molecular structure to chemical and physical behavior. Topics covered include functional groups, nomenclature, structure, bonding, isomers, conformations, chirality, reactions that proceed through ionic mechanisms, structure elucidation using NMR, MS, and IR, and introduction to multistep synthesis. Specific reactions covered include acid-base, nucleophilic substitution, elimination, oxidation, reduction, and carbon-carbon bond formation reactions. Laboratory work includes appropriate techniques, synthetic and analytical methods including melting points, recrystallization, distillation, chromatography, extraction, GC/MS, and IR. Three hours classroom, three hours laboratory. Prerequisites: CHE 151

CHE 340: Biophysical Chemistry with Lab, 4 credits: Exploration of the states of matter and laws of thermodynamics applied to chemical systems, and rates of reactions. Emphasis will be placed on the physical chemistry of biological systems and the theoretical basis for various biophysical techniques. Six hours per week consisting of a mixture of lecture and classroom work. Prerequisites: MA 172, PHY 125, CHE 151.

CHE 355: Modern Methods of Chemical Analysis w/Lab, 4 credits: A survey of methods used by chemists for qualitative analysis (What is this?) or quantitative analysis (How much of this do I

have?). Covers chemical methods based on equilibrium, instrumental methods (spectroscopy, electrochemistry, and chromatography), and basic statistics. Course includes a comparison of methods with regard to type of data obtainable, sensitivity, selectivity, and cost. Three hours lecture, three hours classroom. Pre- or co-requisites: CHE 230. Prerequisite: completion of GCR Data Analytics Foundational Level.

CHE 370: Environmental and Green Chemistry w/Lab, 4 credits: Exploration of the chemistry of the environment including the atmosphere, soil, water, and energy sources. Emphasis will be placed on perturbations of natural processes as a result of human activity and on the principles of green chemistry, through which chemists could reduce their footprint on the environment. Three hours classroom, three hours lab. Prerequisites: CHE 230.

CHE 372: Inorganic Chemistry, 4 credits: Structure, bonding, and reactivity of coordination and organometallic compounds. Course has a strong emphasis on group theory and molecular orbital theory. Four hours classroom. Prerequisites: CHE 230.

CHE 465: Quantum Chemistry & Spectroscopy w/Lab, 4 credits: Introduction to quantum theory and its applications to chemistry and atomic and molecular spectroscopy. Six hours per week consisting of a mixture of classroom and laboratory work. Prerequisites: MA 172, PHY 126, and CHE 340.

ES 100: Introduction to Environmental Science, 4 credits: This course explores current environmental issues with the goal of evaluating how the integration of biological, chemical, geological, and physical principles is vital for identifying and understanding environmental problems and for shaping policies for effective solutions. The laboratory centers on the application of scientific principles and protocols to investigate both natural and urban environments. Discussions will focus on global environmental issues, including global warming, water and air quality, urbanization, biodiversity, human population growth, and food production. This course involves required field trips. Four hours lecture/laboratory.

ES 200: Environmental Geology, 4 credits: This course examines the interconnectivity of geologic processes, climate change, and life on Earth. Topics include rock formation, soils, earthquakes, volcanoes, landslides, floods, and river and groundwater pollution. Emphasis will be placed on the application of geologic principles to solve some environmental problems.

ES 206: Agriculture and the Environment, 4 credits: This course explores the application of scientific principles as they relate to plants, animals, soil and food in agriculture. The impacts of agricultural practices, such as animal breeding, genetics, aquaculture, forestry, organic farming, pest and disease control, genetically modified organisms and their effects on the environment will be discussed. Throughout the course, students will examine the complexity of agricultural systems and how to address the global need for sustainable practices.

ES 238: Ecology, 4 credits: An introduction to the diverse terrestrial, marine, and aquatic habitats of the Earth and how the organisms found in these habitats interact with their biotic and abiotic environment. Individual, population, community, and ecosystem levels of ecology will be discussed, with an emphasis on environmental sustainability and how climate change and other human induced activities may impact the ecology of organisms. Lecture, discussion, and some fieldwork.

ES 311: Environmental Analysis and Statistics, 4 credits: This course provides students with an understanding of descriptive and inferential statistics and systems thinking approaches critical for

understanding environmental issues. Specifically, this course employs case studies and projects of topical issues at the intersection of ecological questions and social institutions. These case studies and projects will permit students to apply interdisciplinary inquiry, particularly through the use of quantitative and theoretical frameworks of analysis. Emphasis is placed on cultivating the ability to understand disciplinary abstraction, to apply such knowledge to understand environmental problems, and to provide solutions to address them. The course is intended to support development of key intellectual and practical tools for future careers in environmental studies. Prerequisite: ES 100; and completion of GCR - Data Analytics Foundational Level course.

