PCC Proposal to Establish a Bachelor of Science in Biocomputational Engineering (PCC 19030)

PRESENTED BY	Janna Bianchini, Chair, Senate Programs, Curricula, and Courses Committee
REVIEW DATES	SEC – January 27, 2020	SENATE – February 5, 2020
VOTING METHOD	In a single vote
RELEVANT POLICY/DOCUMENT	NA
NECESSARY APPROVALS	Senate, President, University System of Maryland Board of Regents, and Maryland Higher Education Commission

ISSUE

The Fischell Department of Bioengineering within the A. James Clark School of Engineering proposes to establish a Bachelor of Science in Biocomputational Engineering. Biocomputational engineering brings together the field of bioengineering, a discipline grounded in fundamentals of physics, chemistry, and biology, with computation and data science, which enhances the value of all fields. The objective of the biocomputational engineering program is to provide a breadth of fundamentals in biology and quantitative problem solving while developing skills in computation and data science. These skills can be applied to the modeling of complex biological systems and the analysis of complex biological data sets, leading to the creation of new knowledge from the molecular to the organ to the system levels, and to the development of innovative processes for disease prevention, diagnosis, and treatment. This synthesis of bioengineering, computation, and data science will give graduates unique capabilities to solve existing and emerging challenges of the modern medical world.

This program will be offered at the Universities of Shady Grove and is mainly intended for students who have completed an associate's degree from a Maryland public community college. The program will be supported through a targeted enhancement-funding request to the State of Maryland, and through tuition revenue. Reallocated funds assume support from the state's Workforce Development Initiative targeted towards programs to be delivered at the Universities at Shady Grove.

The program will offer courses at the 300 and 400-level, which constitute the junior and senior year of the program. The curriculum will require 48 credits of core courses and 12 credits of program-specific electives. The program is designed to include fundamentals associated with bioengineering, including quantitative physiology, molecular thermodynamics, analysis of complex fluids, and synthetic biology, while also adding valuable computational skills, such as programming in Python and Matlab, machine learning, image processing, and bioinformatics. The program will produce a unique body of graduates with fundamentals in bio/biomedical engineering and strong computational skills with expertise in data science as applied to biological systems.

This proposal was approved by the Senate Programs, Curricula, and Courses committee on December 6, 2019.

RECOMMENDATION(S)

The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new degree program.

COMMITTEE WORK

The committee considered this proposal at its meeting on December 6, 2019. Ian White, Associate Chair in the Fischell Department of Bioengineering, and Bill Churma, Associate Director of Academic and Student Affairs in the Fischell Department of Bioengineering, presented the proposal and responded to questions from the committee. The proposal was approved by the committee.

ALTERNATIVES

The Senate could decline to approve this new degree program.

RISKS

If the Senate declines to approve this degree program, the University will lose an opportunity to take advantage of additional state funding to provide University of Maryland students at Shady Grove with a new program option in a growing technological industry.

FINANCIAL IMPLICATIONS

The program will be supported through a targeted enhancement funding request to the State of Maryland, and through tuition revenue. Reallocated funds assume support from the state's Workforce Development Initiative targeted towards programs to be delivered at the Universities at Shady Grove.

666: BIOCOMPUTATIONAL ENGINEERING

In Workflow

1. D-BIOE Curriculum Manager (churma@umd.edu; helim@umd.edu; ianwhite@umd.edu)
2. D-BIOE PCC Chair (ajones21@umd.edu; helim@umd.edu; ianwhite@umd.edu)
3. D-BIOE Chair (churma@umd.edu; ianwhite@umd.edu; jpfisher@umd.edu)
4. ENGR Curriculum Manager (ENGR Curriculum Manager@umd.edu)
5. ENGR PCC Chair (mcbell@umd.edu; nroop@umd.edu; sash1@umd.edu)
6. ENGR Dean (kkiger@umd.edu; mcbell@umd.edu; nroop@umd.edu; sash1@umd.edu)
7. Academic Affairs Curriculum Manager (mcolson@umd.edu)
8. Senate PCC Chair (jcwb@umd.edu; mcolson@umd.edu)
9. University Senate Chair (mcolson@umd.edu)
10. President (mcolson@umd.edu)
11. Board of Regents (mcolson@umd.edu)
12. MHEC (mcolson@umd.edu)
13. Provost Office (mcolson@umd.edu)
14. Undergraduate Catalog Manager (lyokoi@umd.edu)

Approval Path

1. Thu, 26 Sep 2019 01:09:16 GMT
   Bill Churma (churma): Approved for D-BIOE Curriculum Manager
2. Thu, 26 Sep 2019 02:24:34 GMT
   Ian White (ianwhite): Approved for D-BIOE PCC Chair
3. Thu, 26 Sep 2019 12:37:23 GMT
   John Fisher (jpfisher): Approved for D-BIOE Chair
4. Thu, 26 Sep 2019 17:17:14 GMT
   Michael Colson (mcolson): Approved for ENGR Curriculum Manager
5. Tue, 08 Oct 2019 14:45:28 GMT
   Michael Colson (mcolson): Rollback to D-BIOE Chair for ENGR PCC Chair
6. Tue, 08 Oct 2019 15:52:04 GMT
   Bill Churma (churma): Approved for D-BIOE Chair
7. Tue, 08 Oct 2019 16:00:31 GMT
   Michael Colson (mcolson): Approved for ENGR Curriculum Manager
8. Mon, 28 Oct 2019 19:19:52 GMT
   Suzanne Ashour-Bailey (sash1): Approved for ENGR PCC Chair
9. Tue, 29 Oct 2019 18:50:03 GMT
   Kenneth Kiger (kkiger): Approved for ENGR Dean
10. Wed, 27 Nov 2019 20:03:20 GMT
    Michael Colson (mcolson): Approved for Academic Affairs Curriculum Manager
11. Fri, 06 Dec 2019 14:33:52 GMT
    Janna Bianchini (jcwb): Approved for Senate PCC Chair

New Program Proposal

Date Submitted: Thu, 26 Sep 2019 01:06:40 GMT

Viewing: 666 : Biocomputational Engineering
Last edit: Mon, 28 Oct 2019 19:19:40 GMT

Changes proposed by: Bill Churma (churma)

Program Name

Biocomputational Engineering

Program Status

Proposed

Effective Term

Fall 2021

Catalog Year

2021-2022

Program Level

Undergraduate Program

Program Type

Undergraduate Major

Delivery Method

Off Campus

Does an approved version of this program already exist?

No

Departments

Department
Fischell Department of Bioengineering

Colleges

College
The A. James Clark School of Engineering

Degree(s) Awarded

Degree Awarded
Bachelor of Science

Proposal Summary

A new bachelor of science degree program in Biocomputational Engineering is proposed for delivery at the Universities at Shady Grove. The program is designed to produce graduates with the preparative foundation in bioengineering and quantitative data science, either for employment or for pursuit of advanced degree educational programs. Successful students will have a foundational breadth in computational bioengineering, which includes strong fundamentals in biology combined with quantitative problem solving skills. In addition, the program aims to equip its students with applicable skills in data science to position them to contribute to the fields of bioengineering, the biological sciences, and medicine beyond the capabilities of bioengineering and biomedical engineering graduates. Programs at the Universities at Shady Grove are years 3 and 4 only and are designed to be a transfer pathway for students from regional community colleges. The most common partner with the Universities at Shady Grove is Montgomery College.

Program and Catalog Information

Provide the catalog description of the proposed program. As part of the description, please indicate any areas of concentration or specializations that will be offered.

