

**BOARD OF HIGHER EDUCATION
REQUEST FOR BOARD ACTION**

NO: BHE 20-12

BOARD DATE: May 5, 2020

**APPROVAL OF LETTER OF INTENT OF BRIDGEWATER STATE UNIVERSITY TO
AWARD THE BACHELOR OF SCIENCE IN PHOTONICS AND AUTHORIZATION
FOR FAST TRACK REVIEW**

MOVED: The Board of Higher Education (BHE) has evaluated the Letter of Intent of Bridgewater State University to award the **Bachelor of Science in Photonics** and has determined that the proposal aligns with BHE criteria. Accordingly, the BHE authorizes the Commissioner to review the program and to make a final determination on degree granting authority pursuant to the Fast Track review protocol.

VOTED: Motion adopted by BHE 5/5/2020.

Authority: Massachusetts General Laws Chapter 15A, Section 9(b); AAC 18-40.

Contact: Winifred M. Hagan, Ed.D., Senior Associate Commissioner for Strategic Planning and Public Program Approval

**BOARD OF HIGHER EDUCATION
May 2020**

**Bridgewater State University
Letter of Intent (LOI)**

Bachelor of Science in Photonics and Optical Engineering

DEGREE TITLE ABSTRACT ON INTENT AND MISSION OF PROGRAM

Bridgewater State University's (BSU) proposed B.S. in Photonics and Optical Engineering (BS/POE), in collaboration with regional, state, and national partners is expected to train and educate students to support an expanding advanced manufacturing workforce, research, and development in tele- and data-communication, precision measurements, biomedical sensing and imaging, optic and laser development, auto-driving, and other advanced manufacturing industries in Massachusetts. It is also planned that the BS/POE will fill a higher education void by providing the only undergraduate program in photonics and optical engineering in Massachusetts. It is further expected to support regional, state, and national investments (e.g., AIM Photonics) in innovation and research in the area of integrated photonics and optics, as well as provide access to, and support for the Massachusetts network of Labs for Education and Application of Prototypes (LEAPs) housed at Bridgewater, the Massachusetts Institute of Technology, Worcester Polytechnical Institute, Quinsigamond Community College, and Stonehill College, enabling both the fabrication of prototypes and initial proof of manufacturing and the creation of new high-tech integrated photonics manufacturing jobs. Finally, it is planned that the proposed program will provide an option for engineering in a developing field for students from underrepresented communities at an accessible institution of public higher education.

Bridgewater State University's proposed program LOI has obtained all necessary governance approvals and was approved by the Bridgewater State University Board of Trustees on December 5, 2019. The LOI was circulated on January 11, 2020. No comments were received.

A. ALIGNMENT WITH MASSACHUSETTS GOALS FOR HIGHER EDUCATION

Address Gaps in Opportunity and Achievement in Alignment with Campus-Wide Goals

Each program in the Bartlett College of Science and Mathematics at BSU, works to ensure accessibility and affordability for all students, close gaps in student opportunity and achievement, and improve college completion rates. BSU regularly assesses progress in this work and make reasonable and intentional changes for improvement.

BSU faculty and staff members in the Department of Physics are committed to equity and have a well-established record of creating internally- and externally-funded programs which help students find pathways to success in their academic programs and STEM careers. They are Principle Investigators on grants to provide scholarships to low income students, future teachers and other programs designed to support underserved students in the sciences, especially women and students of color. The faculty in the department are authors on publications focused

