Senate Reference No. 23-16

MEMORANDUM

TO: 2023-2024 Senate Executive Committee

FROM: K. Fineran

Chair, Graduate Subcommittee

DATE: November 30, 2023

SUBJECT: Graduate Program Proposal: Master’s Degree in Applied Physics

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The Graduate Subcommittee reviewed and supports the proposal from the Department of Physics in the College of Science for a new program: Masters of Science in Applied Physics. We find that the proposal requires no Senate review.

Thank you for the opportunity to review this new program.

Approved	**Opposed**	**Absent**	**Non-Voting**
Kerrie Fineran	Lukmon Otunubi	Alan Legg	Abraham Schwab
Kate White			Terri Swim
Sarah Wagner			
Hadi Alasti			
Lyzbeth King			
John Minnich			
Nurgul Aitalieva			

Degree/Certificate/Major/Minor/Concentration Cover Sheet

Date: 10/25/2023

Institution: Purdue

Campus: Fort Wayne

School or College: College of Science

Department: Physics

Location: On Campus ▾ 80% or more online: Yes ○ No ●

County: Allen

Type: New Degree Level ▾

Program name:

Masters of Science in Applied Physics

Graduate/Undergraduate: Graduate ▾

Degree Code: MS ▾

Brief Description:

The Master of Science in Applied Physics is a program that advances students' physics knowledge, sharpens their experimental and/or computational skills, develops their strength in building quantitative models and utilization of scientific tools in applied physics, and prepares students for a professional career or doctoral studies.

The MSAP program offers opportunities for research &/or courses in Opto-electronics, Materials science, and Acoustics. It is designed to be accessible to those with bachelor's degrees in Physics and closely related fields, such as Math, Chemistry, or Engineering, and to be doable either full-time or part-time in evenings for those who work. We provide supportive, research-based pedagogy with a track record of success. The students will complete the program with experimental, computational, and analytical skills that allow them to apply their physics content knowledge to industrial problems.

Rationale for new or terminated program:

Opto-electronics, materials science, and acoustics are valuable to industry, but not currently addressed by other PFW MS programs. (PFW's Electrical and Mechanical Engineering programs currently focus on other specialties.) National investments in these fields include the 2011 Materials Genome Iniative, the 2018 National Quantum Initiative Act, 2018 move to establish Quantum Information Science research institutes, and the 2022 CHIPS & Science Act. The Greater Fort Wayne Inc Metro Chamber Alliance has identified target industries that include Advanced Materials. Local companies employing many of our Physics BS alumni include Fort Wayne Metals, Raytheon, BAE, Ultra Maritime, and L3Harris. Many of our current students and alumni, as well as other local area physicists, have expressed interest in pursuing this degree opportunity here at Purdue Fort Wayne. There is no other MSAP program in Indiana, though there are some programs with overlapping areas of interest, including at Ball State, IUPUI, and PWL.

CIP Code: 14.1201

Name of Person who Submitted Proposal:

Gang Wang

Contact Information (phone or email): wangg@pfw.edu

Master of Science in Applied Physics

To Be Offered by the College of Science at Fort Wayne Campus

a. Program Description – *The Master of Science in Applied Physics is a program that advances students' physics knowledge, sharpens their experimental and/or computational skills, develops their strength in building quantitative models and utilization of scientific tools in applied physics, and prepares students for a professional career or doctoral studies.*

b. NCES Degree Level[1]: Master's Degree

c. Major: Applied Physics

d. Other (majors or concentrations associated with new degree)

e. Mode of Delivery (Residential [<25% online; Hybrid [25-80% online; Online [> 80% online]):

Residential

f. Prospective Curriculum

Please see details in the full proposal, Appendix 4.

g. Suggested CIP Code for Program: 14.1201

h. Any new or special tuition rate/fee for this program?

[✓ a. No]
b. Yes, PWL
c. Yes, PFW/PNW

i. Admission Requirements – *Please include any specific requirements above and beyond the standard entry requirements for Applicants.*

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[1] National Center for Education Statistics Award Level Definitions

Program Description

Master of Science in Applied Physics
To Be Offered by the College of Science, Purdue University Fort Wayne

1. Characteristics of the Program
   - a. **Campus Offering Program**: Purdue University Fort Wayne
   - b. **Type of delivery:** On-campus only
   - c. **Mode of Delivery:** Classroom/Lab
   - d. **Other delivery aspects:** Capstone Project
   - e. **Academic Unit Offering Program:** Department of Physics in the College of Science

2. Rationale for the Program

a. Institutional Rationale (Alignment with the Institutional Mission and Strengths)

As northeast Indiana's comprehensive metropolitan public university, it is appropriate for Purdue Fort Wayne to have programs that serve and partner with local industry. A Master of Science in Applied Physics (MSAP), with opportunities for research or coursework in opto-electronics, materials science, or acoustics, would fill a niche valuable to industry but not currently addressed by other PFW MS programs. (PFW's electrical and mechanical engineering programs currently focus on other specialties.) Targeting areas of need for local industries would be in keeping with PFW Strategic Plan 2020-2025 Promote Engagement with our Communities Objective 2, Strategic Activity 2.2. "Develop undergraduate and graduate programs that drive economic development, increase social mobility, and address community needs". The most recent Northeast Indiana Target Report has a list of current target industries including vehicles, medical device & technology, and advanced materials.[1] The previous targets included all the current targets, along with defense, which remains a big industry in Fort Wayne. We have many alumni from our Bachelor of Science in Physics program employed in all of these industries, so adding the MSAP would further contribute to meeting the needs of these local industries, and equip individuals in the area to advance in their careers.

The MSAP will build on our award-winning undergraduate program that includes concentrations in biomedical physics, optoelectronics and photonics, engineering physics, computational/mathematical physics, materials science, and astrophysics. Because of the broad foundation that undergirds a physicist's training, they bring a uniquely holistic and basic principles approach to problem-solving. This complements the specialized view of those educated in engineering disciplines. Physicists' core education includes mechanics, electricity & magnetism, quantum mechanics, and thermodynamics, equipping them to communicate with and translate between people of many disciplines, including mechanical engineering, electrical engineering, and chemistry. Multi-disciplinary teams come up with more creative solutions to problems. The American Institute of Physics explains that "Applied physicists use physics or conduct physics research to develop new technologies or solve engineering problems," and lists "Fiber optics, astrophysics, vacuum tunneling, nondestructive testing, acoustics, semiconductors, laser and quantum optics, and condensed matter" as "booming fields at present."[2] In addition, due to their analytic and modelling skills, physicists are often sought for Data Science, Financial Analyst, and a variety of R & D positions. The job title "physicist" essentially does not exist in industry, but

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[1] https://www.greaterfortwayneinc.com/wp-content/uploads/2015/07/Target-Industry-Study_final_-6.6.16.pdf

[2] https://www.aip.org/jobs/profiles/applied-physics-jobs

physicists are valued for their broad foundational understanding and ability to simplify complex problems. Their job titles usually include the word "engineer", but they often perform different functions than those educated as engineers, looking at whole systems instead of specialized parts. Besides all manner of engineering occupations, physicists will be found with the job title material scientist. Materials science is interdisciplinary and involves physicists, chemists, and a variety of engineers. The MSAP curriculum will be designed to be accessible to physics, chemistry, engineering, and math majors.

The Physics Department's culture has long exemplified PFW's core values of Students First, Excellence, Innovation, Diversity & Inclusion, and Engagement. We do this through practices such as building community among students, faculty, and staff; outreach events that share the wonder of physics with the public; research-informed interactive engagement pedagogy in our courses; and requiring research and practical skill development for all students. We have a track record of success at PFW's stated aspiration that "We will prepare students for academic, personal, and professional success. Through an enriching and supportive environment, students will be exposed to new thoughts and ideas, promoting confidence and maximizing their potential." Our exit interviews and informal interactions with alumni indicate they are appreciative of their experiences here, including the relationships built within the department, and the development of their thinking skills. They are professionally successful, most with titles such as electrical engineer, acoustic engineer, optical engineer, systems engineer, design engineer, data scientist, etc.

The number of physics majors who graduated from the PFW Physics BS program in 2019 was in the 90th percentile nationwide for undergraduate only physics programs according to the American Institute of Physics. Over the past 10+ years, about half of our approximately 86 alumni have stayed to work in local industries. Many want further education, but do not necessarily want to pursue a Purdue Fort Wayne MS in Math or Engineering, or an online degree from another institution. Of 21 respondents to a survey of PFW Physics alumni conducted in Spring 2021, 11 were interested and 5 were potentially interested in the proposed MSAP. Several other individuals contacted the department to express interest after the survey was closed. Tapping into this demand aligns with PFW Strategic Plan Enhance Quality of Place Objective 1, Strategic Activity 1.1: "Strengthen our reputation for the quality of student experience and career preparedness, leading to growth in undergraduate and graduate student enrollment," and with the Expected Behavior of contributing "to lifelong learning opportunities."

The MSAP program will be structured to accommodate students working full time by scheduling classes in the early evening, encouraging them to connect their capstone project to their work, and our philosophy of supporting students academically, for example if they need refreshers about past academic subjects. The MSAP can give its graduates the skills and credentials needed to advance to positions of higher responsibility, in alignment with PFW Strategic Plan Expected Behavior of Human Capital Development and Social Mobility through "delivery of relevant degree... programs to build skill sets" and promoting "social mobility through the delivery of educational programs and experiences that benefit the populations of our region." We will pursue ABET accreditation to make the program more valuable to students and employers. Obtaining and maintaining ABET accreditation will require ongoing assessment of the program and "a culture of continuous improvement in all we do", which is also one of PFW's core values.