Biocomputational engineering brings together the field of bioengineering, a discipline grounded in fundamentals of physics, chemistry, and biology, with computation and data science, which enhances the value of all fields. The objective of the biocomputational engineering program is to provide a breadth of fundamentals in biology and quantitative problem solving while developing skills in computation and data science that can be applied to the modeling of complex biological systems and the analysis of complex biological data sets in order to create new knowledge from the molecular to organ to system levels, and to develop innovative processes for the prevention, diagnosis, and treatment of disease. The synthesis of bioengineering, computation, and data science gives the graduates unique capabilities to solve existing and emerging challenges of the modern medical world.

Catalog Program Requirements:

PRIOR STUDY

Prior to being admitted to the Biocomputational Engineering major, students should have completed the Engineering LEP gateway courses, basic math/science courses, lower-level General Education requirements (or an Associate's Degree from a Maryland public institution), and 60 credits.

Course	Title	Credits
ENGL101	Academic Writing	3
MATH140	Calculus I	4
MATH141	Calculus II	4

MATH241	Calculus III	4
MATH246	Differential Equations for Scientists and Engineers	3
PHYS161	General Physics: Mechanics and Particle Dynamics	3
PHYS260	General Physics: Vibration, Waves, Heat, Electricity and Magnetism	3
PHYS261	General Physics: Vibrations, Waves, Heat, Electricity and Magnetism (Laboratory)	1
ENES100	Introduction to Engineering Design	3
CHEM135	General Chemistry for Engineers	3
CHEM136	General Chemistry Laboratory for Engineers	1
CHEM231	Organic Chemistry I	3
CHEM232	Organic Chemistry Laboratory I	1
BSCI170	Principles of Molecular & Cellular Biology	3
or BIOE120	Biology for Engineers	
Matlab	Course Matlab Not Found (Matlab programming course -- e.g. BIOE241 or equivalent)	3
Gen Ed	Course Gen Ed Not Found (Lower-level general education requirements or AA/AS degree from a Maryland public institution)	18
Total Credits		60

REQUIRED COURSES

Course	Title	Credits
ENBC301	Course ENBC301 Not Found (Introduction to Biocomputational Engineering)	1
ENBC311	Course ENBC311 Not Found (Python for Data Analysis)	3
ENBC312	Course ENBC312 Not Found (Object Oriented Programming in C++)	3
ENBC321	Course ENBC321 Not Found (Machine Learning for Data Analysis)	3
ENBC322	Course ENBC322 Not Found (Algorithms)	3
ENBC331	Course ENBC331 Not Found (Applied Linear Systems and Differential Equations)	3
ENBC332	Course ENBC332 Not Found (Statistics, Data Analysis, and Visualization)	3
ENBC341	Course ENBC341 Not Found (Biomolecular Engineering Thermodynamics)	3
ENBC342	Course ENBC342 Not Found (Computational Fluid Dynamics and Mass Transfer)	3
ENBC351	Course ENBC351 Not Found (Quantitative Molecular and Cellular Biology)	3
ENBC352	Course ENBC352 Not Found (Molecular Techniques Laboratory)	2
ENBC353	Course ENBC353 Not Found (Synthetic Biology)	3
ENBC425	Course ENBC425 Not Found (Imaging and Image Processing)	3
ENBC431	Course ENBC431 Not Found (Finite Element Analysis)	3
ENBC441	Course ENBC441 Not Found (Computational Systems Biology)	3
ENBC491	Course ENBC491 Not Found (Senior Capstone Design in Biocomputational Engineering)	3
ENGL393	Technical Writing	3
Elective Courses		12
Total Credits		60

See Appendix 1 for course descriptions.

ELECTIVE COURSES

Students are required to take four technical electives (12 credits). The courses must be selected from an approved list of engineering and biology courses; the list will be updated regularly by the Program Director. At least two of the elective courses must be from the category of engineering, mathematics, or programming, while at most two of the electives can be from the category of biology courses. The program will offer electives; at the same time, the program will arrange for opportunities for electives outside the program, including USG programs offered by other universities.

Course	Title	Credits
Possible technical electives		12
ENBC411	Course ENBC411 Not Found (Advanced Programming in Python)	
ENBC413	Course ENBC413 Not Found (Data Analysis with R)	
ENBC435	Course ENBC435 Not Found (Numerical Methods)	
ENBC442	Course ENBC442 Not Found (Computational Molecular Dynamics)	
ENBC443	Course ENBC443 Not Found (Multiscale Simulation Methods)	
ENBC444	Course ENBC444 Not Found (Modeling Protein Folding)	

| ENBC445 | Course ENBC445 Not Found (Spatial Control of Biological Agents) |
| ENBC455 | Course ENBC455 Not Found (Bioinformatics Engineering) |

Sample plan. Provide a term by term sample plan that shows how a hypothetical student would progress through the program to completion. It should be clear the length of time it will take for a typical student to graduate. For undergraduate programs, this should be the four-year plan.

PLAN OF STUDY for YEARS 3 and 4

Junior Year

Semester 1	Credits	Semester 2	Credits
ENBC301 (Introduction to Biocomputational Engineering)	1	ENBC312 (Object Oriented Programming in C++)	3
ENBC311 (Python for Data Analysis)	3	ENBC322 (Algorithms)	3
ENBC331 (Applied Linear Systems and Differential Equations)	3	ENBC342 (Computational Fluid Dynamics and Mass Transfer)	3
ENBC332 (Statistics, Data Analysis, and Data Visualization)	3	ENBC352 (Molecular Techniques Laboratory)	2
ENBC341 (Biomolecular Engineering Thermodynamics)	3	Elective 1	3
ENBC351 (Quantitative Molecular and Cell Biology)	3		
	16		14

Senior Year

Semester 1	Credits	Semester 2	Credits
ENBC321 (Machine Learning for Data Analysis)	3	ENBC425 (Imaging and Image Processing)	3
ENBC353 (Synthetic Biology)	3	ENBC441 (Computational Systems Biology)	3
ENBC431 (Finite Element Analysis)	3	ENBC491 (Senior Capstone Design in Biocomputational Engineering)	3
ENGL393	3	Elective 3	3
Elective 2	3	Elective 4	3
	15		15

Total Credits 60

List the intended student learning outcomes. In an attachment, provide the plan for assessing these outcomes.

Learning Outcomes

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

(3) An ability to communicate effectively with a range of audiences.

(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

New Program Information

Mission and Purpose

Describe the program and explain how it fits the institutional mission statement and planning priorities.

The fields of Biomedical Engineering and Bioengineering are impacting our society by delivering new imaging and diagnostics technologies, new therapeutic delivery methods, and the possibility of new methods for the repair or construction of tissues and organs. At the same time, computational methods and data science are perfusing into every field of engineering, as well as the life sciences, economics, law, and others. The proposed program aims to provide its students with a foundational breadth in computational bioengineering, which includes strong fundamentals in biology combined with quantitative problem solving skills. In addition, the program aims to equip its students with applicable skills in data science to position them to contribute to the fields of bioengineering, the biological sciences, and medicine beyond the capabilities of bioengineering and biomedical engineering graduates. As a result, graduates will be well-positioned for rewarding careers while also providing a workforce that will fill needs within the state of Maryland.

The proposed program would be created in alignment with the missions of the University of Maryland and the A. James Clark School of Engineering. A key aspect of the mission of the University of Maryland College Park for undergraduate education is that, "The University will continue to elevate the quality and accessibility of undergraduate education, with programs that are comprehensive and challenging, and that serve students well as a foundation for the workplace, advanced study, and a productive, fulfilling life." Aligned with this, our program seeks to produce graduates with the preparative foundation in bioengineering and quantitative data science, either for employment or for pursuit of advanced degree educational programs. The University's detailed mission statement continues, focusing on a commitment to "foster education, critical thinking and intellectual growth, ensuring the knowledge and impact of our graduates are both robust and sustainable." This aligns closely with our aim to produce graduates with awareness of their field and an understanding of how they can utilize their unique skill sets in bioengineering and data science to address challenges facing society in both the near and long term.