on student success in the sciences and lead outreach activities on campus and in local schools, that allow students from a variety of different backgrounds to learn more about science and mathematics. The faculty and staff members in Physics will continue to work with members of the college, the wider BSU campus, and local and professional communities, to make the BSU engineering program accessible, affordable, valuable, and achievable. BSU notes that the proposed new B.S. degree will be the first undergraduate engineering program in photonics and optics in the state of Massachusetts and the region, and one of the few in the nation. It is also planned to be a more affordable engineering programs in the state. The program is expected to create a new range of opportunities at an institution that is teaching-intensive, student-centered, and prepared to serve a wide diversity of students while supporting a growing workforce need. BSU has clear articulation agreements with three regional community colleges in all the science and mathematics disciplines. Initial work is underway to expand these articulation agreements and advertise new programs to faculty and students at community colleges. In addition, BSU partners with Stonehill College to provide a Certificate in Advanced Manufacturing in Photonics and Optics. This 15-month program is designed to prepare high school graduates and job re-trainers with the skills needed to participate in advanced manufacturing. As the degree program is developed, a pathway will be developed for graduates of the Certificate program to return to BSU to complete a 4-year degree.

Program or Department Supports to Ensure Student Retention and Completion

BSU Physics faculty are reported to be leaders in teaching and faculty development, who have demonstrated strong skills in research, teaching and at new course and lab development. In particular, BSU Physics has been a regional and national leader in the development of next-generation physics and optics labs, leading to successful placement of graduates in optics companies in MA and the nation. The department plans to learn more about how to implement strong student supports unique to engineering. The department will seek and obtain accreditation for the program through ABET, the industry standard for engineering accreditation, which will help the program market a strong program providing students with industry and manufacturing ready skills. The Bartlett College has experience with ABET accreditation in the Department of Computer Science.

Alliances and Partnerships with PK-12, Other IHE's, Community Employers

The development of the Photonics and Optical Engineering degree program has been aided by collaborations with MIT, AIM Photonics, MassTech, and faculty from the Rose Hulman Institute for Technology and the University of Central Florida. BSU will create an Advisory Board consisting of Higher Education leaders, industry leaders and regional company executives in Photonics and Optics. The program will make strong use of existing connections to Bristol, Massasoit, and Cape Cod Community Colleges, including the established CC2BSU programs, to invite students to attend open houses and ultimately transfer and complete a bachelor's degree at BSU. Likewise, the department will work to recruit students from its strong network of high school physics teachers.

Relationship to MassHire Regional Blueprints

Photonics and Optical Engineering are shown to be fast growing areas for employment nationally and regionally. As a result, BSU has engaged with MIT to create a program for technician training and with MassTech to provide equipment for degree programs. AIM

Photonics (an industry leading partnership) estimates 600 job postings annually in photonics and optical engineering in MA and the surrounding New England Region.

Duplication

The proposed BS/POE program is not provided at the undergraduate level in the New England Region. Several schools (UMass Lowell, MIT, BU) have Master's or Ph.D.-level programs, but none have dedicated undergraduate programs. The proposed program is expected to provide a clear pathway to graduate programs in photonics and optics in the state.

Innovative Approaches to Teaching and Learning

This is a lab-based engineering program, which will consistently involve students in active learning that considers environmental impact, societal need, and economic viability. To support this program, new digital resources in the library will be required, following standard science-based curriculum support. A substantial investment in advanced equipment will be made to allow for true active, learner-centered pedagogy. Specifically, BSU plans that all graduates will have completed a two-semester Senior Design sequence where each student selects a project that is relevant to a regional company, conducts a study of the needs and societal impacts related to the project, and designs, manufactures, and tests their solution. Students will prepare detailed written and oral presentations related to all facets of the engineering design and testing of their solutions. As part of the required Senior Design sequence, all students will partner with regional companies or conduct lab-based research, providing a built-in high-impact, capstone experience which graduates will be able to highlight when applying for jobs.

B. ALIGNMENT WITH CAMPUS STRATEGIC PLAN AND MISSION

Priority Rationale and Support of Strategic Plan and Overall Mission of Institution

It is planned that the BS/POE will directly address strategic goals for BSU and as mentioned previously it is planned to provide an option for engineering in a developing field for students from underrepresented communities at an accessible institution of public higher education. BSU will focus resources and decisions on the overarching priority of student success, provide a teaching and learning environment with opportunities for intellectual, creative and professional growth, and serve as a regional catalyst for economic, cultural and intellectual engagement. Providing dynamic learning environments, invest in high-impact practices and the people who advance them.