As given in full detail in the Program Competencies section near the end of this document, the proposed MSAP learning outcomes include goals that match with PFW's values. PFW's mission is to "educate and engage our students and communities with purpose by cultivating learning, discovery, and innovation in an inclusive environment." PFW Strategic Plan has an Expected Behavior of encouraging "the pursuit of new ideas, entrepreneurial thinking, and interdisciplinary collaboration." These values are reflected in the learning outcomes of the "ability to develop and conduct experiments" (Learning Outcome #3), to "demonstrate the role of physics in industry or entrepreneurism" (Learning Outcome #8), and "to function on teams" (Learning Outcome #6). A capstone project will be required of all students, in keeping with the PFW Expected Behavior to "Advance research, scholarship, and creative endeavor." Our plan to develop partnerships with local industry aligns with PFW's Expected Behavior that "the university plays a key role in business retention, attraction, and expansion efforts through applied research, technology development, and other economic engagements."

b. State Rationale

The proposed MSAP's requirement of a capstone project is in line with Governor Holcomb's commitment to "making Indiana a global leader in innovation and entrepreneurship"[3] It is also in line with the following priorities and guiding principles in ***Reaching Higher In A State Of Change***. [4]

- Talent priority: Require 100 percent of postsecondary programs to have an internship, work-based learning, research project or other student engagement experience that has career relevance.
- Community Engagement: Foster a culture that values lifelong learning and develop partnerships that improve the economic health and vitality of communities.
- Quality: Emphasize excellence to ensure lifelong learner success and meet employer, economic and civic needs.
- Equity: Ensure academic rigor and workforce relevance are prioritized.
- Learner-Centered: Emphasizing the needs of individual learners.
- Talent-Driven: Increased collaboration among institutions, employers, and communities to meet economic need.
- Future-Focused: Meet the needs of an uncertain future economy.
- Completion: When learners pursue and complete credentials that provide individual opportunity, it naturally strengthens Indiana's economy.

Regarding item 2 about lifelong learning, we get periodic inquiries from local physicists asking about graduate study opportunities. For items 3 & 4 about excellence, learner success, and academic rigor, our department's research based pedagogy and strong support of students' success was recognized by the American Physical Society's award of "2014-2017 Department of Distinction for supporting best practices in education". One way we support student success is through placing a high value on getting to know each student and their own particular circumstances to meet their specific needs and goals, in line with item 5 of being Learner-Centered, as well as item 4 on Equity. Because the MSAP will be designed to allow students already in the workforce to participate, those students are likely to center their capstone project around the needs of their employer, in line with item 6 of being Talent-Driven. The degree will allow people working in local industry to come back to grow their skills any time the need arises for their employer or for their own personal growth, in line with item 7 of being Future-Focused, and item 8 on Completion. The Completion section of *Reaching Higher* further acknowledges that "completion is comprehensive—including everything from micro-credentials … to … graduate degrees—allowing learners to build, expand, stack and show

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[3] https://www.iedc.in.gov/program/innovation-entrepreneurship/overview

[4] https://www.in.gov/che/files/2019-20_Strategic_Plan_03-14-2020-spreads.pdf

what they know throughout their careers." The partnerships we hope to build with local companies will help ensure the credential has "meaning and value to our state's employer community and the Hoosiers they employ."

Because of its breadth and emphasis on understanding of fundamental principles that underlie all technology, applied physics is uniquely positioned to produce "well-rounded, analytical people" who are "critical and creative thinkers with communication and problem-solving skills." Our pursuit of ABET accreditation also will help "demonstrate that learners have acquired the competencies employers need," all of which are mentioned in the Talent section of *Reaching Higher*.[5]

c. Evidence of Labor Market Need

i. National, State or Regional Need

Our nation has a history of investing in materials and quantum research to aid in the emergence of new technologies. In 2011 there was the Materials Genome Initiative, "a federal multi-agency initiative for discovering, manufacturing, and deploying advanced materials."[6] In December 2018, the National Quantum Initiative Act was signed into law, in order to "accelerate quantum research and development for the economic and national security of the United States."[7] In August 2020, the White House :announced over $1 billion in awards for the establishment of 12 new artificial intelligence and quantum information science (QIS) research institutes nationwide."[8] In 2022, the CHIPS & Science Act allocated $50 billion in chips manufacturing and R&D funding.[9] Purdue West Lafayette is involved in both the national QIS effort through its Quantum Science and Engineering Institute,[10] and in the national semiconductor effort through recent creation of its Semiconductor Degrees Program that includes an interdisciplinary master's degree.[11] Nine of 13 faculty involved with Purdue West Lafayette's Quantum Science and Engineering Institute are physicists, demonstrating the relevance of physics to the effort. A PFW MSAP can prepare students in our region to innovate in the interrelated quantum science, materials science, and semiconductor sectors.

The Northeast Indiana Regional Partnership his identified target industries including Medical Devices, and Defense & Aerospace.[12] Greater Fort Wayne Inc Metro Chamber Alliance has identified target industries including Medical Devices & Tech, and Advanced Materials.[13,14] Many of our PFW Physics BS graduates have gone on to work in these industries. In materials work, we have

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[5] https://www.in.gov/che/files/2019-20_Strategic_Plan_03-14-2020-spreads.pdf

[6] https://www.mgi.gov/about

[7] https://www.quantum.gov/

[8] https://www.energy.gov/articles/white-house-office-technology-policy-national-science-foundation-and-department-energy?_ga=2.194427117.1776090677.1633813325-1938445947.1633813325

[9] https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/25/fact-sheet-president-biden-signs-executive-order-to-implement-the-chips-and-science-act-of-2022/

[10] https://www.purdue.edu/newsroom/releases/2020/Q3/purdue-to-participate-in-national-quantum-science-research-push.html

[11] https://www.purdue.edu/newsroom/releases/2022/Q2/purdue-launches-nations-first-comprehensive-semiconductor-degrees-program.html

[12] https://neindiana.com/doing-business-here/target-industries

[13] https://www.greaterfortwayneinc.com/economic-development/target-industries/

[14] https://www.greaterfortwayneinc.com/wp-content/uploads/2015/07/Target-Industry-Study_final_-6.6.16.pdf

had students and alumni do the following, where the number in parenthesis is the number of our people who have been involved in it.

Fort Wayne Metals, metal analyst (1)
Fort Wayne Metals, mechanical design engineer (1)
Continental Diamond Tool (New Haven), ceramics engineering (1)
DePuy Synthes, Orthopaedics Company of Johnson & Johnson (Warsaw), metallurgy (1)
Paragon Medical Implants, quality engineer (1)

Notice that materials work and medical devices overlap in the list above. In the defense industry we have had students work at

Raytheon (2)
BAE (3)
Ultra Maritime (formerly USSI) (4)
L3Harris (8 currently and several others in the past)
Northrup Grumman (2).

Beyond the target industries of Medical Devices, Defense & Aerospace, and Advanced Materials, we have had graduates work as engineers at Shambaugh and Sons, Kautex, Convoy Technology, and Regal Beloit, which all have a local presence.

ii. Preparation for Graduate Programs or Other Benefits

The MSAP can aid students in preparing for further graduate study in physics, materials science, optics, or engineering. Our pedagogy stresses sense-making, so the coursework will give students a better understanding of the fundamental principles underlying these fields. Additional research experience through the required capstone project, and additional teaching experience as Graduate Teaching Assistants are also valued by graduate programs. We will train our GTAs to use research-based pedagogy to enhance their effectiveness as instructors, making them more valuable to other graduate programs.

Anecdotal discussion with several recent graduates and other area physicists suggests they miss the intellectual stimulation of formal study and would find the educational experience of the MSAP personally enriching beyond just job preparation.

iii. Summary of Indiana DWD and/or U.S. Department of Labor Data

People educated as physicists are often hidden in roles with a variety of job titles. According to the American Institute of Physics, about three-quarters of those with new bachelor's degrees in physics, and half of those with new master's degrees are employed in either engineering, computer or information systems, or other STEM fields. The remaining new degree holders are in physics/astronomy, education, or non-STEM jobs.[15,16] An analysis of the labor market for the MSAP requires looking beyond the physicist category.

Data from Indiana's Department of Workforce Development (IN DWD) is presented in detail in Appendix 1 for two broad categories of fields: physical science and engineering. For Allen County, raw demand is significantly higher for engineering, but projected growth for 2018 to 2028 is significantly higher for the physical sciences (with a simple average of 20%) than for engineering (with a simple average of negative 8%). Looking at the state as a whole, the projected growths are more similar, averaging 8% for the physical sciences and 6% for engineering. Graduates of the

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[15] https://www.aps.org/careers/statistics/bsprivatesec.cfm

[16] https://www.aip.org/statistics/physics-trends/field-employment-new-physics-masters

MSAP program will be equipped to fill either role, so they are both ready to meet current needs, and positioned for the future.

Data from the U.S. Bureau of Labor Statistics for both engineering and physical science occupations is also included in Appendix 1. Because of having a projected growth rate of 8% for the nation, Physicist is on a list of "Bright Outlook" occupations.[17] For every occupation listed, the state projected growth rate is 5% or more.

iv. National, State, or Regional Studies

What follows is discussion of a number of initiatives that our federal government has prioritized, and how physics in general and our department's strengths in particular can contribute to these endeavors. If students go to graduate school in the area, they are more likely to stay in the area.

In 2020, the "Quantum Frontiers Report on Community Input to the Nation's Strategy for Quantum Information Science" gathered input from the quantum information science community and synthesized eight priorities for research and federal investment.[18] The PFW Physics Department has researchers who may be able to contribute to such goals as "Harnessing Quantum Information Technology for Precision Measurements," "Implementing Algorithms on Available Devices and Exploring Their Performance", "Enabling Quantum State Transduction", and "Expanding the Limits of Physical Theory ".