The proposed program is equally aligned with the A. James Clark School of Engineering Strategic plan, which describes as its mission to "improve millions of lives," and has ascribed the term MPact to this mission. The School of Engineering has defined, among others, the following goals to MPact society. Specifically, the college aims to "Create and demonstrate the value of engineering education, research, and service on economic development at the campus, local, state, national, and global levels." The program is certainly geared to impact economic development at the campus and metropolitan levels by generating alumni that will fill the need for expertise in biological sciences, quantitative problem solving, and data science. In addition, graduates from the program will be provided with a foundation in professional ethics to encourage them to positively impact their profession, community, and society at all scales.

Program Characteristics

What are the educational objectives of the program?

1. Produce graduates with the educational depth, technical skills, and practical experiences to be competitive for placement in biocomputational engineering careers or post-graduate educational pursuits;

2. Produce graduates with an awareness of their field and an understanding of how they can address the data-driven computational biomedical challenges facing society in both the near and long term;

3. Produce graduates with a foundation in professional ethics who will actively seek to positively impact their profession, community, and society.

Describe any selective admissions policy or special criteria for students interested in this program.

As an undergraduate program within the A. James Clark School of Engineering, the Biocomputational Engineering major will seek approval to be designated as a Limited Enrollment Program (LEP). Admission to this program will follow the School of Engineering's admissions criteria found on the LEP website: http://www.lep.umd.edu.

Students beyond their first semester and those off campus wishing to transfer are required to meet the following gateway criteria:

- Completion of MATH141 (Calculus II) with a minimum grade of B-
- Completion of PHYS161 (Physics I) with a minimum grade of B-
- Completion of either CHEM135 or CHEM271 or CHEM134 with a minimum grade of C-. (Students who take CHEM134 must also have completed CHEM131 with a minimum grade of C-.)

Additionally, students seeking admission to the Biocomputational Engineering major will need to fulfill the following requirements:

- Completion of all prior study courses (as outlined in section #7) with a minimum grade of C-.
- Completion of all lower-level University General Education requirements.
- Completion of at least 60 applicable degree credits.

A minimum grade point average of 3.0 in all courses taken at the University of Maryland and all other institutions is required for internal and external transfer students.

Due to the similarity in curriculum content and the physical location of course offerings, students in the Bioengineering program at UMCP will not be eligible to add Biocomputational Engineering as a second major or degree (and vice versa).

The proposed curriculum will offer courses at the 300- and 400-level, which constitute the junior and senior year of the program. The program is primarily intended for students transferring from a Maryland public community college. While students at the College Park campus can pursue the program, they will not be able to seek admission into the School of Engineering and the Biocomputational Engineering major until they have completed the Engineering LEP gateway courses, required prior study major courses, lower-level General Education requirements (or an Associate's Degree), and have earned at least 60 credits.

Summarize the factors that were considered in developing the proposed curriculum (such as recommendations of advisory or other groups, articulated workforce needs, standards set by disciplinary associations or specialized-accrediting groups, etc.).

Bioengineering is a growing field, and one that will have a significant impact on society. At the same time, computational methods and data science are perfusing into every field of engineering, as well as the life sciences. A need exists for graduates trained in the fundamentals of engineering and life sciences with strong skills in computational methods and data science. In fact, a survey of the Bioengineering Department's External Advisory Board demonstrated significant enthusiasm for the program's goals of generating graduates with knowledge of life sciences, engineering, programming, and computation. The advisory board rated the demand for these graduates at a score of 4.67 out of 5. The advisory board also emphasized that the Biopharmaceutical industry (which has a strong base in Maryland), the Biomedical Instrumentation industry, and hospitals and insurance companies are currently targeting employees with this skill set.

The program is designed to include fundamentals associated with Bioengineering, including quantitative physiology, molecular thermodynamics, analysis of complex fluids, and synthetic biology. To this the program adds valuable skills, including programming in Python and Matlab, machine learning, image processing, and bioinformatics. The program will produce a unique body of graduates with fundamentals in bio/biomedical engineering and strong computational skills with expertise in data science as applied to biological systems.

Identify specific actions and strategies that will be utilized to recruit and retain a diverse student body.

Recruitment for the Biocomputational Engineering major will target students attending Montgomery College (MC), which has a very diverse student population. Per the Office of Institutional Research & Analysis, 52% of students at MC are from an underrepresented minority group; from this population 27.4% are African American and 24.6% are Hispanic (Source: MC at Glance https://cms.montgomerycollege.edu/research/). The program will also recruit in other Maryland community colleges through transfer fairs, Universities at Shady Grove recruitment programs, and individual institution visits.

To ensure the success of a diverse student body, the program will implement a mandatory advising system, where students will be required to meet with an academic advisor each semester to track their academic progress. In addition to mandatory semester advising, staff advisors will work closely with faculty to identify students in need of early intervention through such actions as issuing mid-term grades. Furthermore, the program will identify any major courses with a high drop, withdrawal, or fail (DWF) rate, and will provide academic support to students in those courses. Finally, the program will work with the existing academic support units at Shady Grove, such as the Center for Academic Success, to provide academic coaching and support services to our students (https://shadygrove.umd.edu/student-services/center-for-academic-success).

Off Campus

Indicate the location for this off-campus program.

At the launch of the program, courses will only be offered in classrooms at the Universities at Shady Grove.

Describe the suitability of the site for the off-campus programs.

This program is designed specifically for delivery in the new Biomedical Sciences and Engineering Education Building (BSE, or Building IV) at the Universities at Shady Grove. The curriculum is designed to articulate well with the most common source of transfer students to USG, Montgomery College.

Describe the method of instructional delivery, including online delivery, on-site faculty, and the mix of full-time and part-time instructors (according to MHEC 13B.02.03.20.D(2), "At least # of the classes offered in an off-campus program shall be taught by full-time faculty of the parent institution").

The program will be offered in a semester format only, on site at the Universities at Shady Grove. The department will have a mix of tenure track and professional track faculty in residence at USG and may also utilize faculty from the College Park campus.

Discuss the resources available for supporting faculty at the location. In an attachment, please indicate the faculty involved in the program. Include their titles, credentials, and courses they may teach for the program.

It is anticipated that two tenure-track (TTK) faculty and four professional-track (PTK) lectures will serve as full-time instructors at the Shady Grove campus and will teach all of the ENBC courses. Faculty at the UMCP campus within the Bioengineering Department will be offered the opportunity to move to the Shady Grove campus. All other spots will be filled through external hires before the program launch. A tenured faculty (located at the Shady Grove campus at least two days per week) will serve as Program Director.

All faculty will receive guidance from the Bioengineering Department, which considers teaching to be critical to the success of its program. All faculty will also be directed to consult with UMCP's Teaching and Learning Transformation Center (TLTC) for guidance on improving instruction performance and incorporating new practices into the classroom.

A description of the faculty who would provide instruction is provided in Appendix 3.

Discuss how students will have reasonable and adequate access to the range of student support services (library materials, teacher interaction, advising, counseling, accessibility, disability support, and financial aid) needed to support their learning activities.

To fully serve the academic and support needs of the Biocomputational Engineering students, the program will employ one full-time academic advisor at Shady Grove. Anticipating student growth, additional part-time or full-time advisors will be needed in subsequent years. All academic advisors will report directly to the Fischell Department of Bioengineering Associate Director of Academic and Student Affairs. Academic advisors at Shady Grove will manage course scheduling, perform academic advising each semester, track degree requirements, and provide academic and support resources when appropriate. The academic advising team will also assist in outreach efforts and building a strong community among prospective and current students.