6. Identify any specialized accreditation or graduate certification requirements for this program and its students.

No specialized accreditation is required for this program.

7. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.

Not applicable.

8. Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.

Students may register and pay for courses, access their registration and financial aid information, access their faculty and key staff, seek advice and answers to academic and administrative questions, and access technology support online or in person. All course materials and information can be obtained online through the Canvas learning management system. Catalogs and college policy and requirements are all accessible online through the Goucher College website. Incoming first-year students attend a three-day orientation in which college expectations and policies are communicated, and continue with a 7-week co-curricular experience in which staff and student mentors provide guidance and further orientation to new students.

9. Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.

Faculty in this proposed program will work with the marketing and communication division of the college to ensure all advertising, recruiting, and admissions materials that have been specifically designed for this program will clearly and accurately represent the proposed program. Furthermore, faculty in the program are tasked with keeping program web pages up to date.

H. Adequacy of Articulation

1. If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.

Not applicable.

I. Adequacy of Faculty Resources.

1. Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faculty member will teach in the proposed program.

The three full-time program faculty are all accomplished teachers and scholars, who have a combined total of over 50 years' teaching experience, primarily in small colleges such as Goucher. They have a long history of innovative pedagogy and best practices in science teaching, including being an early adopter of the Workshop Physics¹² model for integrated and hands-on physics teaching. Faculty have repeatedly taken advantage of development opportunities to become familiar with the state of the art in pedagogical methods, including experience in project-based learning (PBL), Just-in-Time Teaching (JiTT), Peer Instruction, and inquiry-based learning (IBL). The introductory physics courses utilize extensive hands-on learning experiences and activities, continuing with sustained project-based learning in upper-level courses. Graduates of the physics program, as with other natural science programs at Goucher, have overwhelmingly been successful in finding employment and completing graduate degrees, with nearly 90% of known alumni having careers in STEM or related fields.

The program faculty are also active scholars and productive researchers, and each of them regularly involves undergraduate students in on-campus research. All three faculty members have been awarded research grants from the National Science Foundation, supporting accomplishments in condensed matter theory, experimental investigations of quantum transport in semiconductors, and development of novel particle acceleration methods. Research results are regularly presented at national and international conferences and published in peer-reviewed journals; in many cases, undergraduate students contributed to the work and took part in the presentation as an author or speaker. The faculty expect to use their real-world experience of scientific investigation to build the detailed curriculum for this new program.

The faculty plan to rotate courses among themselves on a regular basis, and as explained earlier will also teach service and general education courses, but the following includes planned course assignments for the initial launch of the new program. The program faculty are all full-time and tenured or tenure-track, and are listed here:

- Professor Sasha Dukan, Ph.D. in theoretical condensed-matter physics, will teach Analytical Mechanics in the new program
- Associate Professor Rodney Yoder, Ph.D. in experimental accelerator physics, will teach Electronics, the Advanced Laboratory course, and the Capstone Project in the new program
- Associate Professor Nina Markovic, Ph.D. in experimental condensed-matter physics, will teach the two-course Introductory Physics sequence and the Classical/Quantum Waves course in the new program.

2. Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in (i) pedagogy that meets the needs of students and (ii) the learning management system:

Goucher College supports ongoing pedagogy faculty development and training in evidence-based best practices through its Center for the Advancement of Scholarship and Training, as well as by funding travel to national workshops and conferences sponsored by science teaching organizations such as the American Association of Physics Teachers and the Advanced

¹² P. W. Laws (1991), *Physics Today*, vol. 44, no. 12, p. 24, and https://www.physport.org/methods/method.cfm?G=Workshop_Physics

Laboratory Physics Association. At Goucher, workshops on pedagogy that meets students’ needs and on the Canvas learning management system are offered on a regular basis.

J. Adequacy of Library Resources

1. Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program.

Goucher College is prepared to support this new program through its existing library holdings, through the Baltimore Area Library Consortium, and through other library agreements. The library has staff member to liaise with academic programs, which would include the proposed new program. Services provided to students include research instruction and assistance, online tutorials, interlibrary loan, and a digital repository for theses and capstone projects. The library holds thousands of print volumes in applied sciences and provides subscription access to hundreds of relevant journals.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment

1. Provide an assurance that physical facilities, infrastructure and instructional equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences.

