

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

COMMITTEE Academic Affairs

NO. AAC 21-08

COMMITTEE DATE: April 27, 2021

BOARD DATE: May 4, 2021

**APPROVAL OF LETTER OF INTENT OF THE UNIVERSITY OF MASSACHUSETTS
LOWELL TO AWARD THE BACHELOR OF SCIENCE IN ENGINEERING PHYSICS AND
AUTHORIZATION FOR FAST TRACK REVIEW**

MOVED: The Board of Higher Education (BHE) has evaluated the Letter of Intent of the **University of Massachusetts Lowell** to award the **Bachelor of Science in Engineering Physics** 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 AAC 4/27/2021; adopted by BHE 5/4/2021.

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
April 27, 2021
University of Massachusetts Lowell
Letter of Intent
Bachelor of Science in Engineering Physics

DEGREE TITLE ABSTRACT ON INTENT AND MISSION OF PROGRAM

The intent of the proposed program in the Department of Physics and Applied Physics at the University of Massachusetts Lowell (UML) is to fill the need for a workforce trained in technologies where the traditional disciplinary lines between science and engineering are being merged. The program is intended to build on the existing strengths and capacities of the department, housed in the Kennedy College of Sciences, together with the Francis College of Engineering. The proposed program will offer concentrations in mechanical and electrical engineering and is a unique program in the five-campus UMass system. The proposed program is intended to provide an initial focus on foundational knowledge followed by specialization at upper levels, enabling students to have the time and freedom to explore their strengths. The proposal is also intended to increase bachelor of science enrollments at UML.

The proposed Bachelor of Science in Engineering Physics was approved by the University of Massachusetts' Board of Trustees on December 5, 2018. The LOI was circulated on January 6, 2021. No comments were received.

A. ALIGNMENT WITH MASSACHUSETTS GOALS FOR HIGHER EDUCATION

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

The mission of UML is to prepare students to succeed as lifelong learners and informed citizens. The proposed Engineering Physics (EP) program is reported to be aligned with

this mission by offering an affordable undergraduate degree that prepares students for professional careers. The proposed program has been designed to meet campus goals of gender equity as well as improving inequities for under-represented students in STEM. UML reported a slow but steady increase in the percent of women students at the university, from 38% of the 2018 incoming class to 41% of the 2020 incoming class. As well, UML has assembled a gender diversity steering committee chaired by the Associate Dean of Engineering, in addition to other initiatives including the Research, Academics and Mentoring Pathways (RAMP) program, which offers incoming, first-year, and transfer students the chance to start their coursework early, collaborate on research projects and get a sense of what the engineering field and UML college-life is like. The National Science Foundation has awarded UML a \$3.5M grant for "Making WAVES" to promote and support women and STEM. The Physics Department Chair is affiliated with the WAVES initiative as an Equity Leader. WAVES is a faculty team responsible for developing and offering Bystander Intervention Training Workshops on campus, which seek to address subtle bias and micro-aggressions, and to promote an inclusive climate for all members of the UML community. The Chair of Physics also led the Department to be accepted as a member of the American Physical Society's Inclusion, Diversity and Equity Alliance (APS-IDEA). This has allowed a departmental team of faculty and students (undergraduate and graduate) to actively engage with other institutions through discussions at the national level, and to learn how to effect change in culture from the ground up.

Program or Department Supports to Ensure Student Retention and Completion

UML plans that the proposed program will have the same checks, balances, advising, mentoring and other support structure and practices that have been in place for existing students and graduates of the B.S. in Physics program. The Associate Chair for

Undergraduate Education acts as the overall advisor for all undergraduate majors in the department, sharing some of the academic advising load with a faculty advising committee. Students are required to meet with their academic advisors every semester and plan their courses for the upcoming semester before they can register for classes. UML has found that this process ensures that the stipulated degree pathways is carefully followed, and students are on track for graduation within the typical four-year. In addressing students who may stop-out or need extra time to complete, UML's College-Based Advising and Centers for Learning engage in a re-enrollment campaign using the CRM Software Salesforce to create caseloads for students who take time off. UML advising and Solution Center Staff reach out to these students and assist them with re-enrollment, with the goal of providing the academic, financial, or other support they need to successfully return to campus. Additionally, UML has close partnerships with two community colleges, Middlesex and Northern Essex. Many students who start at UML take a break and take classes at MCC or NECC for personal or financial reasons. Working with transfer staff at these institutions, UML maintains connections with students for the purpose of bringing them back to UML when the time is right.