Additionally, the Biocomputational Engineering major will identify a Faculty Program Director who will reside at Shady Grove at least two days per week. The Faculty Program Director will work closely with the UMCP liaisons as well as all TTK and PTK faculty in addressing student and instructor concerns, developing electives, and performing assessment measures.

Additional services are provided for all programs at the Universities at Shady Grove through USG's Center for Academic Success.

Discuss how the off-campus program will be comparable to the existing program in terms of academic rigor. What are the learning outcomes for the online offering? Do they differ from the existing on-site program?

The Biocomputational Engineering program will maintain the rigor that is characteristic of the A. James Clark School of Engineering. As an Engineering program accredited by ABET, the learning outcomes of this program will be consistent with those for all engineering programs. The learning outcomes and assessment process can be found in appendix 2.

Describe the quality control and evaluation of the off-campus program's effectiveness. How will the program be evaluated?

The Biocomputational Engineering program will strive for continuous improvement through annual assessment. The program will complete annual learning outcome assessments for the Middle States Accreditation process in addition to a Self Study every six years for ABET accreditation. Seven student learning outcomes will be assessed in pursuit of continuous improvement, in accordance with ABET accreditation.

Relationship to Other Units or Institutions

If a required or recommended course is o#ered by another department, discuss how the additional students will not unduly burden that department's faculty and resources. Discuss any other potential impacts on another department, such as academic content that may significantly overlap with existing programs. Use space below for any comments. Otherwise, attach supporting correspondence.

Only one of the required courses will not be delivered by the Biocomputational Engineering program within the Bioengineering Department: ENGL 393. The Provost's Office will coordinate with the Professional Writing program in the English Department to offer a section of ENGL393 for Engineering majors at USG.

Accreditation and Licensure. Will the program need to be accredited? If so, indicate the accrediting agency. Also, indicate if students will expect to be licensed or certified in order to engage in or be successful in the program's target occupation.

While accreditation is not required, it will make the program more appealing. It is expected that accreditation from ABET will be pursued three years after launch.

Describe any cooperative arrangements with other institutions or organizations that will be important for the success of this program.

The program does not require cooperation from any other organizations, as all required courses (except for ENGL393) will be taught within the Biocomputational Engineering program.

Faculty and Organization

Who will provide academic direction and oversight for the program? In an attachment, please indicate the faculty involved in the program. Include their titles, credentials, and courses they may teach for the program.

It is anticipated that two TTK faculty and four PTK lectures will serve as full-time instructors at the Shady Grove campus and will teach all of the ENBC courses. Faculty at the UMCP campus within the Bioengineering Department will be offered the opportunity to move to the Shady Grove campus. All other spots will be filled through external hires before the program launch. A tenured faculty (located at the Shady Grove campus at least two days per week) will serve as Program Director.

All faculty will receive guidance from the Bioengineering Department, which considers teaching to be critical to the success of its program. All faculty will also be directed to consult with UMCP's Teaching and Learning Transformation Center (TLTC) for guidance on improving instruction performance and incorporating new practices into the classroom.

A description of the faculty who would provide instruction is provided in Appendix 3.

Indicate who will provide the administrative coordination for the program

The Biocomputational Engineering major will be managed by a Faculty Program Director who will reside at Shady Grove at least two days per week. The Faculty Program Director will work closely with the UMCP liaisons as well as all TTK and PTK faculty in addressing student and instructor concerns, developing electives, and performing assessment measures.

Admissions will be administered by UMCP's Undergraduate Admissions Shady Grove Coordinator and the Biocomputational Engineering Program Director. Following procedures previously established at the Universities at Shady Grove, the Clark School's Assistant Director of Transfer Student Advising and Admissions will review the accepted Biocomputational Engineering cohort to ensure all students meet the Clark School's LEP admission criteria. It is expected that admissions will require only a minimal burden upon the Clark School staff and the Fischell Department of Bioengineering staff.

The assigned laboratory space for the program will be managed in tandem by the Biocomputational Engineering full-time PTK faculty and hired technical support staff.

Resource Needs and Sources

Each new program is required to have a library assessment prepared by the University Libraries in order to determine any new library resources that may be required. This assessment must be done by the University Libraries. Add as an attachment.

See appendix 4 for a library assessment prepared by the University Libraries. The Universities at Shady Grove's Priddy library is part of the UMCP Libraries. In addition, all resources that are available on the UMCP campus are also available to UMCP students at Shady Grove.

Discuss the adequacy of physical facilities, infrastructure and instructional equipment.

The program will be delivered in the new Biomedical Sciences and Engineering Education (BSE) building (also called Building IV) at the Universities at Shady Grove. This state-of-the-art educational facility has a suite of shared active-learning classrooms, computing resources, wet labs, a dental clinic, product design laboratory and maker space, as well as offices for faculty and staff delivering the curricula and student support services. The biocomputational engineering program expects to have 1-2 dedicated laboratory spaces for its programmatic needs.

Discuss the instructional resources (faculty, staff, and teaching assistants) that will be needed to cover new courses or needed additional sections of existing courses to be taught. Indicate the source of resources for covering these costs.

It is expected that two TTK faculty and four PTK lecturers will represent the program at USG. This is sufficient to provide 8 courses per semester, which enables coverage of all of the planned ENBC courses (the program requires sixteen ENBC courses, but three of those are 1 credit only). Adjunct faculty may also be contracted to cover courses as needed. Class sizes are expected to be on the order of 30 students, and thus teaching assistants will not be needed. Undergraduate Teaching Fellows (senior students in the program) will be used to support courses when possible.

Discuss the administrative and advising resources that will be needed for the program. Indicate the source of resources for covering these costs.

To fully serve the academic and support needs of the Biocomputational Engineering students, the program will initially employ one full-time academic advisor at Shady Grove. Anticipating student growth, additional part-time or full-time advisors will be needed in subsequent years. All academic advisors will report directly to the Fischell Department of Bioengineering Associate Director of Academic and Student Affairs. Academic advisors at Shady Grove will manage course scheduling, perform academic advising each semester, track degree requirements, and provide academic and support resources when appropriate. The academic advising team will also assist in outreach efforts and building a strong community among prospective and current students.

Additionally, the Biocomputational Engineering major will identify a Faculty Program Director who will reside at Shady Grove at least two days per week. The Faculty Program Director will work closely with the UMCP liaisons as well as all TTK and PTK faculty in addressing student and instructor concerns, developing electives, and performing assessment measures.

Admissions will be administered by UMCP's Undergraduate Admissions Shady Grove Coordinator and the Biocomutational Engineering Program Director. Following procedures previously established at the Universities at Shady Grove, the Clark School's Assistant Director of Transfer Student Advising and Admissions will review the accepted Biocomputational Engineering cohort to ensure all students meet the Clark School's LEP admission criteria. It is expected that admissions will require only a minimal burden upon the Clark School staff and the Fischell Department of Bioengineering staff.

The assigned laboratory space for the program will be managed in tandem by the Biocomputational Engineering full-time PTK faculty and hired technical support staff.

Use the Maryland Higher Education Commission (MHEC) commission financial tables to describe the program's financial plan for the next five years. See help bubble for financial table template. Use space below for any additional comments on program funding.

See Appendix 5

Implications for the State (Additional Information Required by MHEC and the Board of Regents)

Explain how there is a compelling regional or statewide need for the program. Argument for need may be based on the need for the advancement of knowledge and/or societal needs, including the need for "expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education." Also, explain how need is consistent with the Maryland State Plan for Postsecondary Education (https://mhec.state.md.us/About/Documents/2017.2021%20Maryland%20State%20Plan%20for%20Higher%20Education.pdf)**.**

In recent years the Bioengineering program at UMCP has placed about 30% of its graduates into graduate programs, and about 50-60% of its graduates into industry, including biopharmaceutical, biomedical instrumentation, and consulting jobs; nearly all graduates are placed before their graduation day. However, the department's advisory board has communicated that there are additional jobs to be filled, with an emphasis on programming, computation, and data analysis that goes beyond the capabilities of the department's graduates. While graduates in computer science are considered for these jobs, employers in the biopharma and biomedical space prefer multi-disciplinary talents, including fundamental knowledge in life sciences.