"A Quadrennial Review of the National Nanotechnology Initiative" published on April 7, 2020, by the National Academies of Sciences, Engineering, and Medicine (NASEM), identifies three priorities for the National Nanotechnology Initiative, which began in 2003. One of these is "increased recruitment and training of future scientists and engineers, with an intentional focus on accelerated technology translation, and with robust investments in next-generation infrastructure to support basic science and commercialization." Nanoscience and technology contributes to areas as diverse as "medicine, food, water, energy, microelectronics, communications, defense."[19]

The Materials Genome Initiative began in 2011 with the goal of shortening the time scale between discovery and deployment of new materials.[20] As reported in "New Frontiers for the Materials Genome Initiative," published April 5, 2019, and emphasized in *Creating The Next-Generation Materials Genome Initiative Workforce* (The Minerals, Metals & Materials Society (TMS), Creating the Next-Generation Materials Genome Initiative Workforce (Pittsburgh, PA: TMS, 2019)), this is accomplished "by synergistically combining experiment, theory, and computation". Physics plays a prominent role in the examples of successful application of MGI principals described in the article. One "combined physics-based molecular modeling, small-angle X-ray scattering, and evolutionary optimization to accurately deduce the molecular structure of experimental films in unprecedented detail". Another "applied quantum mechanical simulations to design, in silico, a room-temperature polar metal exhibiting unexpected stability, and then successfully synthesized this material using high-precision pulsed laser deposition."[21] Atomic, molecular, and optical physics is a research focus for several of our faculty. This, along with the emphasis on computational physics that is infused throughout our curriculum, positions us to support students interested in similar projects. An effort can be made to have projects available that fit with the goals of MGI.

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[17] https://www.onetonline.org/find/bright?b=1

[18] https://www.quantum.gov/wp-content/uploads/2020/10/QuantumFrontiers.pdf

[19] https://www.ncbi.nlm.nih.gov/books/NBK561705/

[20] https://www.mgi.gov/sites/default/files/documents/materials_genome_initiative-final.pdf

[21] https://www.nature.com/articles/s41524-019-0173-4

The semiconductor industry employs around a quarter million people in the US, around a quarter of whom are in design or engineering roles.[22,23,24] About 26% of workers in the semiconductor industry have graduate degrees, and another 30% have Bachelor's degrees.[25] The Semiconductor Industry Association (SIA) in their document, "Charting a Course for Success: America's Strategy for STEM Education," published September 4, 2020, talks about graduate education generating expertise in materials science, physical chemistry, and electrical engineering being important to the semiconductor industry.[26] Applied physics is widely acknowledged as one pathway to a semiconductor career.[27,28,29] Eighty-two percent of executives responding to a Deloitte-SEMI survey mentioned a shortage of qualified candidates in fields critical to the semiconductor industry.[30] In March 2022, Intel & the US National Science Foundation (NSF) announced new investments in education & research in chip design and manufacturing.[31]

i. Surveys of Employers or Students and Analyses of Job Postings

Surveys were conducted in Spring 2021 and Spring 2022.

In Spring 2021, a survey about the potential MSAP was sent to 77 alumni. Of the 21 who responded, 52% were interested and 24% potentially interested. Six indicated that the PFW Physics Department would be their preferred placed to pursue an MS. The 5 respondents (24%) who were not interested in the MSAP had careers that had either progressed too far already, or moved in a different direction. Besides the 21 who responded to the survey, several others contacted the department separately to inquire about the program. About half of the survey respondents had companies in mind that would likely be interested in hiring graduates of the program and perhaps partnering with it in other ways.

A similar survey was repeated in Spring 2022. It was sent to about 77 alumni & 118 students. Nineteen alumni and nineteen current students replied. The bar chart shows the percentage of alumni or students who answered yes or maybe to questions asking if they may be interested in the MSAP in the near future, or if they would have been interested in the past.

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[22] https://www.semiconductors.org/wp-content/uploads/2021/09/2021-SIA-State-of-the-Industry-Report.pdf

[23] https://www.semiconductors.org/wp-content/uploads/2020/10/SIA-Response-RFI-on-National-STEM-Strategy-October-19-2020-.pdf

[24] https://www.semiconductors.org/wp-content/uploads/2021/05/SIA-Impact_May2021-FINAL-May-19-2021_2.pdf

[25] https://www.semiconductors.org/wp-content/uploads/2021/05/SIA-Impact_May2021-FINAL-May-19-2021_2.pdf

[26] https://www.semiconductors.org/wp-content/uploads/2020/10/SIA-Response-RFI-on-National-STEM-Strategy-October-19-2020-.pdf

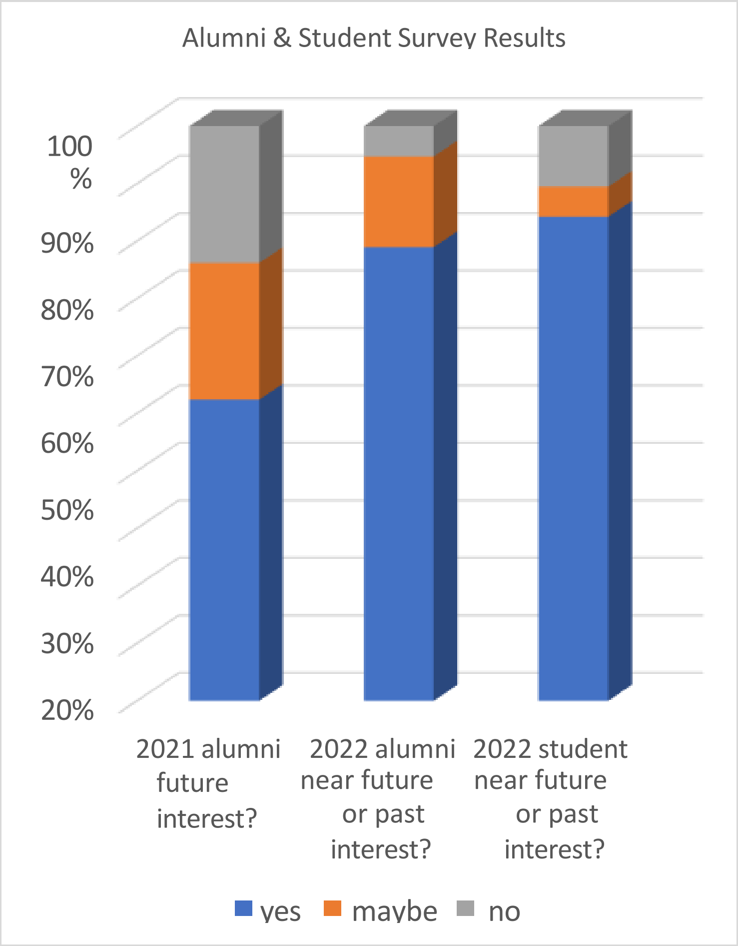
[27] https://www.borntoengineer.com/become-a-semiconductor-engineer

[28] https://www.purdue.edu/science/careers/what_can_i_do_with_a_major/Career%20Pages/semiconductor_engineer.html

[29] https://www.ziprecruiter.com/e/What-Are-the-Qualifications-to-Get-a-Semiconductor-Job

[30] https://www.semi.org/en/workforce-development/diversity-programs/deloitte-study#_edn9

[31] https://www.fierceelectronics.com/electronics/intel-invests-100m-education-chip-rd-across-us



On May 19, 2021, indeed.com was searched for "applied physics" jobs. There were over 4000 hits with 994 of them having been posted in the previous 14 days. Of the first 100 listings, 53 asked for a PhD. Of the remaining 47 jobs, 21 were science or engineering, 10 were in data science, 4 were connected to biology, and 12 were for internship or other jobs. If the percentages in the first 100 postings are similar to the whole, then we would expect approximately 200 of the national listings on this site in the two weeks before May 19, 2021 to have been in science or engineering and not requiring a PhD.

ii. Letters of Support

Below is a selection of quotes from the surveys of alumni and students. Letters of support for the proposed program can be found in Appendix 2.

"The prospect of being able to go higher in my degree, while remaining local physically, is very appealing"

"I would love to pursue a masters program in physics! It would help me greatly in my current job and help me achieve my future career goals."

"A Masters in applied physics would allow me to continue to learn in the way I want to learn. This department has been amazing in helping students tailor their education to their needs. Whether it be through classes or class projects."

"I currently work at L3Harris, and would be able to have my grad school paid for by my employer. This combined with my desire to go to grad school anyway puts PFW at the crossroads of opportunity and accessibility for me."

"I want a Masters in Physics and I have heard and experienced great things with the PFW Physics department. I think a Masters in Physics would accelerate my career."

"I found that my optics and electronics knowledge that I received from PFW/IPFW was ahead of my fellow students when entering graduate school. If this continues to be the case, I would recommend leaning into the strengths of the department and focusing on optics and electronics."

"Materials is exactly what I would like to pursue! I am currently a materials engineer and would love a masters degree in this."

"My current job hired me specifically because of my Physics BS so I'm sure they would love an MS even more."

3. Cost of and Support for the Program

a. Costs

i. Faculty and Staff

Due to recent attrition, the Purdue Fort Wayne Physics Department has declined from eleven to nine full-time faculty members, one of whom is in a visiting position. We would ask to replace the visiting position with a regular faculty position, and replace the attrition. This would be needed by the 4th year of running the program. As the MSAP program grows, we may seek to employ 3 to 6 students as graduate teaching assistants, which could reduce costs.

ii. Facilities

The Purdue Fort Wayne Physics Department currently has space in both Kettler Hall and the Science Building. We will need to change the lab tables in SB 225 & SB 227. This is to relieve pressure on the two advanced labs in use in Kettler Hall to allow laboratory coursework by the graduate students. The estimated cost of the room renovations is $250,000. This would be needed by the 4th year of running the program.

iii. Other Capital Costs (e.g. Equipment)

The department already has a scanning electron microscope (SEM), an atomic force microscope (AFM), a half-meter spectrometer, an Ocean Optics Flame spectrometer, and an electroforce calibrator to support the materials science research opportunities that will be part of the MSAP. Additional equipment that may be helpful consists of a femto-second laser, a fiber laser, an intensified camera, an x-ray diffractometer, a vapor deposition system, and a newer spectrometer. This equipment is estimated to cost a total of $150K-250K, and would be needed by the 5th year of the MSAP. Undergraduates would also benefit from this equipment.

b. Support

i. Nature of Support (New, Existing, or Reallocated)

The proposed MSAP program uses many courses currently taught in existing programs within the University. Initially, some existing resources (~$3000) will be reassigned to market the MSAP. After the program reaches 10 FTE students, it is expected to be self-sustaining.