The proposed program will use existing space that was designed for the discontinued physics program and physics service courses. The space consists of offices and lab space for up to four faculty, and four combination lecture/lab classrooms. Each classroom is already outfitted with laboratory stations, including computer data acquisition systems that enable a wide range of experiments and activities. The program will also take ownership of a large collection of physics teaching and lab equipment, from introductory to advanced level, and will continue to develop the collection over time.

2. Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to an institutional electronic mailing system, and a learning management system that provides the necessary technological support for distance education.

Does not apply, as this program will only be offered in an on-campus format.

L. Adequacy of Financial Resources with Documentation

TABLE 1: RESOURCES					
Resource Categories	2020-21	2021-22	2022-23	2023-24	2024-25
1. Existing Funds	4,288	4,288	4,288	4,288	4,288

2. Tuition/Fee Revenue (c+g below)	664,500	1,506,200	2,392,200	3,278,200	3,278,200
a) # F/T Students	15	34	54	74	74
b) Annual Tuition/ Fee Rate	44,300	44,300	44,300	44,300	44,300
c) Total F/T Revenue (a x b)	664,500	1,506,200	2,392,200	3,278,200	3,278,200
d) # P/T Students	0	0	0	0	0
e) Credit Hr. Rate	1,448	1,448	1,448	1,448	1,448
f) Annual Credit Hr.	0	0	0	0	0
g) Total P/T Revenue (d x e x f)	0	0	0	0	0
3. Grants, contacts, & other external sources	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (add 1-4)	668,788	1,510,488	2,396,488	3,282,488	3,282,488

Narrative Explanation for Table 1. Program implementation will begin in Fall 2020, with projections for the first five years of program operation.

a. Existing (Reallocated) Funds. The existing physics program includes three tenure-line faculty members, one visiting faculty member, and one support staff person, as well as an operating budget for equipment and supplies. While the physics program is being discontinued (and the visiting faculty position will not continue), some service and general education courses

in physics will still be offered to support other programs, making up part of the future teaching load for the three tenure-line faculty. The remaining portion of the current salary budget for these three faculty members and support staff person will be reallocated to the proposed new program. The new program will also be allocated the majority of the operating budget (for supplies and equipment) that previously supported the physics program.

Line 1 of the table includes the non-salary operating budget designated for the proposed program, a portion of the salaries and benefits paid to faculty who will teach courses specific to the new program, and a portion of the salary and benefits paid to the support staff person. Since the three program faculty members also teach general education courses for the college and service courses in physics for other majors, only part of their time is allocated to the new program. An example of a specific breakdown of faculty load for one year is detailed here:

Faculty member	Course load	Percentage taught in proposed program
Dukan	Service courses: PHY542 [9 cr], PHY543 [9 cr] (post-baccalaureate) Program courses: Analytical mechanics [4 cr]	2/20 = 10%, plus 2 credits overload
Markovic	General education courses: CPED science course [4 cr] Program courses: PHY125 [6 cr], 126 [6 cr], Advanced Lab [4 cr]	16/20 = 80%
Yoder	Service courses: PHY115 [6 cr], 116 [6 cr] (biology and pre-med) Program courses: Electronics [4 cr], Capstone [4 cr]	8/20 = 40%

2. Tuition and Fee Revenue. This category only shows revenue for students in the proposed program. The number of full-time students in the proposed program was modeled using typical engineering interest in first-year enrollment in recent years. We anticipate that only full-time students will participate in the program.

3. Grants and Contracts. We assume no external funding sources.

4. Other Sources. No other sources.

5. Total of rows 1, 2, 3, and 4.

TABLE 2: EXPENDITURES

Expenditure Categories	2020-21	2021-22	2022-23	2023-24	2024-25
1. Faculty (b+c below)	25,740.94	61,446.12	98,042.71	100,488.01	118,786.31
a) Number of FTE	0.3	0.8	1.2	1.2	1.4
b) Total Salary	22,521.60	56,762.40	88,783.20	90,925.20	106,935.60
c) Total Benefits	3,219.34	7,683.72	12,259.51	12,562.81	14,850.71
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)	4,838.75	10,080.72	10,080.72	10,080.72	10,080.72
a) Number of FTE	0.12	0.25	0.25	0.25	0.25
b) Total Salary	4,289.88	8,937.24	8,937.24	8,937.24	8,937.24

c) Total Benefits	548.87	1,143.48	1,143.48	1,143.48	1,143.48
4. Technical support and equipment	4,288	4,288	4,288	4,288	4,288
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	2000	2000	2000	2000	2000
TOTAL (add 1-7)	36,867.69	77,814.84	114,411.43	116,856.73	135,155.03