While a new program could be launched at UMCP, we are proposing to launch the program at USG specifically to target the talented pool of students who complete an engineering program at a community college and aim to work in the biopharma and biomedical industries. By attracting this population into the field, the proposed program will contribute strongly to the diversity of their employers, which are generally hiring from degree programs lacking in diversity.

Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program. Possible sources of information include industry or disciplinary studies on job market, the USBLS Occupational Outlook Handbook (https://www.bls.gov/ooh)**, or Maryland state Occupational and Industry Projections** (http://www.dllr.state.md.us/lmi/iandoproj) **over the next five years. Also, provide information on the existing supply of graduates in similar programs in the state (use MHEC's Office of Research and Policy Analysis webpage** (http://mhec.maryland.gov/publications/Pages/research) **for Annual Reports on Enrollment by Program) and discuss how future demand for graduates will exceed the existing supply. As part of this analysis, indicate the anticipated number of students your program will graduate per year at steady state.**

The Provost's Office provided the Bioengineering Department with job outlook data from Emsi (https://www.economicmodeling.com/data/). The analysis projected job trends in the field of bioinformatics in the MD/VA/DC region. Note that in the proposed program we use the term "bioinformatics" specifically to imply the analysis of genomic and proteomic data; however, the term is frequently used to describe more generally information science, data analysis, and computation as applied to the life sciences. The analysis suggests that in Maryland, bioinformatics jobs will increase from about 60,000 to about 70,000 between 2018 and 2028, a 16% change (it predicts a 7% regional change and a 16% national change over the same period). Note that this analysis does not include the expected Amazon headquarters in Northern Virginia.

The Emsi report cites Booz Allen Hamilton, Leidos Holdings, and Oracle as likely employers. In addition to Amazon, the department's External Advisory Board has identified the following as employers for the graduates of the proposed program: Becton Dickinson (BD), Roche, Abbott, Beckman, Siemens, GE, Amgen, Kite Pharma, Edwards Life Sciences, numerous hospitals and insurance companies, and most biopharmaceutical companies. In addition, federal and federally-supported laboratories, including NIH, FDA, NRL, NIST, and APL are in need of employees with computational skills and fundamentals in life science and engineering.

Identify similar programs in the state. Discuss any di#erences between the proposed program and existing programs. Explain how your program will not result in an unreasonable duplica on of an existing program (you can base this argument on program di#erences or market demand for graduates). The MHEC website can be used to find academic programs operatinng in the state: http://mhec.maryland.gov/institutions_training/pages/HEPrograms.aspx

The most closely related program to the proposed Biocomputational Engineering program is the Bioengineering program that already exists at College Park (and exists within the same Bioengineering Department as the proposed program). The first half of the program is almost the same, but the second half of the programs differ significantly. The proposed program offers opportunities for training in programming, computational methods, and data science that go well beyond that of a "track" or "specialization." Thus, the graduates from the proposed program would be unique in the Clark School.

Bowie State University offers a Bioinformatics degree that has similarities to the proposed program, including the opportunity for training in both the life sciences and computer programming. At the same time, UMUC offers a degree in Biotechnology, while UMBC offers a degree in Translational Life Science Technology. Some overlap will exist in the skill sets between these graduates and graduates from the proposed program. However, the key difference is that the proposed program is an engineering degree, and thus will emphasize an engineering approach to problem solving above all else.

Discuss the possible impact on Historically Black Institutions (HBIs) in the state. Will the program affect any existing programs at Maryland HBIs? Will the program impact the uniqueness or identity of a Maryland HBI?

Currently no HBIs offer similar undergraduate programs (Morgan State University offers a Master's Degree in Bioinformatics, implying that the proposed program could serve as a feeder program).

Supporting Documents

Attachments

Appendix1-ENBC.pdf
Appendix2-ENBC.pdf
Appendix3-ENBC.pdf
Appendix4-ENBC.pdf
Appendix5-ENBC.pdf

Reviewer Comments

Michael Colson (mcolson) (Tue, 08 Oct 2019 14:45:28 GMT): Rollback: Trying to rollback for college.

Key: 666

APPENDIX 1: Course Descriptions

ENBC301: Introduction to Biocomputational Engineering

Credits: 1

Grading method: regular, pass-fail, and audit

Prerequisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in Biocomputational Engineering major.

Description: Provides practical tools to help Biocomputational Engineering majors to think critically about their goals and career paths and to utilize their major to set their career trajectory.

ENBC311: Python for Data Analysis

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE489A or BIOE442 or ENBC311.

Description: Provides an introduction to structured programming, computational methods, and data analysis techniques with the goal of building a foundation allowing students to confidently address problems in research and industry. Fundamentals of programming, algorithms, and simulation are covered from a general computer science perspective, while the applied data analysis and visualization portion makes use of the Python SciPy stack.

ENBC312: Object Oriented Programming in C++

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Provides an introduction to object oriented programming in the C++ language.

ENBC321: Machine Learning for Data Analysis

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC312 and ENBC332 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Provides an introduction to artificial intelligence methods for mining big data sets and for making decisions using data sets.

ENBC322: Algorithms

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC311 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: ENEB355 or ENBC322.

Description: Utilizing the Python programming language for a systematic study of the complexity of algorithms related to sorting, graphs and trees, and combinatorics. Algorithms are analyzed using mathematical techniques to solve recurrences and summations.

ENBC331: Applied Linear Systems and Differential Equations

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of MATH246 and Matlab prior study requirement with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE371 or ENBC331.

Description: Applications of linear algebra and differential equations to bioengineering and biomolecular systems. Designed to instruct students to relate mathematical approaches in bioengineering to their physical systems. Examples will emphasize fluid mechanics, mass transfer, and physiological systems.

ENBC332: Statistics, Data Analysis, and Data Visualization

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE372 or ENBC332 or STAT464.

Description: This course will instruct students in the fundamentals of probability and statistics through examples in biological phenomenon and clinical data analysis. Data visualization strategies will also be covered.

ENBC341: Biomolecular Engineering Thermodynamics

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of MATH246 and PHYS260 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE232 or ENBC341 or CHBE301.

Description: A quantitative introduction to thermodynamic analysis of biomolecular systems. The basic laws of thermodynamics will be introduced and explained through a series of examples related to biomolecular systems.

ENBC342: Computational Fluid Dynamics and Mass Transfer

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC341 and Matlab prior study requirement with a grade of "C-" or better; and must have completed (with a grade of "C-" or better) or be concurrently enrolled in ENBC331.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE331 or ENBC342.

Description: Principles and applications of fluid mechanics and mass transfer with a focus on topics in the life sciences and an emphasis on computational methods and modeling. Content includes conservation of mass, momentum, and energy, as well as the application of these fundamental relations to hydrostatics, control

volume analysis, internal and external flow, and boundary layers. Applications to biological and bioengineering problems such as tissue engineering, bioprocessing, imaging, and drug delivery.

ENBC351: Quantitative Molecular and Cellular Biology

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: Completion of BSCI170 or BIOE120 with a grade of "C-" or better.

Co-requisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Quantitative analysis of the behavior of cellular and molecular systems.

ENBC352: Molecular Techniques Laboratory

Credits: 2

Grading method: regular, pass-fail, and audit

Prerequisites: Must have completed (with a grade of "C-" or better) or be concurrently enrolled in ENBC351.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Wet lab experiments to observe cellular and molecular processes and phenomenon.