In addition, the PFW physics department received a major equipment donation from Wattre Inc. valued at $328K. The equipment was delivered to PFW on 09/29/2023 and is ready to be installed. It will be used to support physics student research. The contract of the donation for the first batch of equipment is attached in appendix 3. Further support is under negotiation.

ii. Special Fees above Baseline Tuition

No special fees above the baseline tuition are required for this program.

4. Similar and Related Programs

a. List of Programs and Degrees Conferred

i. Similar Programs at Other Institutions

There is no MS in Applied Physics in Indiana. Not including graduate physics programs focused on education, or on health or medical physics, there are 5 institutions offering graduate programs in physics with some overlapping areas of interest. Condensed matter physics is closely related to materials science, which is one of the available areas of research in the proposed MSAP.

Institution	Related Graduate Programs
Ball State University[32], Muncie, IN	• MS or MA in Physics with opportunities for research in condensed matter physics, electronic structure of materials & devices, fabrication & characterization of nano-scale devices, medical physics, and more
Indiana University[33], Bloomington, IN	• MS in Physics • MS in Beam Physics & Technology • PhD in Physics • PhD in Astrophysics • PhD in Chemical Physics • PhD in Mathematical Physics • PhD minor in Scientific Computing
Indiana University Purdue University Indianapolis[34], Indianapolis, IN	• MS or PhD in Physics with opportunities for research in biological physics; atomic, molecular, and optical physics; condensed matter physics; and interdisciplinary collaborations with other science and engineering departments, as well as the School of Medicine, and the School of Informatics
Purdue University, West Lafayette, IN	• Materials Engineering Professional Master's Program[35] • Interdisciplinary Master of Science in Engineering, with a major in Microelectronics and Semiconductors[36] • MS in Physics, where most students do it on the way to a PhD, rather than as a final degree[37] • PhD in Physics including research opportunities in Applied Physics; Atomic, Molecular, and Optical Physics; Condensed Matter Physics; • and Quantum Information Science[38]

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[32] https://www.bsu.edu/academics/collegesanddepartments/physics-astronomy/academic- programs/ma-ms-physics

[33] https://physics.indiana.edu/graduate/index.html

[34] https://science.iupui.edu/physics/academics/degrees-and-programs/index.html

[35] https://engineering.purdue.edu/MSE/academics/pmp-faqs

[36] https://engineering.purdue.edu/online/programs/masters-degrees/semiconductors

[37] https://www.physics.purdue.edu/academic-programs/graduate/summary-ms.html

[38] https://www.physics.purdue.edu/academic-programs/graduate/index.html

University of Notre Dame, Notre Dame, IN	• PhD in Physics including research opportunities in condensed matter physics[39] • PhD in Physics: Materials Science and Engineering. An interdisciplinary degree in Materials Science and Engineering is offered through any of seven home departments, including the Department of Physics[40,41]

ii. Related Programs at the Proposing Institution

At Purdue Fort Wayne, related programs are a Master of Science in Mathematics, and a Master of Engineering with concentrations in Systems Engineering, Electrical Engineering, or Mechanical Engineering. Neither of these is accredited by the Accreditation Board for Engineering and Technology (ABET)'s Engineering Accreditation Commission. We plan to pursue accreditation for the MSAP through ABET's Applied and Natural Science Accreditation Commission.

b. List of Similar Programs Outside Indiana

Similar programs in Michigan, Ohio, and Illinois are listed below. Only the first three are specifically an MS in Applied Physics.

Institution	Related Graduate Programs
Illinois Institute of Technology, Chicago, IL (~3 hours away)	• MS in Applied Physics[42]
University of Michigan, Ann Arbor, MI (~2.5 hours away)	• MS in Applied Physics—**only for students admitted to the PhD program**, received when they pass the candidacy stage of the PhD process[43] • PhD in Applied Physics[44]
Michigan Technological University, Houghton, MI (~9.5 hours away)	• MS in Applied Physics[45]
Oakland University, Rochester, MI (~3 hours away)	• MS in Physics[46] • PhD in Applied and Computational Physics[47,48,49]
Michigan State University[50], East Lansing, MI (~2 hours away)	• MS in Physics • PhD in Physics
Eastern Michigan University[51], Ypsilanti, MI (~2.5 hours away)	• MS in Physics

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[39] https://physics.nd.edu/graduate/

[40] https://science.nd.edu/graduate/materials-science-and-engineering/

[41] https://nano.nd.edu/materials-science/

[42] https://www.iit.edu/academics/programs/applied-physics-ms

[43] https://lsa.umich.edu/appliedphysics/prospectivestudents.html

[44] https://lsa.umich.edu/appliedphysics/prospectivestudents/academic-programs.html

[45] https://www.mtu.edu/gradschool/programs/degrees/applied-physics/

[46] https://oakland.edu/physics/academic-programs/

[47] https://catalog.oakland.edu/programs/descriptions/doctor-of-philosophy-in-applied-and-computational-physics.html

[48] https://catalog.oakland.edu/preview_program.php?catoid=47&poid=8219

[49] https://oakland.edu/grad/graduate-programs/

[50] https://reg.msu.edu/academicprograms/Programs.aspx?PType=GR

[51] https://www.emich.edu/physics-astronomy/programs/graduate.php

Wayne State University[52], Detroit, MI (~2.5 hours away)	• MS in Physics • MA in Physics • PhD in Physics
Miami University[53], Oxford, OH (~2.5 hours away)	• MS in Physics
Ohio State University, Columbus, OH (~3 hours away)	• MS in Materials Science and Engineering[54] • MS in Physics as a Bridge to PhD program, not a terminal degree. • PhD in Physics[55]
Kent State, Kent, OH (~3.5 hours away)	• MS in Materials Science • PhD in Materials Science[56] • MS in Physics • MA in Physics • PhD in Physics[57]
Wright State University, Dayton, OH (~2.5 hours away)	• MS in Physics[58] • Interdisciplinary Applied Science & Mathematics PhD[59]
Northwestern University[60], Evanston, IL (~3.5 hours away)	• MS in Physics • PhD in Physics
Southern Illinois University[61], Carbondale, IL (~6 hours away)	• MS in Physics • PhD in Applied Physics
University of Illinois at Urbana-Champaign, IL (~4 hours away)	• Master of Engineering in Instrumentation and Applied Physics[62] • MS in Physics—only for students seeking a PhD [63] • PhD in Physics[64]

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[52] https://clas.wayne.edu/physics/programs

[53] https://miamioh.edu/cas/academics/departments/physics/academics/graduate-program/index.html

[54] https://gpadmissions.osu.edu/programs/program.aspx?prog=0130

[55] https://physics.osu.edu/graduate-student-home-page/prospective-students/graduate-admissions- how-apply

[56] https://www.kent.edu/materials-science/ms-phd-materials-science

[57] https://www.kent.edu/physics/graduate-study-phd-physics-program

[58] https://science-math.wright.edu/physics/master-of-science-in-physics

[59] https://www.wright.edu/degrees-and-programs/profile/interdisciplinary-applied-science-mathematics

[60] https://www.tgs.northwestern.edu/admission/academic-programs/explore-programs/physics.html

[61] https://physics.siu.edu/graduate/program-discriptions.php

[62] https://physics.illinois.edu/academics

[63] https://physics.illinois.edu/academics/graduates/ms-degree-requirements

[64] https://physics.illinois.edu/academics/graduates

Similar programs offered online are listed below.

Institution	Related Graduate Programs
Johns Hopkins University	• Online Part Time Applied Physics Master's Degree[65]
University of Central Florida	• Online MS in Optics and Photonics[66]
Arizona State University	• Online MS in Materials Science and Engineering[67]

c. Collaboration with Similar or Related Programs on Other Campuses

No plans are currently in place to collaborate with similar or related programs on other campuses.

d. Articulation of Associate/Baccalaureate Programs

Not applicable.

5. Quality and Other Aspects of the Program

a. Credit Hours Required / Time to Completion

The proposed MSAP will require at least 30 credit hours for students who enter with a BS in Physics. With 9 credits per semester a full-time student can finish in three semesters plus a summer for the capstone project. Part time students or those missing prerequisites will take longer. A part time student who takes 6 credits per semester and 3 credits in summer can finish the degree in two years. Sample curricula are provided in Appendix 4.

b. Exceeding the Standard Expectation of Credit Hours

The proposed MSAP does not exceed the standard 30 credit hour limit.

c. Program Competencies or Learning Outcomes

The following outcomes include those required by the Accreditation Board for Engineering and Technology (ABET):

1. An ability to identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of mathematics and science and/or technical topics to areas relevant to the discipline.
2. An ability to formulate or design a system, process, procedure or program to meet desired needs.
3. An ability to conduct experiments or test hypotheses, analyze and interpret data and use scientific judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal contexts.
6. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.
7. An ability to use and critically evaluate current technical/scientific research literature, online information, or information related to scientific issues in the mass media.
8. Demonstrate the role of physics in industry and/or entrepreneurism.
9. Demonstrate mastery of basic physics.