Overall Goals, Learning Objectives, Outcomes Evaluation (see Form B Appendices)

The B.S. in Photonics and Optical Engineering will prepare graduates to work with integrity towards solutions to significant world challenges through applications of photonics and optical engineering. The program will provide a strong base in foundational knowledge in physics, which graduates will apply throughout their careers, and help graduates to excel individually and contribute to economic growth and world challenges.

Student outcomes are designed to be consistent with ABET accreditation requirements for engineering programs. It is expected that graduates will have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Graduates will be able 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, and to communicate effectively with a range of audiences. Graduates will be expected 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, and to function effectively on a team providing leadership, creating a collaborative and inclusive environment, establishing goals, planning tasks, and meeting objectives. BSU will also expect graduates to be able to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions, as well as acquire and apply new knowledge as needed, using appropriate learning strategies.

C. ALIGNMENT WITH OPERATIONAL AND FINANCIAL OBJECTIVES OF INSTITUTION

Enrollment Projections (see Form C Appendices)

The projected enrollment for the proposed program is 50 total majors at full capacity in five years. BSU anticipates growth as follows: 2020-2021: 10 majors // 2021-2022: 20 majors // 2022-2023: 35 majors // 2023-2024 & after: 50 majors. It is anticipated that the program may slightly decrease the number of majors in Physics-related programs, but will not significantly draw from other programs. BSU expects that as its' first engineering major, the program will likely attract new students who would not otherwise have considered Bridgewater State University.

Resources and Financial Statement of Estimated Net Impact on Institution (see FORM D Appendices)

The BS/POE will require resources in personnel, facilities, equipment, and efforts to develop and maintain connections to regional industries. Offsetting these needs, the program will provide three new revenue opportunities. The creation of the first undergraduate engineering program at a state university, outside of specialized programs at Mass Maritime, presents new opportunities for serving students and is expected to attract new, highly qualified students to BSU. Second, photonics and optical engineering are critical industries, supported by a wide network of grant opportunities through the National Science Foundation (NSF), Department of Energy (DoE), Department of Defense (DoD), and the Commonwealth of Massachusetts. Already, BSU participates in a grant of over \$200,000 in collaboration with MIT from the Department of Defense to create a technician-training program. A \$1.4 million grant for equipment funded by AIM Photonics (DoD) and the Commonwealth's MassTech Initiatives has been secured and will provide needed educational, research and design equipment. Third, the program will result in new industry, state, and academic partnerships leading to future support while lending prestige to BSU in unique, marketable ways. In total, a fully operating BS/POE at BSU is expected to require 2 additional tenure track faculty (hired for fall 2019), 2 new and renovated faculty and student research lab spaces (work begun fall 2019), one lightly renovated teaching lab, and significant equipment. The program will be housed in the existing Department

of Physics, which will be renamed to reflect the new degree, with both programs led by one department chair and served by one existing administrative assistant. The academic program will dovetail with physics and other BSU course offerings, so that enrollment in some classes will increase, but remain within existing course caps, and not require a significant number of new course sections.

BSU has committed to roughly \$700,000 in renovation costs in FY2020 and FY 2021. The main equipment needed to initialize the program is being provided by two grants that have been secured. Recurring costs of faculty and needed increases in departmental budget for travel, small equipment and repairs total \$220,000 annually, so that enrollment increases will lead to sufficient revenue to maintain the program.

STAFF REVIEW AND VALIDATION

Staff thoroughly reviewed the **LOI** proposing full degree granting authority for the **Bachelor of Science in Photonics and Optical Engineering** submitted by **Bridgewater State University**. Staff validate that the LOI includes all data required by the Massachusetts Board of Higher Education. Staff recommendation is for BHE authorization for the Commissioner to review the program pursuant to the Fast Track review protocol.