ENBC353: Synthetic Biology

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: Completion of BSCI170 or BIOE120 with a grade of C- or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE461 or ENBC353.

Description: Students are introduced to the scientific foundation and concepts of synthetic biology and biological engineering. Current examples that apply synthetic biology to fundamental and practical challenges will be emphasized. The course will also address the societal issues of synthetic biology, and briefly examine interests to regulate research in this area.

ENBC411: Advanced Programming in Python

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC311 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Advanced programming methods with an emphasis on biocomputational applications.

ENBC413: Data Analysis with R

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC332 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Provides an introduction to programming techniques for data analysis with the statistical software "R."

ENBC425: Imaging and Image Processing

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC321 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Examines the physical principles behind major biomedical imaging modalities, including X-Ray, CT, MRI. Instructs students in mathematical tools for extracting information from images. Provides an introduction to the use of machine learning for interpreting images. Matlab and/or Python utilized for image processing exercises.

ENBC431: Finite Element Analysis

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of MATH246 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Instructs students to use computer tools to analyze the thermal and mechanical properties of devices or systems. The course will focus specifically on the biomechanics of biomedical devices.

ENBC435: Numerical Methods

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: none

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: The review of numerous mathematical methods to simplify complex problems.

ENBC441: Computational Systems Biology

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC351 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Introduction to building computer models that analyze dynamic functions within a cell, organ, tissue, or organism.

ENBC442: Computational Molecular Dynamics

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC341 and ENBC332 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE464 or ENBC442.

Description: Designed to introduce students to the principles, methods, and software used for simulation and modeling of macromolecules of biological interest such as proteins, lipids, and polysaccharides. Class topics:

Basic statistical thermodynamics, force fields, molecular dynamics/ monte carlo methods, conformational analysis, fluctuations & transport properties, free-energy calculations, multiscale modeling.

ENBC443: Multiscale Simulation Methods

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC341 and ENBC332 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Credit only granted for: BIOE463 or ENBC443.

Description: Introduction to approaches to modeling a system at different scales, such as atomic, molecular, and macromolecular. Examples will focus on proteins for which models include the interactions with water, atomic interactions within the molecule, and interactions between multiple molecules; models that span both short and long time scales are also studied.

ENBC444: Modeling Protein Folding

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC341 and ENBC332 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Computational prediction of the structure of proteins with applications in protein misfolding diseases such as Alzheimer's Disease and other prion diseases.

ENBC445: Spatial Control of Biological Agents

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC342 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Description and solution of the movement of passive and active biological agents in homogeneous and heterogeneous bioenvironments using partial differential equations and numerical methods. Identification and diagnosis of hot spots. Prescription of control strategies using techniques from Artificial Intelligence (AI) and verification of effectiveness. Applications environments may include landscapes and tissues.

ENBC455: Bioinformatics Engineering

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of ENBC311 with a grade of "C-" or better.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Introduces students to core problems in bioinformatics, along with databases and tools that have been developed to study them. Students will learn to utilize Python to process data sets.

ENBC491: Senior Capstone Design in Biocomputational Engineering

Credits: 3

Grading method: regular, pass-fail, and audit

Prerequisites: completion of 18 credits in ENBC courses.

Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and must be in the Biocomputational Engineering major.

Description: Senior design project, in which students work in teams to utilize the skills acquired through the major to identify and solve quantitative problems in bioengineering. Ethics in bioengineering and biotechnology will also be covered.

ENGL393: Technical Writing
Credits: 3
Grading method: regular
Prerequisites: ENGL101.
Restriction: Must have earned a minimum of 60 credits.
Description: The writing of technical papers and reports.

APPENDIX 2: Plan to Assess Student Learning Outcomes

The Biocomputational Engineering program will strive for continuous improvement through annual assessment. The program will complete annual learning outcome assessments for the Middle States Accreditation process in addition to a Self Study every six years for ABET accreditation. Seven student learning outcomes will be assessed in pursuit of continuous improvement, in accordance with ABET accreditation. The learning outcomes are as follows.

The student learning outcomes are aligned exactly with the outcomes assessed in accordance with ABET.

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The ABET accreditation cycle is six years. Each learning outcome above is mapped to one or more courses in the program for assessment, as follows.

SLO 1: ENBC342, ENBC331
SLO 2: ENBC353
SLO 3: ENBC491
SLO 4: ENBC491
SLO 5: ENBC491
SLO 6: ENBC352
SLO 7: ENBC321

Each course will be assessed once every three years (i.e., twice per ABET cycle) to determine whether the program is achieving each outcome; at least one course will be assessed every year (as indicated in the table below). The assessment will be conducted by the instructor; the instructor will then submit the assessment to the Bioengineering Department's Undergraduate Studies Committee. This committee will provide recommendations for modifications to the instructor. The process will be carefully documented on a form included in the assessment template. This process is currently utilized by the Bioengineering program at UMCP.

	SLO 1	SLO 2	SLO 3	SLO 4	SLO 5	SLO 6	SLO 7
Year 1	ENBC331 ENBC342	ENBC353					

Year 2						ENBC352	ENBC321
Year 3			ENBC491	ENBC491	ENBC491		

The assessment reports will follow a template developed by the Undergraduate Studies Committee in the Fischell Department of Bioengineering. The template contains a rubric to standardize the assessment. In addition, the template contains fields to track the discussion by the Undergraduate Studies Committee, the feedback provided by the committee, and the date of approval. The template is presented below.

Template begins here

Introduction

Course title (ENBC###) is a junior/senior level, required course for the undergraduates in the Biocomputational Engineering program at the University of Maryland. *Notable history of the course (New course? Major changes? Long established course?)*

Details about course content.

Details about major contents; how students earn their grades (exams, projects, reports, presentations, problem sets, labs, etc.)

Student Outcomes

Course title (ENBC###) is meant to address the following Student Outcomes:
(List all applicable ABET outcomes.)

Mapping to Student Outcomes

In addition, a mapping of the Student Outcomes to courses has been established in the Bioengineering Program so that each Student Outcome is specifically assessed approximately every three years. The *Course title (ENBC###)* course most heavily focuses upon Student Outcome*(s) list outcomes here*.

Quantitative Assessment

To assess the students' performance in Outcome (#), *describe in detail what was assessed and how it was assessed. Refer to the rubric below. Clearly describe what constitutes mastery of the subject.*

Scoring Rubric

Outcome *(#): outcome text*
One sentence description of the assessment.

4. Complete mastery of the assessed concept.
3. Sufficient mastery of the assessed concept to apply the learning as a post-graduate.
2. Sufficient mastery of only portions of the assessed concept or insufficient mastery of the assessed concept to apply the learning as a post-graduate.
1. Complete lack of mastery of the assessed concept.
0. No attempt

Expected Attainment Level

The expected attainment level for completing Student Outcomes is a class average score of 3.0, implying that on average students will be successful applying the assessed outcome as a post-graduate.

Result of Assessment

State the mean and standard deviation. State any additional observations about the scores.

Conclusions and Recommendations

Briefly summarize again what was assessed and whether it was successful. Elaborate further on the meaning or implication of the success or failure. State any recommendations to improve the course in order to increase the score.

For administrative use only	
Date received	
Date discussed by UGS committee	
Comments or recommendations from the committee	
Summary of revisions	
Date approved	
Director UGS name	
Director UGS signature	

 Template ends here

In addition to the course assessment process, a senior exit survey will be conducted prior to graduation every year. Students will be asked to assess their capabilities related to the seven learning outcomes above. These results will be reviewed by the Undergraduate Studies Committee and recommendations for improvements to the curriculum will be provided to the program's Director as needed.