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[65] https://ep.jhu.edu/programs/applied-physics/masters-degree-requirements/

[66] https://www.ucf.edu/online/degree/optics-and-photonics-ms/

[67] https://asuonline.asu.edu/online-degree-programs/graduate/master-science-materials-science-and-engineering/

d. Assessment

Tentative ideas for assessing learning outcomes, formulated after consultation with PFW's executive director for assessment and program review, are as follows:

	Learning Outcome	Assessment Method
1.	An ability to identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of mathematics and science and/or technical topics to areas relevant to the discipline.	Projects in any graduate level physics course except Phys 59000
2.	An ability to formulate or design a system, process, procedure or program to meet desired needs.	Projects in Phys 51100, 52200, 52400, 52500, 53600, 57000
3.	An ability to conduct experiments or test hypotheses, analyze and interpret data and use scientific judgment to draw conclusions.	Projects in Phys 52200, 52400, 52500, 53600
4.	An ability to communicate effectively with a range of audiences.	Oral presentation about capstone project
5.	An ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal contexts.	Targeted assignments embedded in courses
6.	An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.	Capstone and/or projects in Phys 52400, 53600. A journal reflecting on their team participation may be required.
7.	An ability to use and critically evaluate current technical/scientific research literature, online information, or information related to scientific issues in the mass media.	Writing about capstone, including a review of background literature on the topic
8.	Demonstrate the role of physics in industry and/or entrepreneurism.	Capstone
9.	Demonstrate mastery of basic physics.	$\geq$ B- in required courses

Students will be encouraged to keep a portfolio of any projects they do, and to include reflections about their role on any team projects. Special attention will have to be paid to Outcome 5. Assignments requiring students to consider ethics need to be embedded in MSAP courses. Examples include the responsibility to overdesign nuclear power plants, or to consider the environmental impacts of byproducts of production, or end of life disposal of products.

e. Licensure and Certification

i. State License: No state licenses apply to this program.

ii. National Professional Certifications (including the bodies issuing the certification): No professional certifications apply to this program.

iii. Third-Party Industry Certifications (including the bodies issuing the certification): No third-party industry certifications apply to this program.

f. Placement of Graduates

Most of the graduates of the MSAP program are expected to work in various engineering, research and development, or science positions, especially those involving an understanding of optics, electronics, materials, or acoustics. It is expected that some students pursuing the MSAP will be sponsored by their employers. Others who are not planning to continue on to a PhD program will be encouraged to work in industry during their studies, with the help of either PFW Career Services, or through the Physics Department's connections to its alumni and area businesses.

Alumni of the MSAP program may also pursue admission into PhD programs in physics, materials science, optics, or engineering, especially electrical, mechanical, or systems engineering.

g. Accreditation

To increase the attractiveness of the program for both students and employers, the MSAP program has been designed with an eye towards pursuing accreditation from the Accreditation Board for Engineering and Technology (ABET). We must have at least one graduate before applying for accreditation, after which the process takes another 18 months to complete. Therefore, accreditation is not expected until about 4 years after inception.

6. Projected Headcount and FTE Enrollment and Degrees Conferred

Below is the projected enrollment. The prediction was based on current enrollment trends in both undergraduate and MS programs at PFW. PFW Engineering, Math and CS have a MS/undergraduate ratio of 5.3%, 21.8%, and 44% respectively (in 2022). Approximately 17% of physics majors who graduated in the most recent ten years went to graduate school within a year of graduation. Three 2023 physics graduates have already been accepted to graduate schools. This was used as the basis for the enrollment projection for the first year of the MSAP, which will have limited lead time for marketing. The number of our undergraduate majors has been kept at an annualized growth rate of 6% over the past two decades (from 19 in 2002 to 67 in 2022, and projected to be 92 in 2027.) The percentage of students interested in MS program was assumed to be constant at 17%

	Year # 1	Year # 2	Year # 3	Year # 4	Year # 5
Projections:	FY 2025	FY2026	FY 2027	FY 2028	FY 2029
Full-time	2	3	5	7	10
Part-time		2	3	5	6
Total Headcount	2	5	8	12	16
Enrollment (FTE)	2	4	7	10	14
Degree Completions	0	2	3	7	10

Appendix 1: Indiana DWD and US Department of Labor Data

Data from Indiana's Department of Workforce Development (IN DWD) is presented for two broad categories of fields: physical science in the first table and engineering in the second table. The engineering occupations listed have been chosen based on the job titles and graduates programs our alumni have pursued. There are higher absolute numbers of engineering jobs, but generally lower projected growth rates. Included is data for the state as a whole, and for our area: Allen County & Region 3.

Our area has low Location Quotients. "Location quotient (LQ) is a way of quantifying how concentrated a particular occupation is in a region compared to the nation. "[68] Location Quotients for the physical science fields in our area are approximately 0.2, while for materials, electrical, and mechanical engineering, they are approximately 1.5. An LQ significantly less than 1.0 may indicate an opportunity to develop businesses in the local area to meet area demand."[69] A location quotient greater than 1.25 might indicate the region is an exporter.[70] The Automation Indices are less than 100 for both physical science and engineering fields, indicating a below average risk of automation.[71] They are a bit lower for the physical science fields than engineering.

Table for Physical Sciences with data from the Indiana Department of Workforce Development[72]:

Occupation -- Automation Index	County	Current Employment (2018)	% Growth (2018 to 2028)	Annual Openings	Location Quotient
Physicists – 72.8	Allen	4	25.0	1	0.18
	Region 3	8	12.5	1	0.17
	Indiana	267	10.1	25	0.70
Physical Scientists, All Other – 76.4	Allen	7	28.6	1	0.24
	Region 3	14	21.4	2	0.25
	Indiana	176	11.4	17	0.36
Materials Scientists – 74.2	Allen	3	0.0	0	0.26
	Region 3	9	0.0	1	0.41
	Indiana	282	2.8	27	1.55

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[68] https://datavizpublic.in.gov/views/EMSIOccupationSnapshot/EmsiOccupationSnapshot?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

[34] http://www.incontext.indiana.edu/2006/march/1.asp

[35] http://www.incontext.indiana.edu/2006/march/1.asp

[71] https://datavizpublic.in.gov/views/EMSIOccupationSnapshot/EmsiOccupationSnapshot?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

[72] https://datavizpublic.in.gov/views/EMSIOccupationSnapshot/EmsiOccupationSnapshot?iframeSizeToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

Table for Engineering with data from the Indiana Department of Workforce Development[73]:

Occupation -- Automation Index	County	Current Employment (2018)	% Growth (2018 to 2028)	Annual Openings	Location Quotient
Materials Engineers -- 87.3	Allen	56	1.8	4	1.50
	Region 3	105	2.9	8	1.48
	Indiana	968	-1.9	72	1.58
Nuclear Engineers – 75.7	Allen	9	0.0	1	0.33
	Region 3	38	0.0	3	0.73
	Indiana	166	7.8	15	0.37
Electronics Engineers, Except Computer – 85.4	Allen	158	-23.4	9	0.87
	Region 3	287	-14.3	18	0.84
	Indiana	2393	4.8	178	0.81
Electrical Engineers – 84.8	Allen	369	-8.9	22	1.52
	Region 3	547	-4.6	36	1.20
	Indiana	3296	8.0	250	0.84
Aerospace Engineers – 77.2	Allen	25	-28.0	1	0.28
	Region 3	37	-13.5	2	0.22
	Indiana	549	5.5	38	0.37
Mechanical Engineers – 83.4	Allen	577	0.3	37	1.50
	Region 3	1012	6.5	73	1.40
	Indiana	8148	9.5	617	1.30
Engineers, All Other – 88.2	Allen	204	2.9	14	1.02
	Region 3	313	4.5	22	0.83
	Indiana	2466	8.3	185	0.76

Below is data for Indiana and for the nation from the US Department of Labor, and the US Bureau of Labor Statistics. As mentioned previously, because of having a projected growth rate of 8% for the nation, Physicist is on a list of "Bright Outlook" occupations.[74]

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[73] https://datavizpublic.in.gov/views/EMSIOccupationSnapshot/EmsiOccupationSnapshot?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

[74] https://www.onetonline.org/find/bright?b=1

Table with data from the US Department of Labor, and the US Bureau of Labor Statistics:

Occupation Title	Employment IN 2020 [75] / US 2021 [76]	Projected Employment IN 2030 / US 2031	Projected Annual Openings IN 2020-30 / US 2021-31	Projected Percent Change IN 20-30 / US 21-31
Physicists * Fluid Dynamicist* Health Physicist* Mathematical Physicist* Medical Physicist* Molecular Physicist* Nuclear Physicist* Optical Scientist* Research Physicist* Rheologist* Thermodynamic Physicist* Thermodynamicist	180 / 23,000	190 / 24,800	10 / 1,900	6.0 / 8.2
Materials scientists * Materials Scientist* Metal Alloy Scientist* Plastics Scientist	800 / 7,000	840 / 7,400	80 / 600	5.0 / 6.0
Materials engineers * Automotive Sheet Metal Engineer* Ceramic Engineer* Forensic Materials Engineer* Glass Science Engineer* Metallographer* Metallurgical Engineer* Metallurgist* Welding Engineer	590 / 22,100	660 / 23,400	40 / 1,700	12.0 / 6.1
Engineers, all other * Corrosion Control Engineer* Mathematical Engineer* Optical Engineer* Ordnance Engineer* Photonics Engineer* Salvage Engineer	3,150 / 168,600	3,320 / 168,600	220 / 10,800	5.0 / 0.0
Bioengineers and biomedical engineers * Bio-Mechanical Engineer* Biochemical Engineer* Biomaterials Engineer* Biomedical Engineer* Dialysis Engineer* Genetic Engineer	960 / 17,900	1040 / 19,700	70 / 1,200	8.0 / 9.8
Biochemists and biophysicists * Biochemist* Biological Chemist* Biophysicist* Clinical Biochemist* Physical Biochemist	510 / 37,500	540 / 43,200	50 / 4,000	6.0 / 15.3

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[75] https://www.onetonline.org/

[76] https://data.bls.gov/projections/occupationProj

Appendix 2: Letters of Support

Letters of support from local professionals are included below.

ULTRA MARITIME

Ultra Maritime US
4868 East Park 30 Drive
Columbia City. IN 46725

T (260) 248-3500
ultra.group/maritime

February 6, 2023

Chris Lowery
Commissioner for Higher Education
Indiana Commission for Higher Education
101 West Ohio Street, Suite 300
Indianapolis, IN 46204-4206

Dear Commissioner Lowery,

I am writing to express my strong support for the proposed Master of Science in Applied Physics graduate program. Based on my experience and knowledge in the engineering field, I am confident that this program will make a significant contribution to the industry, just like its Bachelor of Science program which has already contributed six engineers to Ultra Maritime (USSI) in Columbia City. Each one has been a valued asset with strong analytical thinking, interdisciplinary understanding, and practical skills that quickly integrate them into any team across any discipline.