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

UML and Middlesex Community College were recently selected to participate in the national Transfer Equity Initiative, which will support cohorts of under-represented students, beginning with recruitment to community college through graduation from the four-year-university. Dual Enrollment and Early College opportunities at UML exist for many high schools in the area, and new partnerships with community colleges described is expected to increase these linkages. For example, as part of the proposed degree program initiative, the Physics Department is building on existing partnerships

with NECC, MCC and BHCC. In addition to working on MassTransfer pathways, UML has submitted federal funding requests for research internship training grants specifically for under-represented minorities. The funding exercise has opened new communication channels between institutions, specifically focused on recruitment of transfer students. UML provided a distinguished slate of charter board members within the full application materials for the proposed program. It was noted that the board was specifically constituted to ensure the proposed program is guided by the relevant and requisite alliances and partnerships needed for its' success. Membership is reported to include a majority of UML alumna with graduation years spanning two decades. Two members are cited as distinguished leaders in education at the Chair and Dean levels and others are in leadership positions in the high-tech industry sector in Massachusetts. One of the board members is a physics teacher at Pentucket Regional High School in West Newbury MA, which has a specific STEM pathway for students interested in studying and applying the engineering design process through hands-on project-based learning. Still other members are, in addition, already current members of the Physics advisory board. UML expects to seek the advice and input of the board members. The proposed program and its' planned initial launch have been and are expected to continue to be significantly informed by the charter members. It is planned that the board will meet annually to assess progress and plan adjustments as appropriate and necessary.

Relationship to MassHire Regional Blueprints

Statistical analysis published in Fall 2020 by the American Institute of Physics, a non-profit organization that has been tracking employment and education trends for over six

decades, indicates that as many as 35% of individuals with new physics bachelor's degrees are employed in engineering positions¹.

The field of employment for recent physics bachelor's in the private sector are overwhelmingly in the engineering and technology sectors, as evidenced by the compiled statistics of about a hundred Massachusetts employers of recent physics bachelor's degree recipients². UML expects that the graduates of the proposed program will be employed as electrical / electronic engineers, mechanical engineers or as physical scientists. These occupations are expected to see a steady growth in Massachusetts in the next ten years³.

Title	Employment 2018	Employment 2028	Change Level	Change Percent	Annual Average Openings
Electrical Engineers	7422	7825	403	5.4%	544
Electronics Engineers	4030	4205	175	4.3%	290
Mechanical Engineers	10125	10399	274	2.7%	722
Engineers. All Other	3468	3587	119	3.4%	255
Physical Sciences, All Other	454	484	30	6.6%	43

¹ American Institute of Physics, 2020, Fields of Employment of New Physics Bachelors. Retrieved 3/25/21 <https://www.aip.org/statistics/physics-trends/field-employment-new-physics-bachelors-17-18>.

² American Institute of Physics, 2020, Who's Hiring Physics Bachelors? Retrieved 3/25/21 <https://www.aip.org/statistics/reports/whos-hiring-physics-bachelors>). A review of these employers reveals that many of them are short on qualified

³ Labor Market Information from The Massachusetts Executive Office of Labor and Workforce Development. Retrieved 3/25/21 <https://lmi.dua.eol.mass.gov/lmi/LongTermOccupationProjections>

⁴ Ibid

UML reports that recent B.S. Physics graduates include hires by Raytheon, Draper Laboratories, and SSG L-3 Communications into engineering positions requiring US citizenship for security clearance.

Duplication

The University of Massachusetts Boston, the University of New Hampshire, Brown University and Tufts University offer a B.S. in Engineering Physics program with a primary goal of producing broadly trained engineers. Worcester Polytechnic Institute offers an engineering-oriented B.S. in Applied Physics. The University of Maine, Orono, the only accredited engineering physics program in New England, offers a curriculum in applied science, with concentrations in one of the traditional engineering fields. There does not appear to be comparable degree programs offered in a physics and applied physics department in the region. UML holds that offering an undergraduate degree in engineering physics will make the institution more competitive in attracting students.