Appendix 3: Program Faculty

The Fischell Department of Bioengineering will provide opportunities for its current TTK and PTK faculty to transition to the USG program[1]. All remaining positions will be added through external hires. The three TTK faculty will have the choice to locate their research program at USG or UMCP, though they will provide instruction at the USG campus. In line with the current policy in the Fischell Department of Bioengineering, tenured faculty teach three courses per year, though if they meet the "research active" threshold, they teach two courses per year. Junior TTK faculty teach two courses per year. PTK lectures are expected to teach 5.5 courses per year. The PTK faculty will be located at USG full time.

The descriptions of the faculty positions are provided below.

TTK #1
Research strengths: multi-scale modeling and protein folding with applications in disease.
Capable of teaching:
- ENBC332: Statistics, Data Analysis, and Data Visualization
- ENBC341: Biomolecular Engineering Thermodynamics
- ENBC442: Computational Molecular Dynamics
- ENBC443: Multiscale Simulation Methods
- ENBC444: Modeling Protein Folding

TTK #2
Research strengths: multi-scale modeling and molecular assembly; cells and or biomaterials.
Capable of teaching:
- ENBC332: Statistics, Data Analysis, and Data Visualization
- ENBC341: Biomolecular Engineering Thermodynamics
- ENBC442: Computational Molecular Dynamics
- ENBC443: Multiscale Simulation Methods
- ENBC444: Modeling Protein Folding

PTK #1
Research strengths: computational systems biology.
Capable of teaching:
- ENBC331: Applied Linear Systems and Differential Equations
- ENBC342: Computational Fluid Dynamics and Mass Transfer
- ENBC351: Quantitative Molecular and Cellular Biology
- ENBC431: Finite Element Analysis
- ENBC441: Computational Systems Biology
- ENBC445: Spatial Control of Biological Agents

PTK #2
Teaching strengths: Computer programming and machine learning.
Capable of teaching:
- ENBC301: Introduction to Biocomputational Engineering
- ENBC311: Python for Data Analysis
- ENBC312: Object Oriented Programming in C++

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[1] List of current BIOE TTK and PTK faculty is included at the end of appendix 3.

- ENBC321: Machine Learning for Data Analysis
- ENBC322: Algorithms
- ENBC411: Advanced Programming in Python
- ENBC425: Imaging and Image Processing

PTK #3

Teaching strengths: Biomedical engineering and biotechnology.

Capable of teaching:
- ENBC301: Introduction to Biocomputational Engineering
- ENBC351: Quantitative Molecular and Cellular Biology
- ENBC352: Molecular Techniques Laboratory
- ENBC353: Synthetic Biology
- ENBC455: Bioinformatics Engineering
- ENBC491: Senior Capstone Design in Biocomputational Engineering

PTK #4

Teaching strengths: Mathematical methods in engineering, programming.

Capable of teaching:
- ENBC301: Introduction to Biocomputational Engineering
- ENBC311: Python for Data Analysis
- ENBC312: Object Oriented Programming in C++
- ENBC321: Machine learning for Data Analysis
- ENBC331: Applied Linear Systems and Differential Equations
- ENBC332: Statistics, Data Analysis, and Data Visualization
- ENBC342: Computational Fluid Dynamics and Mass Transfer
- ENBC425: Imaging and Image Processing
- ENBC431: Finite Element Analysis

Current List of Fischell Department of Bioengineering TTK and PTK Faculty

Faculty Name	Rank
Aranda-Espinoza, Helim	Associate Professor
Bentley, William	Professor
Clyne, Alisa	Associate Professor
Duncan, Gregg	Assistant Professor
Eisenstein, Edward	Associate Professor
Fisher, John	Professor
He, Xiaoming	Professor
Herold, Keith	Professor Emeritus
Huang, Huang-Chiao	Assistant Professor
Jay, Steven	Associate Professor

Jewell, Christopher	Associate Professor
Johnson, Arthur	Professor Emeritus
Jones, Angela	PTK
Locascio, Laurie	Professor
Ma, Lan	PTK
Maisel, Katharina	Assistant Professor
Matysiak, Silvina	Associate Professor
Montas, Hubert	Associate Professor
Pranda, Marina	PTK
Scarcelli, Giuliano	Assistant Professor
Stroka, Kimberly	Assistant Professor
Tao, Yang	Professor
White, Ian	Associate Professor
Zhang, Li-Qun	Professor

Appendix 4: Library Assessment

DATE: September 24, 2019

TO: Ian M. White

               Associate Chair and Director of Undergraduate Studies

               Fischell Department of Bioengineering

FROM: On behalf of the University of Maryland Libraries:

               Sarah Over, Engineering Librarian

               Amy Trost, Data Services Librarian, Priddy Library

               Maggie Saponaro, Head of Collection Development Strategies

               Daniel Mack, Associate Dean, Collection Strategies & Services

RE: Biocomputational Engineering Library Collection Assessment

We are providing this assessment in response to a proposal by the Bioengineering Department in the A. James Clark School of Engineering to create a new major in Biocomputational Engineering to be offered at the Universities at Shady Grove. The request asked that we at the University of Maryland Libraries assess our collection resources to determine how well the Libraries support the curriculum of this proposed program.

Serial Publications

The University of Maryland Libraries currently subscribe to a large number of scholarly journals, with almost all in online format that focus on various areas in bioengineering, computation, and data science, including those relevant to this proposed program in biocomputational engineering such as machine learning. Those serials not available online can be requested via the article/chapter request form within Interlibrary Loan (ILL, https://www.lib.umd.edu/access/ill) so that faculty and students at Shady Grove can utilize these publications without traveling to College Park.

The Libraries subscribe to many of the top ranked journals that are listed in the Biotechnology & Applied Microbiology, Computer Science – Interdisciplinary, and Engineering, Biomedical categories in *Journal Citation Reports.** These journals include the following, all of which are available online:

- **Nature Biotechnology**

- **Biotechnology Advances**

- **IEEE Transactions on Pattern Analysis and Machine Intelligence**

- **Annual Review of Biomedical Engineering**

- **Medical Image Analysis**

- **IEEE Transactions on Biomedical Engineering**

- **IEEE Journal of Biomedical and Health Informatics**

- **Machine Learning**

- **Other IEEE publications**

Since biocomputational engineering involves medicine as well, there are highly-ranked core journals to which the Libraries in College Park do not currently subscribe to as these are available at other UMD institutions (i.e. Baltimore). However, articles in journals that we do not own likely will be available through ILL (more details given later in this document).

*Journal Citation Reports is a tool for evaluating scholarly journals. It computes these evaluations from the relative number of citations compiled in the *Science Citation Index* and *Social Sciences Citation Index* database tools.

Databases

The Libraries' *Database Finder* (http://www.lib.umd.edu/dbfinder) resource offers online access to databases that provide indexing and access to scholarly journal articles and other information sources. Many of these databases cover subject areas that would be relevant to this proposed program, especially due to the variety of applications for biocomputational engineering. Databases that would most be useful for this program include: *ACM Digital Library*, *BioOne*, *IEEE Xplore*, *IEEE/Wiley eBooks*, *Merck Index*, and *Springer eBooks in Computer Science*. Some of the more interdisciplinary databases that would be relevant to this curriculum include: *Knovel*, *ScienceDirect*, *SIAM eBooks*, *SPIE eBook Collection*, and *Web of Science.* The Libraries also indexes free/open databases such as *PubMed* in its database list that this program can take advantage of for instruction.

In many and likely in most cases, these indexes offer full text copies of the relevant journal articles. In those instances that the journal articles are available only in print format, the Libraries can make copies via Interlibrary Loan article/chapter request.

Monographs

The Libraries regularly acquire scholarly monographs in a variety of topics relevant to biocomputational engineering. Monographs not already part of the collection can usually be added directly to the collection at Shady Grove upon request.