The program has been carefully designed to meet the needs of the industry and to provide students with the skills and knowledge necessary to succeed in engineering. The curriculum covers a wide range of topics, including biomedical physics, optoelectronics and photonics, engineering physics, computational/mathematical physics, materials science, and astrophysics, which will give students a comprehensive understanding of the field. Additionally, the program's focus on research-informed educational approaches has a proven track record of equipping graduates with the skills to succeed in industry, setting it apart from other programs and providing students with a competitive advantage in the job market.

The program is also well-equipped with highly qualified and experienced faculty members who are leaders in their respective fields. They bring a wealth of knowledge and expertise to the program, which will greatly benefit students. The faculty members have a proven track record of conducting cutting-edge research in Optoelectronics, Materials Science, and Acoustics and providing high-quality, student-first education that builds skills both inside and outside of the classroom.

In conclusion, I believe that the proposed Master of Science in Applied Physics graduate program has the potential to become one of the leading programs in the field, and I strongly recommend its approval. I am confident that it will have a positive impact on the field and on the students who enroll in the program.

Thank you for considering my recommendation.

Sincerely,

John Fehring

Director of Engineering, Sonobuoy Systems
T: +1 260 248 3616
E: john.fehring@ultra-ussi.com

Chris Lowery
Commissioner for Higher Education
Indiana Commission for Higher Education
101 West Ohio Street, Suite 300
Indianapolis, IN 46204-4206

February 17th, 2023

Dear Commissioner Lowery,

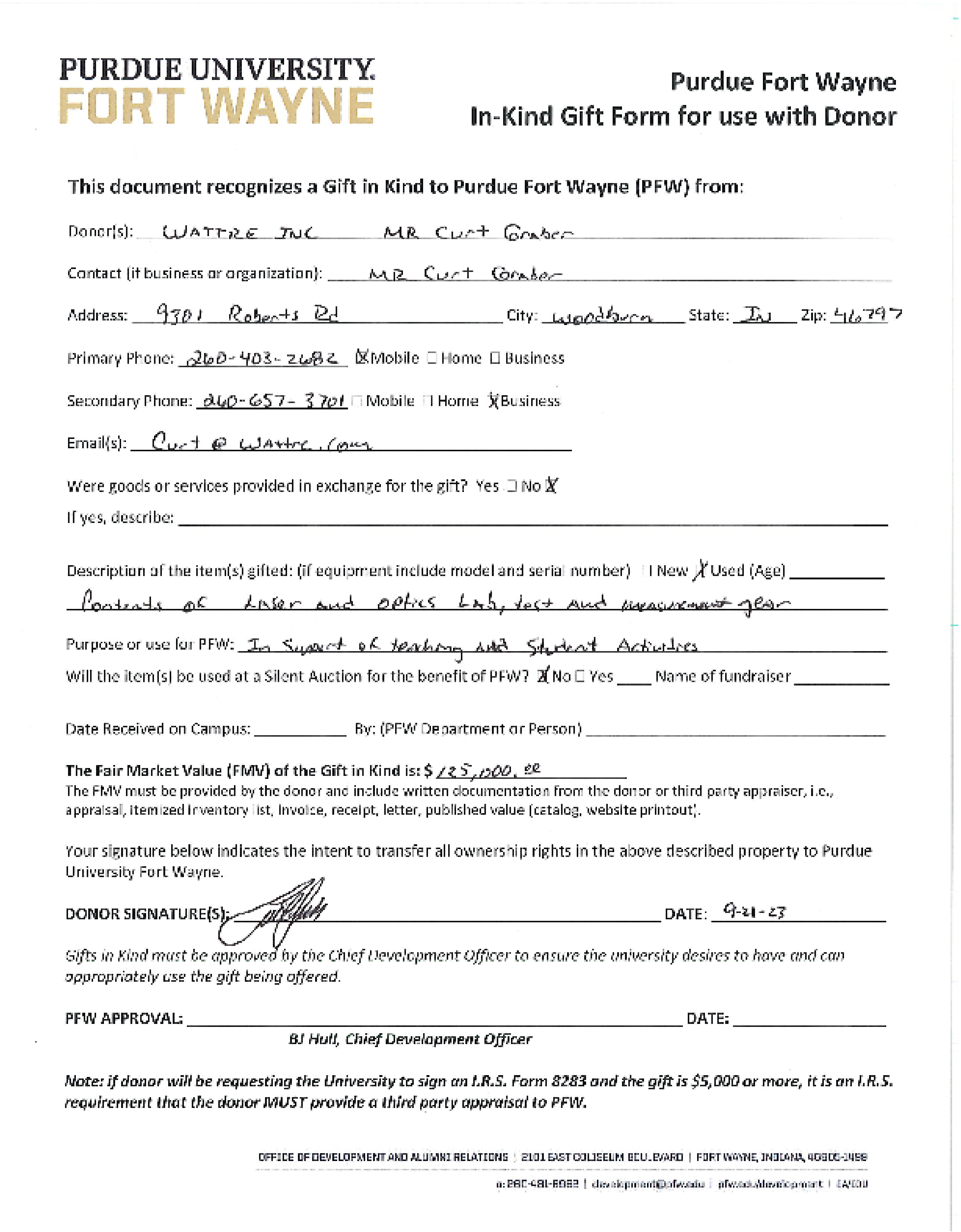
I strongly support Purdue Fort Wayne Physics Department's proposal to create a Master of Science in Applied Physics. Since I've graduated back in 2018 I have had the pleasure of working with many team members who are also physics alumni. They have been valuable contributors with strong analytical thinking, interdisciplinary understanding, and practical skills. This can be seen in the wide variety of roles that we have taken after graduation. This is just a few names of (I)PFW Physics Alumni to show the variety of roles we have been able to fill. I have personally worked with everyone on this list at Ultra and L3Harris.

Evan - Senior Associate Systems Engineer
Maryanne - Senior Associate Acoustics Engineer
Todd - Senior Specialist Electrical Design Engineer
Blaine - Specialist Electrical Test Engineer
Andrew - Senior Associate Optical Engineer
Yioti - Senior Associate Integration and Test Engineer
Nick - Senior Associate Mechanical Engineer
Michael - Senior Associate Software Engineer
Matt - Senior Supervisor Systems Engineer

As you can see, there really isn't a role we have yet to tackle as physics majors. That's just to say that a physics degree, especially from PFW, is a force to reckon with. The opportunity to advance our education with possibly courses in this new and exciting program such as Interferometry, Coherent Optics, Radiometry, Instrumentation, Experimental Testing and Modeling of Acoustics and Vibrations, in addition to the capstone project will further enhance graduates of the program with knowledge and skills that will be valuable to the companies we work for. In our industries we are creating leading edge technology surrounding the defense and exploration of space, land, air, and sea. I highly encourage you to approve this proposal so that we may tackle yet another exciting challenge.

Sincerely,
Cy Bentley
Cy Bentley
Senior Associate Electrical Design Engineer
Space & Airborne Systems / L3Harris Technologies
Cell: 260-599-4445
1919 W. Cook Road / Fort Wayne, IN 46818

Appendix 3: PFW In-kind gift form



PURDUE UNIVERSITY.
FORT WAYNE

Purdue Fort Wayne
In-Kind Gift Form for use with Donor

This document recognizes a Gift in Kind to Purdue Fort Wayne (PFW) from:

Donor(s): WATTRE INC MR Curt Graber

Contact (if business or organization): MR Curt Graber

Address: 9301 Roberts Rd City: Woodburn State: IN Zip: 46797

Primary Phone: 260-403-2682 ☒ Mobile ☐ Home ☐ Business

Secondary Phone: 260-657-3701 ☐ Mobile ☐ Home ☒ Business

Email(s): Curt @ Wattre.com

Were goods or services provided in exchange for the gift? Yes ☐ No ☒

If yes, describe: ______

Description of the item(s) gifted: (if equipment include model and serial number) ☐ New ☒ Used (Age) ______

Contents of Laser and optics Lab, test and measurement gear

Purpose or use for PFW: In Support of teaching and Student Activities

Will the item(s) be used at a Silent Auction for the benefit of PFW? ☒ No ☐ Yes ____ Name of fundraiser ______

Date Received on Campus: ______ By: (PFW Department or Person) ______

The Fair Market Value (FMV) of the Gift in Kind is: $ 125,000.00
The FMV must be provided by the donor and include written documentation from the donor or third party appraiser, i.e., appraisal, itemized inventory list, invoice, receipt, letter, published value (catalog, website printout).

Your signature below indicates the intent to transfer all ownership rights in the above described property to Purdue University Fort Wayne.

DONOR SIGNATURE(S): ______ **DATE:** 9-21-23

Gifts in Kind must be approved by the Chief Development Officer to ensure the university desires to have and can appropriately use the gift being offered.

PFW APPROVAL: ______ **DATE:** ______
BJ Hull, Chief Development Officer

Note: if donor will be requesting the University to sign an I.R.S. Form 8283 and the gift is $5,000 or more, it is an I.R.S. requirement that the donor MUST provide a third party appraisal to PFW.

OFFICE OF DEVELOPMENT AND ALUMNI RELATIONS | 2101 EAST COLISEUM BOULEVARD | FORT WAYNE, INDIANA 46805-1499

o: 260-481-6092 | development@pfw.edu | pfw.edu/development | EA/EOU

Appendix 4: Curriculum & Requirements, Detail

The Master of Science in Applied Physics (MSAP) will have opportunities for research or coursework in opto-electronics, materials science, & acoustics.

Admission Requirements

BS in Physics, Chemistry, Engineering, Mathematics, or closely related fields.
GPA of 2.5 or higher. Applicants must submit transcripts, a statement of intent, and references.