**Form A: BS Photonics and Optical Engineering
Curriculum Outline**

Required (Core) Courses in the Major (Total # courses required =22)		
<i>Course Number * indicates new courses developed specifically for the program.</i>	Course Title	Credit Hours
PHYS 211	Machine Shop	1
PHYS 243	General Physics I	4
PHYS 244	General Physics II	4
PHYS 416	Modern Theory	3
PHYS 422	Computational Methods in Physical Sciences	3
PHYS 438	Electricity and Magnetism	3
PHOE 301 *	Foundations of Photonics and Optical Engineering	4
PHOE 323 *	Optical Engineering	4
PHOE 330 *	Fiber Optic Communication with Lab	4
PHOE 342	Digital and Electronic Devices	4
PHOE 403	Semiconductor Devices	3
PHOE 420 *	Laser Engineering	4
PHOE 450 *	Photonics Integrated Circuit Design	3
PHOE 455	Advanced Optics	3
PHOE 483 *	Senior Design I	3
PHOE 484 *	Senior Design II	3
MATH 161	Calculus I	4
MATH 162	Calculus II	4
MATH 261	Multivariable Calculus	4
PHYS 403	Mathematical Methods in Physics	3
CHEM 141	General Chemistry I	4
CHEM 142	General Chemistry II	4
	Sub Total Required Credits	76
Elective Courses (Total # courses required = 3) (attach list of choices if needed)		
PHYS 414	Experimental Physics	4
PHYS 433	Thermal Physics	3
PHYS 434	Quantum Mechanics	3
PHYS 490	Engineering Statics and Dynamics	4

PHOE 332 *	Imaging and Display	4
PHOE 452 *	Testing and Characterization	4
PHOE 456 *	Nonlinear Optics	3
PHOE 465 *	Quantum Optics	3
	Sub Total Elective Credits	9 to 12
Distribution of General Education Requirements (Core Requirements)		#of Gen Ed Credits
Attach List of General Education Offerings (Course Numbers, Titles, and Credits)		43 credits or more (# varies)
BSU's Core Curriculum requirements		
Core Skills: ENGL 101 Writing Rhetorically (3 credits); ENGL 102 Writing Rhetorically with Sources (3 credits); COMM 102 Introduction to Public Speaking or THEA 210 Oral Interpretation of Literature (3 credits); PHIL 111 Foundations of Logical Reasoning or MATH 180 Transition to Advanced Mathematics (3 credits); and Foundations of Mathematical Reasoning – several courses possible (3 credits).		15
Arts: Several courses possible		6
Humanities: Several courses possible		9
Natural Sciences: These are completed by the requirements of PHYS 243 and 244.		7
Social and Behavioral Sciences: Several courses possible.		6
BSU's Core Curriculum also requires that students take courses to fulfill requirements in Writing/Speaking, Global Culture, Multiculturalism, Quantitative Skills, and US and Massachusetts Constitutions. Total number of credit will vary, depending on the student's choice of courses.		varies
Sub Total General Education Credits		43 or more, # varies
Curriculum Summary		
Total number of courses required for the degree		40 3 credit courses (or equivalent)
Total credit hours required for degree		120
Prerequisite, Concentration or Other Requirements:		