Narrative Explanation for Table 2: Expenditures

1. **Faculty (number of full-time employees with salary and benefits):** As the first students will begin the proposed new program as incoming freshmen in Fall 2020, only a few courses are needed during the first years of the program. The increase in FTE from 2020 to 2022 reflects the addition of upper-level courses as the first cohort of students continues through the program. As in Table 1, only the courses specifically taught for the proposed program are included here, and service and general education courses are excluded.
2. **Administrative Staff.** The proposed program has no dedicated administrative staff.
3. **Support Staff.** A portion, roughly 25%, of the effort from the existing support staff member in physics will be reallocated to support the new program. The remainder of the staff member's time will be in support of service courses.
4. **Equipment.** The proposed program is projected to incur equipment support costs comparable to the discontinued physics program, with a comparable budget. These funds will be reallocated from the existing physics operating budget.
5. **Library.** The proposed program does not have library costs.
6. **New and/or Renovated Space.** The proposed program will use the space currently occupied by the existing physics major program, which is being discontinued.
7. **Other Expenses.** We anticipate that one or more student employees will serve as a dedicated tutor for the incoming cohort of students in the program each year. This student would be employed at the standard hourly rate through the Quantitative Resource Center on campus.

M. Adequacy of Provisions for Evaluation of Program

Goucher College has a systematic and sustainable system to assess teaching and learning at all levels and within all units of the institution, in compliance with the Middle States Commission on Higher Education's standards for assessment as well as best practice in assessing student learning outcomes. Learning outcomes will be assessed in this program using evidence-based rubrics applied to examinations, individual and group projects, portfolios, and papers. Student learning outcomes will be assessed in relationship to the quality of the work, and will be supported directly through core and elective curricula. Assessment results will be used to improve and, if necessary, redesign assignments, projects, and courses on a multi-year cycle.

Faculty and courses are evaluated every semester by students, using the college-wide course reflection process. The program coordinator will track the program's courses and outcomes and provide feedback to faculty. The program overall will be evaluated on an ongoing basis by the program's advisory committee and periodically by outside evaluators. Data collected through assessment and evaluations processes on an annual basis are used to identify opportunities for program improvements and areas where additional resources are needed. The college's Office of Institutional Research tracks retention and satisfaction data across the institution and will provide data to the college about the sustainability and cost-effectiveness of the program.

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

Goucher College has a strong commitment to promoting diversity in our recruitment, admission and retention efforts of students, as well as in faculty hiring. The college has successfully recruited minority students via the Video Application (which seeks to eliminate many of the barriers certain minorities face in applying) and specific outreach to local institutions. These efforts have been successful, with 28% of students identifying as non-white in 2014 versus 39% in 2019. Among students who identify as African-American, there were 145 applicants in 2014 (10%) and 227 in 2018 (17%). Hispanic and Latino students were 123 in 2014 (9%) and 150 in 2018 (11%). Among students in the class of 2022 who disclosed their race, 42% self-identified as students of color.

In addition, the proposed program is specifically designed to be accessible to underprepared students who would face barriers to success in a traditional science or engineering major. The student pathway through the program has been completely reimagined, and the program incorporates scaffolded support in quantitative skills and problem-solving during the first several semesters of introductory courses. Insofar as disparities in opportunities and outcomes for under-represented minorities are strongly linked to disadvantages in college preparation, our approach in this program will positively impact the success of minority students. The cohort model we envision, in which each year's entering class forms a learning community and takes many courses together, has been shown to increase resilience, belonging, and success among under-represented minority STEM students in particular.

The college has made efforts in educating its faculty around racial issues through a variety of workshops and seminars. In the Fall of 2015 we held a "What is Race" seven week seminar series organized and led by Faculty in response to the Baltimore Uprising. Continuing training and discussion in racial awareness and equity in teaching has been a feature of our yearly faculty development days. Recently, STEM Faculty also hold regular gatherings focused on Diversity, Equity and Inclusion in our classrooms.

The school has also established a Center for Race, Equity and Identity (CREI). This center supports all marginalized students and has established and ongoing programming for students of color, first-generation, socioeconomically disadvantaged, international and disabled students.

O. Relationship to Low Productivity Programs Identified by the Commission:

Not applicable.

P. Adequacy of Distance Education Programs

Not applicable.