Curriculum Requirements

The Master of Science in Applied Physics consists of at least 30 credit hours, with a 3.0 GPA. Transfer credits are subject to Purdue University Graduate School policies, which include allowance of a maximum of 6 credits at the 300 or 400 level with grade of B- or higher, upon the recommendation of the physics department graduate committee. This makes the program more accessible to those with non-physics bachelor's degrees by allowing them to fill any necessary gaps in their background.

The required capstone project can be done as a thesis if the student wants a thesis degree or for a course grade if the student wants the non-thesis degree option.

Required Core—At least 3 of the following courses: (9-10 credits)

Phys 51000 Physical Mechanics	(4 credits)
Phys 51500 Thermal and Statistical Physics	(3 credits)
Phys 53000 Electricity & Magnetism	(3 credits)
Phys 55000 Introduction to Quantum Mechanics	(3 credits)

Research—6 credits:

Non Thesis Degree:

Phys 59000 Reading and Research (Required Capstone)	(2 x 3 credits)

Thesis Degree:

Phys 69800 Thesis Research (Required Capstone)	(2 x 3 credits)

Electives—remaining from any combination of Categories 1 & 2 below: (15 credits)
Category 1: Graduate courses offered by the Physics Department, including up to three additional credits in research course (Phys 59000). The Physics Department currently offers 42 credits of graduate courses, including Phys 57000: Selected Topic in Physics, which can address a variety of topics.

Category 2: Maximum of 9 other graduate credits approved by the physics department graduate committee as a coherent plan of study.

This particularly benefits to students with a background in closely related fields, such as Math, Engineering, or Chemistry. Since physics is a fundamental science with a huge diversity of application in other fields, the MSAP encourages students to focus on their long-term career when they form a study plan. Graduate courses from other departments can be beneficial when such students apply their physics knowledge to their field. The selection of the non-physics courses must be coherent with the physics electives. The physics department graduate committee will review and approve the plan before out of department courses are taken. Two examples are described below.

Example 1: A student focused on optical communications
Two electric engineering graduate courses (6 credits from category 2), along with Phys 51100 (Laser Physics), Phys 52400 (Physical Optics & Experimental Spectroscopy), and Phys 52200 (Coherent Optics & Quantum Electronics) (10 credits from category 1)

Example 2: A student with interest in computational structural material sciences careers Two Math graduate courses (6 credits from category 2), along with Phys 52000 (Mathematical Physics), Phys 54500 (Solid State Physics), and Phys 52500 (Fundamental Application of Neural Networks) (9 credits from category 1)

Sample Curriculum 1: Two-Year Study Plan with Thesis Option:

A sample curriculum for a thesis option student is provided below.

Year 1 of Two-Year Plan, Thesis Option					
Fall			Spring		
Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 51500	Thermal & Statistical Physics (Core Course 1)	3	Phys 51000	Physical Mechanics (Core Course 2)	4
Phys 52200	Coherent Optics & Quantum Electronics (Elective 1)	3	Phys 53000	Electricity & Magnetism (Core Course 3)	3
Phys 52000	Mathematical Physics (Elective 2)	3	-------	-----------------------	
Total Semester Credit Hours:		9	Total Semester Credit Hours:		7

Year 2 of Two-Year Plan, Thesis Option					
Fall			Spring		
Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 55000	Introduction to Quantum Mechanics (Elective 3)	3	Phys 52400	Physical Optics & Experimental Spectroscopy (Elective 5)	4
Phys 51100	Laser Physics (Elective 4)	3	Phys 69800	Thesis Research	3
Phys 69800	Thesis Research	3	-------	-----------------------	
Total Semester Credit Hours:		9	Total Semester Credit Hours:		7

Sample Curriculum 2: Two-Year Study Plan with Non-Thesis Option:

A sample curriculum for a non-thesis student (who happens to have a background and interests in Engineering) is provided below.

Year 1 of Two-Year Plan, Non-Thesis Option					
Fall			Spring		
Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 51500	Thermal & Statistical Physics (Core Course 1)	3	Phys 53000	Electricity & Magnetism (Core Course 2)	3
ECE 5xx00	Elective 1 (Category 2 Course, pre-approved by the committee)	3	Phys 53600	Electronic Techniques for Research (Elective 2)	4
Phys 59000	Reading & Research	2	-------	-----------------------	
Total Semester Credit Hours:		8	Total Semester Credit Hours:		7

Year 2 of Two-Year Plan, Non-Thesis Option					
Fall			Spring		
Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 55000	Introduction to Quantum Mechanics (Core Course 3)	3	Phys 52200	Coherent Optics & Quantum Electronics (Elective 4)	3
Phys 51100	Laser Physics (Elective 3)	3	ECE 5xx00	Elective 5 (Category 2 Course, pre-approved by the committee)	3
Phys 59000	Reading & Research	2	Phys 59000	Reading & Research	2
Total Semester Credit Hours:		8	Total Semester Credit Hours:		8

Sample Curriculum 3 for a Part-time Graduate Student

A sample curriculum for a part-time student is provided below. We assume this student has a full-time job and only takes evening classes. This limits them to two courses per semester. (Most of the graduate classes are on Monday/Wednesday or Tuesday/Thursday late afternoon/early evening patterns. This allows students to take two classes if he/she is willing to take classes on four evenings.) If the student also takes summer classes, they can still finish the MSAP in two years. The student will be able to finish the minimal requirement for the degree with 31 credit hours. A student only taking one course each semester, or not taking summer classes, would take longer to finish the degree. That would be a less common case and we do not have a detailed sample schedule since the schedule would be more individualized.

Year 1—Part-time Student								
Fall			Spring			Summer		
Course No.	Course Title	Cr	Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 51500	Thermal & Statistical Physics (Core Course 1)	3	Phys 51000	Physical Mechanics (Core Course 2)	4	MA 52100	Intro Optimization (Elective 2, Category 2)	3
Phys 52000	Mathematical Physics (Elective 1)	3	Phys 53000	Electricity & Magnetism (Core Course 3)	3	-------	-----------------------	
Total Semester Credit Hours:		6	Total Semester Credit Hours:		7	Total Semester Credit Hours:		3

Year 2—Part-time Student								
Fall			Spring			Summer		
Course No.	Course Title	Cr	Course No.	Course Title	Cr	Course No.	Course Title	Cr
Phys 55000	Intro. to Quantum Mechanics (Elective 3)	3	Phys 57000	Selected Topics: Nano-Systems (Elective 5)	3	Phys 59000	Reading & Research	3
Phys 54500	Solid State Physics (Elective 4)	3	Phys 59000	Reading & Research	3	-------	-----------------------	
Total Semester Credit Hours:		6	Total Semester Credit Hours:		6	Total Semester Credit Hours:		3

Existing courses in the proposed curriculum already offered regularly:

Cross-listed as dual-level with corresponding undergraduate course	**Stand alone, serving physics undergrads, and graduate students from other departments, such as Math & Electrical Engineering**
Phys 51000 Physical Mechanics (4 credits)	Phys 51100 Laser Physics (3 credits)
Phys 51500 Thermal & Statistical Physics (3 credits)	Phys 52200 Coherent Optics and Quantum Electronics (3 credits)
Phys 52000 Mathematical Physics (3 credits)	Phys 52400 Physical Optics and Experimental Spectroscopy (4 credits)
Phys 53000 Electricity and Magnetism (3 credits)	Phys 52500 Fundamental application of Neural Networks (3 credits)
Phys 55000 Introduction to Quantum Mechanics (3 credits)	Phys 54500 Solid State Physics (3 credits)
	Phys 53600 Electronic Techniques for Research (4 credits)

Existing courses in the proposed curriculum not already offered regularly:

Phys 57000 Selected Topics in Physics(3 credits)-- topics including, but not limited to: Condensed Matter Physics; Nanosystems; Quantum Materials and Devices.

Phys 59000 Reading and Research (1-3 credits)

As MSAP enrollment grows, we predict being able to offer all graduate classes stand-alone in year 3. Even during the starting year of the program when enrollment has yet to reach the stand-alone level, graduate students will be assigned more difficult coursework to match the desired rigor. In physics, we study similar topics at a wide variety of complexities. For example, we offer Mechanics at 4 different levels: algebra based (Phys22000), calculus based (Phys15200), Hamiltonian based (Phys31000), and analytic based (Phys51000). During the transition period where the graduate courses are offered at dual level, graduate students and undergraduate students working on the same problem will have different requirements in their mathematical methods, complexity of the modeling, and level of details.

New courses to be added for the proposed curriculum:

Phys 69800 Thesis Research (1-3 credits)

Appendix 5: PFW Department of Physics Faculty, Detail

Last name	First name	Academic Title	Diploma Information	Specialization Interests
Faramarzi	Shamsolzaman (Homeira)	Visiting Assistant Professor of Physics	PhD in Physics, Tehran Polytechnic, 2006	Applied Physics, Atomic & Molecular Physics, Fabrication of Nanomaterials by Laser-based Technology, Optical Properties of Nanomaterials, Medical applications of Nanomaterials
Grove	Timothy	Associate Professor of Physics	Ph.D. in Physics, The University of Connecticut, 1994	Atomic, Molecular, and Optical Physics; Spectroscopy; Acoustics; Advanced Undergraduate Educational Lab
Johnson	Merrell	Associate Professor of Physics	Ph.D. in Physics, Purdue University, Indianapolis, 2011	Soft Materials; Thin Films; Nanoparticles; Biophysics; Characterization techniques from x-ray scattering to scanning probe microscopy
Maloney	David	Professor of Physics	Ph.D. interdisciplinary in Physics, Geology, & Education, Ohio University, 1975	Physics Education Research
Masters	Mark	Professor of Physics	Ph.D. in Physics, Lehigh University, 1990	Applied Physics; Atomic, Molecular and Optical Physics; LASERS; Quantum Optics; Electro-Optics; Materials (aerogels in particular); Imaging (especially medical); Acoustics
Mikhail	Salam	Clinical Assistant Professor of Physics	Ph.D. in Physics, The Ohio State University, 2011	Nonlinear Dynamics; Fluids

Ursino	Eugenio	Assistant Professor of Physics	Ph.D. in Physics, University of Miami, 2007	Astrophysics, Diffuse X-ray Background, Large Scale Structure
Wang	Gang	Associate Professor	Ph.D. in Physics, Northwestern University, 2003	Optics/Optical Sciences. Optical Physics & Materials Science: Nonlinear Optical Materials; Laser Physics; Optically Assisted Assembly of Nanomaterials; Microscopy; Nonlinear Optical Thin Films, Colloidal materials.
Waly	Noha	Lecturer	Ph.D. in Physical Chemistry, University of Heidelberg, Germany, 2011	Synthesis of Metal Nanoparticles, and Control of their Optical Properties

Appendix 6: Library Memo

A memo from the PFW library is included on the next page.