Innovative Approaches to Teaching and Learning

UML's current B.S. in Physics curriculum includes a required laboratory component that is built into each of the four years of the program. The proposed program follows suit with the same theme in the first two years of the program that are designed with common components for any of the B.S. programs at UML. The proposed Engineering Physics program branches out in the third and fourth years into the two specializations of mechanical engineering and electrical engineering, with additional combinations of required and elective upper-level laboratory courses available in the degree pathways. The laboratory sequence starts off with computational and digital techniques as early as the first year and continues to build on this foundation with advanced labs in the junior and senior years. Upper-level lab sequences in the specific engineering disciplines will

be available as electives for this program. Within the full application, UML provided a detailed list of elective courses that will be available for each of the specializations.

B. ALIGNMENT WITH CAMPUS STRATEGIC PLAN AND MISSION

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

UML plans that the proposed B.S. in Engineering Physics will build on the university's prior work and accomplishments in science and engineering. The proposed program is designed to attract students who are excited by the foundational discipline of physics, and who will be able to enter inter-disciplinary fields, as well as specialized areas upon program completion. UML reports that its history and strength in both physics and applied physics is such that the department already has the necessary bandwidth to offer the program with concentrations in electrical and mechanical engineering. It is anticipated that graduates of the programs will work in Massachusetts-based technology companies in diverse sectors such as aerospace, defense, software, optics, and advanced materials. UML underscores that in this way, the institution fulfills its' strategic goals to provide hands-on, real-world education for students, who in turn present as engineers and entrepreneurs for industries.

C. ALIGNMENT WITH OPERATIONAL AND FINANCIAL OBJECTIVES OF INSTITUTION

Enrollment Projections (Form C, Appendices)

UML anticipates that the program will begin with about 20 students in the first year, subsequently adding a new cohort of about 20-25 students per academic year. The Francis College of Engineering expects to have the capacity to grow without requiring

significant additional resources. It is estimated that the additional tuition revenue will be about \$1.5 million per year for a steady state of about 100 students in this program.

*Resources and Financial Statement of Estimated Net Impact on Institution
(Form D, Appendices)*

The proposed curriculum makes use of existing courses offered by the Kennedy College of Sciences and the Francis College of Engineering. The only exception is a first seminar in Engineering Physics, which is planned as a series of invited presentations and workshops by the alumni of the Physics Department involved in engineering projects. While UML plans that new faculty are not needed, a doubling of the number of majors in a new degree program will need a modicum of additional resources. UML plans this to include two graduate teaching assistants and two undergraduate learning assistants to handle the increased load to support the laboratory intensive courses in the freshman and sophomore years; two part time adjunct faculty are planned to backfill additional teaching needs in service courses ; the equivalent of a half-time administrative assistant is planned to work with the undergraduate coordinator and chair on the additional administration, advising and tracking/assessments for the majors in the different degree pathways, funding allocation for external speakers, and initial costs for advertising and publicizing the new program.

Notably, advising of Physics majors is coordinated with a core group of faculty members led by the Associate Chair for Undergraduate Education, with the largest student-to-advisor ratio being 1/12. This allows for very close advisor-student communication and faculty advisors are supported by UML's centrally managed Office of College-Based Advising. The proposed curriculum has been reviewed and vetted by the faculty and chairs of the departments of Mechanical Engineering as well as Electrical & Computer Engineering and is fully supported by the deans of the two colleges (letters of support

were included in the full application). The Physics faculty are reported to have ample teaching and research resources to accommodate an increase in the number of majors from the existing 100 students to about 200 with modest additional funding. These costs are planned to be covered by the additional tuition revenue from anticipated enrollment.