A search of the University of Maryland Libraries' WorldCat UMD catalog was conducted for monographs, using a variety of relevant subject terms. UMD owns thousands of titles relevant to this proposed program, including:

- **Bioengineering – 1266 items**

- **Bioinformatics – 2314 items**

- **Biotechnology – 6286 items**

- **Data visualization – 638 items**

- **Machine learning – 3335 items**

In addition, we own hundreds of monographs published within the last five years, insuring the program has access to relevant and recent holdings.

A further search revealed that the Libraries' membership in the Big Ten Academic Alliance (BTAA) dramatically increases these holdings with an increase to 4682 title-search results for "bioinformatics" and 8789 results for "machine learning." As with our own materials, students can request that chapters from these BTAA books if the books are not available electronically. Finally, monographs can be sent to Priddy Library for pickup, avoiding the need to travel to College Park, which may be inconvenient for students and faculty in this program.

Interlibrary Loan Services

These services offer online delivery of bibliographic materials that otherwise would not be available online. As a result, these services are especially helpful for users at Shady Grove (or online courses). All Interlibrary Loan services are available free of charge for users.

The article/chapter request within ILL scans and delivers journal articles and book chapters either from UMD's print collection or another university. In most cases, the article or chapter will be delivered electronically to the user within three business days. Book requests within ILL are generally fulfilled in print format with the requested item sent to the location specified by the user. Time for fulfillment depends on the location the book is coming from, but for other Maryland institutions and the BTAA, this may be as little as a couple days.

Additional Materials and Resources

In addition to the serials, monographs, and databases available, students in the proposed program will have access to a wide range of media, datasets, software, and technology. In College Park, media is available in a variety of formats that can be utilized both on-site and via ELMS course media. GIS Datasets are available through the GIS Data Repository (http://www.lib.umd.edu/gis/dataset) while statistical consulting and additional research support is available through the Research Commons (http://www.lib.umd.edu/rc) and technology support and services are available through the Terrapin Learning Commons (http://www.lib.umd.edu/tlc).

Students can access print textbooks required for their classes through Priddy Library's Course Reserves program. This is a critical service due to the rising cost of textbooks.

Additionally, although not likely to be highly used by this program, UMD does have a number of microform collections, which may be of use for interdisciplinary portions of the curriculum. Finally, the STEM Library has patent and trademark consultation services, which are provided by our Patents & Trademarks librarian, James Miller (jmiller2@umd.edu).

The engineering subject specialist at Shady Grove, Amy Trost (atrost1@umd.edu, 301-738-6122), and the subject specialist librarian for Bioengineering in College Park, Sarah Over (sover@umd.edu, 301-405-9142) will both serve as important resources to programs such as the one proposed.

Other Research Collections

Because of the University's unique physical location near Washington D.C., Baltimore and Annapolis, students and faculty have access to some of the finest libraries, archives and research centers in the country vitally important for researchers in this discipline. These include the Library of Congress, the National Archives, the Smithsonian, and more.

Conclusion

With our substantial journals holdings and databases, as well as additional support services and resources, the University of Maryland Libraries have the resources to support teaching and learning in biocomputational engineering. These materials are supplemented by a strong monograph collection and additional holdings through the Big Ten Academic Alliance. Although there is a deficiency in the medical serials, these are not likely to be heavily used by students at the undergraduate engineering level, and those needed by faculty teaching courses can be requested via Interlibrary Loan. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Biocomputational Engineering program to be offered at the Universities at Shady Grove.

Appendix 5: Financial Tables

Resources and Expenditures
Biocomputational Engineering Proposal

TABLE 1: RESOURCES

Resources Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1.Reallocated Funds					
2. Tuition/Fee Revenue (c+g below)	$ 233,600	$ 481,216	$ 743,479	$ 893,414	$ 1,051,675
a. #FT Students	20	40	60	70	80
b. Annual Tuition/Fee Rate	$ 11,680	$ 12,030	$ 12,391	$ 12,763	$ 13,146
c. Annual FT Revenue (a x b)	$ 233,600	$ 481,216	$ 743,479	$ 893,414	$ 1,051,675
d. # PT Students	0	0	0	0	0
e. Credit Hour Rate	$ 485.00	$ 499.55	$ 514.54	$ 529.97	$ 545.87
f. Annual Credit Hours	16	16	16	16	16
g. Total Part Time Revenue (d x e x f)	$ -	$ -	$ -	$ -	$ -
3. Grants, Contracts, & Other External Sources	$ -	$ -	$ -	$ -	$ -
4. Other Sources	$ 900,000	$ 900,000	$ 900,000	$ 900,000	$ 900,000
TOTAL (Add 1 - 4)	**$1,133,600**	**$1,381,216**	**$1,643,479**	**$1,793,414**	**$1,951,675**

Tuition revenue is based on AY19-20 rates for the A. James Clark School of Engineering. It does not include mandatory fees or laboratory fees. Other Sources assumes support from the Governor's Workforce Development Initiative targeted towards programs to be delivered at the Universities at Shady Grove.

TABLE 2: EXPENDITURES

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Full time Faculty (b+c below)	$665,000	$684,950	$846,598	$871,996	$898,156
a. #FTE	5.0	5.0	6.0	6.0	6.0
b. Total Salary	$500,000	$515,000	$636,540	$655,636	$675,305
c. Total Benefits	$165,000	$169,950	$210,058	$216,360	$222,851
2. Part time Faculty (b+c below)	$60,000	$60,000	$60,000	$60,000	$60,000
a. #FTE	1.0	1.0	1.0	1.0	1.0
b. Total Salary	$60,000	$60,000	$60,000	$60,000	$60,000
c. Total Benefits	$0	$0	$0	$0	$0
3. Admin. Staff (b+c below)	$279,300	$287,679	$395,079	$406,932	$419,139
a. #FTE	3.0	3.0	4.0	4.0	4.0
b. Total Salary	$210,000	$216,300	$297,052	$305,964	$315,142
c. Total Benefits	$69,300	$71,379	$98,027	$100,968	$103,997
4. Technical Support staff (b+c below)	$106,400	$109,592	$112,880	$116,266	$119,754
a. #FTE	1.0	1.0	1.0	1.0	1.0
b. Total Salary	$80,000	$82,400	$84,872	$87,418	$90,041
c. Total Benefits	$26,400	$27,192	$28,008	$28,848	$29,713
5. Graduate Assistants (b+c below)	$26,600	$53,200	$53,200	$79,800	$79,800
a. #FTE	1.0	2.0	2.0	3.0	3.0
b. Stipend	$20,000	$40,000	$40,000	$60,000	$60,000
c. Tuition Remission + benefits	$6,600	$13,200	$13,200	$19,800	$19,800
6. Equipment	$20,000	$20,000	$20,000	$20,000	$20,000
7. Library	$5,000	$5,000	$5,000	$5,000	$5,000
8. New or Renovated Space	$0	$0	$0	$0	$0
9. Marketing/Advertising	$25,000	$25,000	$25,000	$25,000	$25,000
10. Other Expenses: Operational Expenses	$50,000	$50,000	$50,000	$50,000	$50,000
11. Office Space Rental	$10,500	$10,815	$11,139	$11,474	$11,818
12. Classroom Rental	$0	$9,000	$9,270	$9,548	$9,835
13. OES admin fee	$23,360	$48,122	$74,348	$89,341	$105,168
14. Admin increments/overloads	$20,000	$20,000	$20,000	$20,000	$20,000
15. Scholarships	$75,000	$75,000	$75,000	$100,000	$125,000
TOTAL (Add 1 - 15)	$1,366,160	$1,458,358	$1,757,514	$1,865,357	$1,948,670