The $25,000 to $30,000 materials costs mentioned would be needed in advance of applying for ABET accreditation. We cannot apply for ABET accreditation until there is at least one graduate, after the 2nd year of the program.

Further conversation with the Librarian indicated that when the program reached 20 FTE, the library would see the marked increase in services needed, such as document deliveries and consultations. The projection for when the program would reach 20 FTE is after the fifth year.

Liaison Librarian Memo

Date: 2/13/23

From: Sarah Wagner, Information Services and Instruction Librarian

To: Dr. Carl N. Drummond, Vice Chancellor for Academic Affairs

Re: MS in Applied Physics

Describe availability of library resources to support proposed new program:

Helmke Library has limited existing resources for applied physics. In addition to having few books and reference materials (print and electronic), the most notable gap is in full-text coverage of the key journals in the subject area. To support this program for accreditation, the library needs $25,000 to $30,000 for journal subscriptions and other materials. Without these subscriptions, I do not believe the library would meet the benchmark of "adequate" for ABET accreditation.

Comments:

I anticipate the addition of this program would also increase the use of Document Delivery Services (DDS), a service already being leaned on to support essential library functions. Obtaining materials via DDS, particularly more recent publications, comes with the cost of both staff time and money in the form of copyright fees. Depending on enrollment, there may also be a marked increase in the support needed from the liaison librarian, a commitment which would be difficult to meet with current staffing levels.

Sarah Wagner 2-13-2023

Liaison Librarian Signature *Date*

Please email academic_program@ipfw.edu with questions about this form.
Send signed original to Carol Sterberger, Kettler Hall, Room 174

Table 1
Program Financial Projection

Financial Office Table
Purdue FTW Campus
Masters of Science in Applied Physics

	Year #1 FY 2025	Year #2 FY 2026	Year #3 FY 2027	Year #4 FY 2028	Year #5 FY 2029
I. ENROLLMENT					
1. Program Credit Hours Generated (FTE * 30 for BS & FTE * 24 for masters/graduate)					
a. Existing Courses	48	120	162	194	246
b. New Courses				36	90
Total	**48**	**120**	**162**	**230**	**336**
2. Full-Time Equivalents (FTE)					
a. Full-Time FTEs	2	3	5	7	10
b. Part-Time FTEs		1	2	3	4
Total Full/Part-Time FTE	**2**	**4**	**7**	**10**	**14**
c. On-Campus Transfer FTEs					
d. New-to-Campus FTEs	2	4	7	10	14
Total On/New-to-Campus FTE	**2**	**4**	**7**	**10**	**14**
3. Program Majors - Headcount					
a. Full-Time Students	2	3	5	7	10
b. Part-Time Students		2	3	5	6
Total Full/Part-Time HC	**2**	**5**	**8**	**12**	**16**
c. In-State	2	4	6	10	13
d. Out-of-State		1	2	2	3
Total In/Out of State HC	**2**	**5**	**8**	**12**	**16**

Notes

For both undergraduate and graduate degree enrollment projections, please carefully consider competitive degree enrollments and how the Purdue program will be marketed in the calculation of enrollment and degree completion projections.

^ Enter footnotes in the last section of this table for to provide additional details (required for 'other' categories) and projection and/or calculation logic.

Table 1
Program Financial Projection

Financial Office Table
Purdue FTW Campus
Masters of Science in Applied Physics

	Year #1 FY 2025	Year #2 FY 2026	Year #3 FY 2027	Year #4 FY 2028	Year #5 FY 2029
II. INCREMENTAL REVENUE					
1. Projected # of *New* Students (1)	2	4	7	10	14
2. General Tuition & Fees (2)(3)					
a. General Service					
b. Technology Fee					
c. Repair & Rehabilitation Fee					
d. Student Fitness & Wellness Fee					
e. Student Activity Fee	8,862	11,260	11,181	11,181	11,181
Total General Service T&F	**$ 8,862**	**$ 11,260**	**$ 11,181**	**$ 11,181**	**$ 11,181**
2. Additional Fees - *if applicable* (4)					
a. Differential Fees					
b. Course Fees					
c. Other Fees					
Total Additional Fees	$ -	$ -	$ -	$ -	$ -
Total Incremental Revenue	**$ 17,724**	**$ 45,041**	**$ 78,268**	**$ 111,811**	**$ 156,536**

Notes

(1) New Students represents the anticipated number of *new* students to campus; transfers or existing students are ***not*** to be included. The Total is set equal to the 'New-to-Campus FTEs' completed in the Enrollment section (I2d).

(2) T&F must match approved Bursar rates (refer to Bursar website). The calculation should be based on the ***Full-Time/ Resident*** Student T&F. If the new degree program is primarily Part-Time students, then the T&F needs to be adjusted appropriately for this type of expected enrollment.

(3) This data assists in answering (Q3bi): Nature of Support.

(4) If additional fees are applicable, then each fee must be individually listed above and match approved Bursar rates (refer to Bursar website).

Bursar T&F Website: https://www.pfw.edu/offices/bursar-office/tuition-fees/

^ Enter footnotes in the last section of this table for to provide additional details (required for 'other' categories) and projection and/or calculation logic.

Table 1
Program Financial Projection

Financial Office Table
Purdue FTW Campus
Masters of Science in Applied Physics

	Year #1		Year #2		Year #3		Year #4		Year #5	
	FY 2025		FY 2026		FY 2027		FY 2028		FY 2029	
III. EXPENDITURES (Question #3A)										
1. Salary and Wages	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost
a. Faculty	0.33	-	-0.17	(13,240)	-0.67	(52,960)	-0.42	(33,365)	-0.17	(13,240)
b. Limited Term Lecturers										
c. Graduate Students			0.50	14,069	1.00	28,138	1.00	28,138	1.00	28,138
d. Other (Post Doc/Staff)										
Total S&W	**0.33**	**$ -**	**0.33**	**$ 829**	**0.33**	**$ (24,822)**	**0.58**	**$ (5,227)**	**0.83**	**$ 14,898**
2. Fringes and Fee Remissions										
a. Fringe Benefits		-		(4,634)		(18,536)		(11,678)		(4,634)
b. Fee Remissions			1	8,582	1	17,005	1	17,005	1	17,005
Total FB & FR		**$ -**		**$ 3,948**		**$ (1,531)**		**$ 5,327**		**$ 12,371**
3. Supplies and Expenses										
a. General Supplies & Expenses										
b. Minor Equipment										
c. Recruiting & Marketing		3,000								
d. Travel & Entertainment										
e. Other (Library, subscriptions, IT)				25,000						
Total Supplies and Expense		**$ 3,000**		**$ 25,000**		**$ -**		**$ -**		**$ -**
4. Capital										
a. Capitalized Equipment										20,000
b. Repair & Replacement								50,000		50,000
Total Equipment		**$ -**		**$ -**		**$ -**		**$ 50,000**		**$ 70,000**
Total Expenditures		**$ 3,000**		**$ 29,777**		**$ (26,353)**		**$ 50,100**		**$ 97,269**
Projected Program Surplus/(Deficit)*		**$ 14,724**		**$ 15,265**		**$ 104,621**		**$ 61,711**		**$ 59,267**

* For the CHE proposal, only identify the nature of the support. It is not necessary to note dollars in the report; however, it should be stated that there is sufficient revenue to cover expenses. Projected surplus/deficit is an aid to identify potential new University revenue, anticipated program costs, and degree substantiality. This does not represent any type of funding request.

Table 2
Program Revenue and Expenditure Summary

Board of Trustees Table
Purdue FTW Campus
Masters of Science in Applied Physics

	Year #1 FY 2025	Year #2 FY 2026	Year #3 FY 2027	Year #4 FY 2028	Year #5 FY 2029
Total Incremental Revenue*	$ 17,724	$ 45,041	$ 78,268	$ 111,811	$ 156,536
Total Expenditures	$ 3,000	$ 29,777	$ (26,353)	$ 50,100	$ 97,269
Projected Program Surplus/(Deficit)**	**$ 14,724**	**$ 15,265**	**$ 104,621**	**$ 61,711**	**$ 59,267**

*Based on the anticipated number of ***new*** students to campus; transfers or existing students are not included. Projected incremental revenue is based on the current ***full-time, resident*** tuition and fees approved by the Bursar.

**Projected surplus/deficit is an aid to identify potential new University revenue, anticipated program costs, and degree substantiality. This does not represent any type of funding request.

Additional Departmental Footnotes:

Year 4&5 profit is projected to be low due to the one time capital investiment of equipment
and renovation of lab spaces for the program.
We will adjust the amortation rate to keep year 4 and 5 in a positive cash flow with minimal profit margin.

Table 3
Projected Headcount and FTE Enrollment and Degrees Conferred (Questions #6)

Board of Trustees & ICHE Table
Purdue FTW Campus
Masters of Science in Applied Physics

	Year #1 FY 2025	Year # 2 FY 2026	Year # 3 FY 2027	Year # 4 FY 2028	Year # 5 FY 2029
Enrollment Projections (Headcount)	2	5	8	12	16
Enrollment Projections (FTE)	2	4	7	10	14
Degree Completions Projection		2	3	7	10