STAFF REVIEW AND VALIDATION

Staff thoroughly reviewed the **LOI** proposing full degree granting authority for the **Bachelor of Science in Engineering Physics** submitted by the **University of Massachusetts Lowell**. 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 A1: LOI Curriculum Outline BS Engineering Physics - ME Option

(detailed list of elective courses provided in full LOI proposa

Required (Core) Courses in the Major (Total # courses required = 30)		
Course Number	Course Title	Credit Hours
PHYS 1120	Freshman Physics Seminar	1
PHYS 1610	Honors Physics I	4
PHYS 1610L	Honors Physics Lab I	2
PHYS 1640	Honors Physics II	4
PHYS 1640L	Honors Physics Lab II	2
PHYS 2690	Honors Physics III	4
PHYS 2100	Modern Physics	3
PHYS 2620	Principles of Lab Automation	3
ENGL 1010	College Writing I	3
ENGL 1020	College Writing II	3
MATH 1310	Calculus I	4
MATH 1320	Calculus II	4
MATH 2310	Calculus III	4
MATH 2340/2360	Differential Equations	3
CHEM 1210	Chemistry I	3
CHEM 1230	Chemistry Lab I	1
CHEM 1220	Chemistry II	3
CHEM 1240	Chemistry Lab II	1
ENGN 2050	Statics	3
MECH 2960	Materials	3
ENGN 2060	Strength of Materials	3
PHYS 3810	Mathematical Physics I	3
PHYS 3820	Mathematical Physics II	3
PHYS 3520	Electromagnetism I	3
PHYS 3930L	Advanced Experimental Physics I	2
MECH 3810	Fluid Mechanics	3
MECH 3820	Heat Transfer	3
PHYS 4130	Mechanics	3
PHYS 4350	Introduction to Quantum Mechanics I	3

PHYS 4540	Physics Capstone	3
	Sub Total Required Credits	87
Elective Courses (Total # courses required = 11) (attach list of choices if needed)		
PHYS/MECH	An upper-level PHYS or MECH elective	3
PHYS/MECH	An upper-level PHYS or MECH elective	3
PHYS/MECH	An upper-level PHYS or MECH elective	3
PHYS/MECH	An upper-level PHYS or MECH elective	3
PHYS/MECH	An upper-level PHYS or MECH elective	3
	An Arts and Humanities elective	3
	An Arts and Humanities elective	3
	An Arts and Humanities elective	3
	A Social Sciences elective	3
	A Social Sciences elective	3
	A Social Sciences elective	3
	Sub Total Elective Credits	33
Distribution of General Education Requirements Attach List of General Education Offerings (Course Numbers, Titles, and Credits)		# of Gen Ed Credits
Arts and Humanities, including Literature and Foreign Languages		9
Mathematics and the Natural and Physical Sciences		9
Social Sciences		9
Sub Total General Education Credits		27
Curriculum Summary		
Total number of courses required for the degree		41
Total credit hours required for degree		120
Prerequisite, Concentration or Other Requirements: This curriculum outline is developed for the Mechanical Engineering track of the BS in Engineering Physics		

Form A2: LOI Curriculum Outline BS Engineering Physics - ECE Option

(detailed list of elective courses provided in full LOI proposal)

Required (Core) Courses in the Major (Total # courses required = 31)		
Course Number	Course Title	Credit Hours
PHYS 1120	Freshman Physics Seminar	1
PHYS 1610	Honors Physics I	4
PHYS 1610L	Honors Physics Lab I	2
PHYS 1640	Honors Physics II	4
PHYS 1640L	Honors Physics Lab II	2
PHYS 2690	Honors Physics III	4
PHYS 2610	Physics of Materials and Devices	3
PHYS 2100	Modern Physics	3
ENGL 1010	College Writing I	3
ENGL 1020	College Writing II	3
MATH 1310	Calculus I	4
MATH 1320	Calculus II	4
MATH 2310	Calculus III	4
MATH 2340/2360	Differential Equations	3
CHEM 1210	Chemistry I	3
CHEM 1230	Chemistry I Lab	1
CHEM 1220	Chemistry II	3
CHEM 1240	Chemistry II Lab	1
EECE 2010	Circuit Theory I	3
EECE 2070	Basic Circuits Lab I	2
EECE 2020	Circuit Theory II	3
EECE 2080	Basic Circuits Lab II	2
EECE 2160	Applications Programming	3
EECE 2650	Logic Design	3
PHYS 3810	Mathematical Physics I	3
PHYS 3820	Mathematical Physics II	3
PHYS 3530	Electromagnetism I	3
PHYS 3540	Electromagnetism II	3
PHYS 3930L	Advanced Experimental Physics I	2