Form B: LOI Goals and Objectives

Goal	Measurable Objective	Strategy for Achievement	Timetable
Develop, offer and assess effectiveness of all courses	All courses in major have been offered, artifacts from each class related to ABET Assessment Table Collected and Evaluated	Chair schedules classes, and PHOE Assessment Committee reviews samples for continuous program improvement	On-going, with all new classes taught once before Spring 2023
Create and implement assessment plans consistent with ABET	Rubrics created for all assignments & artifacts	Assigned to PHOE Assessment Committee	Completed by December, 2021
	Repository (digital and hard-copy) created	Assigned to Department Chair	Completed Fall 2020
Purchase and set up equipment and labs	\$1,440,000 equipment purchased and set up from grants plus an additional \$500,000 in University Cost-share funds	Dr. Ed Deveney, Dr. Elif Demirbas and Dr. Samuel Serna Otalvaro work to identify and purchase equipment, set up labs	\$1.4 million by Jan. 2021, ~\$275k by Jan. 2022, ~\$275k by Jan. 2023
Develop standing recruitment procedures and meet enrollment targets	Timelines and Benchmarks set by Office of Marketing and Communications for Recruitment	Assigned to Department Chair and Office of Marketing and Communications, Office of Admissions	On-going, with continuous review
	Enrollment Targets are met (see Program Enrollment Projection Table below)	Assigned to Admissions, Dept. Chair and PHOE Committee who will visit schools and Community Colleges	On-going, with continuous review
Prepare and apply for ABET accreditation	Existence and use of rubrics & artifact repository; Minutes from PHOE Assessment Committee demonstrate review of program	Assigned to Department Chair and PHOE Assessment Committee	On-going, with continuous review
	Application for ABET Accreditation	Assigned to Department Chair and PHOE Assessment Committee	After 1 st graduate, roughly 2023
Graduate Students with B.S. in Photonics and Optical Engineering	Approximately 60% of graduates begin work in industry, with roughly 1 graduate per year entering K-12 teaching	Department Faculty and Staff create, implement strong program, Department Chair tracks graduates for job and graduate school placement	After 1 st graduate, roughly 2023
	Approximately 40% of graduates pursue advanced studies in graduate programs.		

Form C: LOI Program Enrollment

	Year 1	Year 2	Year 3	Year 4	Year 5
New Full-Time	10	15	15	15	15
Continuing Full-Time	0	8	21	35	35
New Part-Time	1	1	2	2	2
Continuing Part-Time	0	1	2	3	3
Totals	11	25	40	55	55

Form D: LOI Program Budget

One Time/ Start Up Costs	Cost Categories	Annual Expenses				
		Year 1 – FY 2021	Year 2 – FY 2022	Year 3 – FY 2023	Year 4 – FY 2024	Year 5 – FY 2025
	Full Time Faculty (Salary & Fringe)	\$199,734	\$203,729	\$207,804	\$211,960	\$216,199
	Part Time/Adjunct Faculty (Salary & Fringe)	----	----	----	----	----
	Staff	----	----	----	----	----
	General Administrative Costs	\$10,000 (shared with Physics)	\$10,000 (shared with Physics)	\$10,000 (shared with Physics)	\$10,000 (shared with Physics)	\$10,000 (shared with Physics)
	Instructional Materials, Library Acquisitions	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
	Facilities/Space/Equipment	\$300,000	\$280,000	\$15,000	\$15,000	\$15,000
	Field & Clinical Resources	----	----	----	----	----
	Marketing	\$20,000	\$20,000	\$10,000	\$10,000	\$10,000
	Faculty Development and Travel	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
	TOTALS	\$532,734	\$516,729	\$245,805	\$249,960	\$256,799

One Time/Start-Up Support	Revenue Sources	Annual Income				
		Year 1 – FY 2021	Year 2 – FY 2022	Year 3 – FY 2023	Year 4 – FY 2024	Year 5 – FY 2025
	Grants: Two Funded Grants (one from MassTech, one subcontract from MIT funded by Office of Naval Research)	\$285,000	\$250,000	----	----	----
	Tuition & Fees: 10.5, 24.0, 38.0, 52.5, 52.5 full time students at \$10,732 annually	\$112,686	\$257,568	\$407,816	\$564,430	\$564,430
	Departmental					
	Reallocated Funds					
	Other (specify)					
	TOTALS	\$397,686	\$507,568	\$407,816	\$564,430	\$564,430