PHYS 4350	Introduction to Quantum Mechanics I	3
PHYS 4540	Physics Capstone	3
	Sub Total Required Credits	88
Elective Courses (Total # courses required = 11) (attach list of choices if needed)		
PHYS	An upper-level or graduate PHYS elective	3
PHYS	An upper-level or graduate PHYS elective	3
PHYS	An upper-level or graduate PHYS elective	3
EECE	An upper-level or graduate EECE elective	3
EECE	An upper-level or graduate EECE elective	3
	An Arts and Humanities elective	3
	An Arts and Humanities elective	3
	An Arts and Humanities elective	3
	A Social Sciences elective	3
	A Social Sciences elective	3
	A Social Sciences elective	3
	Sub Total Elective Credits	33
Distribution of General Education Requirements Attach List of General Education Offerings (Course Numbers, Titles, and Credits)		# of Gen Ed Credits
Arts and Humanities, including Literature and Foreign Languages		9
Mathematics and the Natural and Physical Sciences		9
Social Sciences		9
Sub Total General Education Credits		27
Curriculum Summary		
Total number of courses required for the degree		42
Total credit hours required for degree		121
Prerequisite, Concentration or Other Requirements: This curriculum outline is developed for the Electrical Engineering track of the BS in Engineering Physics		

Form B: LOI Goals and Objectives

Form B: LOI Goals and Objectives

Goal	Measurable Objective	Strategy for Achievement	Timetable
Double number of physics majors	Increased enrollment (freshman/transfers)	Strategic marketing and publicity through peers and alumni	20-25 per year, 100 in 4-5 years
Better connect Science and Engineering	Increased B.S./M.S. enrollment rates	Dual physics/engineering advising and career planning	5 per year B.S./M.S. in 4 years
Establish pipeline for employment	Placement in industry, national labs and academia	Increase Co-op opportunities and placements	First B.S. graduates in 2025
Increase relationships with industry partners	Attendance at regular meetings to discuss and guide programs	Co-op opportunities plus advisory board and seminar invitations	Invites started in 2020
Increase ties with alumni in high-tech sector	Meeting attendance and increased giving for student scholarships	Advisory board and seminar invitations and Co-op placements	Invites started in 2020

Form C: LOI Program Enrollment

	Year 1	Year 2	Year 3	Year 4	Year 5
New Full-Time	25	25	25	25	25
Continuing Full-Time		22	42	60	71
New Part-Time					
Continuing Part-Time					
Totals	25	47	67	85	96

Form D: LOI Program Budget

One Time/ Start Up Costs		Annual Enrollment				
	Cost Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	Full Time Faculty (Salary & Fringe)					
	Part Time/Adjunct Faculty (Salary & Fringe)	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
	Staff (half-time)		\$25,000	\$25,000	\$25,000	\$25,000
	General Administrative Costs					
	Instructional Materials, Library Acquisitions					
	Facilities/Space/Equipment					
	Field & Clinical Resources					
	Marketing	\$10,000	\$5,000			
	Other (Specify)					
	Grad Teaching Assistant Stipends (\$17,000/yr each)	\$17,000	\$25,500	\$35,000	\$35,000	\$35,000
	UG Learning Assistant Stipends (\$9000/yr each)	\$9,000	\$13,500	\$18,000	\$18,000	\$18,000
One Time/Start-Up Support			Annual Income			
	Revenue Sources	Year 1	Year 2	Year 3	Year 4	Year 5
	Grants					
	Tuition (\$15,000/yr) (in-state)	\$375,000	\$705,000	\$1,050,000	\$1,275,000	\$1,440,000
	Fees (\$550/yr) (in-state)	\$13,750	\$25,850	\$36,850	\$46,750	\$52,800

	Departmental					
	Reallocated Funds					
	Other (specify)					
	TOTALS	\$388,750	\$730,850	\$1,086,850	\$1,321,750	\$1,492,800