Updated: 10 April 2025

Certificate of Graduate Study
"Plasma Science and Engineering"
Overview, Requirements, Admission Procedure

I. Introduction:

Plasma science and engineering (*PSE*) encompasses the investigation of fundamental processes in and technological applications of ionized gases. Plasmas are pervasive across an enormous scale. At one extreme plasmas constitute the matter of interplanetary space. At the other extreme plasmas are the chemically reacting media responsible for fabricating microelectronics devices. The National Research Council Decadal Study "*Plasma Science: Advancing Knowledge in the National Interest*" discussed the anticipated science challenges in the field over the next decade. As described the report, plasma science is an essential link in the interdependent disciplines that constitute our core scientific competencies, and which contributes to many areas of national interest:

- *Economic security and prosperity*: Plasmas are essential to the manufacture of high value products. For example, semiconductor industry is based upon plasma processing technologies which are necessary to make the fine features of microprocessors.
- *Healthcare*: Plasmas and charged particle transport are emerging forces in healthcare. A new field of low temperature plasmas is the use of ionized gases in the treatment of tissue and sterilization. Plasma based particle accelerators are already poised to provide table-top x-ray sources for both radiotherapy and radiography.
- *Energy and environmental security:* The future well being of the world relies on the availability sustainable energy sources and environmentally benign technologies. Plasmas are at the heart of both goals. For example, fusion will produce electricity from the energy released by carbon-free reactions fusing hydrogen nuclei together in plasmas. The majority of renewable energy technologies, such as solar cells, rely on plasma fabrication processes.
- *National security*: Plasma science is at the heart of national security through its contributions to stewardship of nuclear technologies and defensive systems. Research on High Energy Density plasmas advances the fundamental science required for many of these missions, with additional extensive applications to astrophysics, to the development of particle and photon sources for science and medicine, and to advanced manufacturing methods.
- *Scientific discovery:* Perhaps most importantly, *PSE* lies at the heart of scientific discovery. Dark matter aside, the vast majority of the known universe is in the plasma state. The most basic and most extreme processes in interstellar space, nebula, cosmic x-ray sources and the near space environment surrounding the earth are plasma based. Simply getting spacecraft to the outer planets to make observations often requires plasma propulsion systems.

PSE is by any measure an interdisciplinary field and so students pursuing graduate study in topics related to *PSE* may be enrolled in any one of a dozen departments. Their common intellectual thread is the study of fundamental plasma processes which are then applied to the investigation of natural phenomena and society benefiting technologies. This common intellectual thread is addressed by the *Certificate of Graduate Study in Plasma Science and Engineering* (*GPSE*). The *GPSE* accentuates the linkages between these diverse approaches to *PSE* and so broadens the students' graduate experiences.

II. Requirements for the Graduate Certificate in PSE

The requirements for the *Graduate Certificate in Plasma Science and Engineering* are as follows.

1. Coursework in the fundamentals and applications of *PSE*. *(Required)*

14 Graduate Credit Hours are required for the *GPSE.* Since the students entering the *GPSE* are from many different departments and have quite varied backgrounds, specific courses will not be required. Instead, a course of study will be proposed by the student and his/her advisor(s) for discussion and approval by the *GPSE* Program Committee. The *GPSE* approved list of courses appears below. Other courses may be approved by request. The recommended breadth requirements are:

- 1 course in plasma fundamentals
- 1 course in plasma technology
- 1 laboratory course
- 1 course in supporting sciences

Double Counting Courses for the PSE Certificate

Students receiving only an MS degree:
Of the 14 hours required for the PSE Certificate, 1 course (or 3 hours) may be double counted for both the PSE Certificate and the MS degree. This double counting is consistent with Rackham requirements that at most 1/6 of the credits for an MS degree can be double counted with a Certificate.

Students receiving a PhD degree and NOT receiving a MS degree:
There is no restriction on double counting courses for the PhD and PSE Certificate. For example, a student is enrolled in a PhD program that requires 30 hours of courses for graduation and the student takes exactly 30 hours of courses. Within those 30 hours, the student also satisfies the requirements for the PSE Certificate. The student then satisfies the course requirements for both the PhD and the PSE Certificate.

Students receiving both a PhD degree and a MS degree:
Assume that the student has taken 14 hours of courses to be applied to the PSE Certificate. Of the 14 hours required for the PSE Certificate, 1 course (or 3 hours) may be double counted for both the PSE Certificate and the MS degree. If the student double counts 3 hours of PSE courses for the MS degree, there are then 11 hours of courses that can be applied to satisfy both the PSE and the PhD. If the student does not double count any PSE courses to satisfy the MS requirements, then all of the 14 hours can be applied to satisfy both the PSE and the PhD requirements.

Students receiving a dual degree or SAGS:
Please contact Kristen Thornton, ECE Graduate Program Manager (thorntok@umich.edu).

2. The laboratory requirement may be satisfied by an appropriate extramural research experience (e.g., internship at a national laboratory, company or collaborating university) that has a substantial laboratory component. Approval must be obtained by petition from the GPSE Program Committee. The extramural experience may satisfy the laboratory requirement but does not count towards the 14 hours required for the certificate unless the student is simultaneously enrolled in an appropriate University of Michigan special topics course.

3. Research on a topic closely related to *PSE*. *(Required)* This option may be met in one of two ways:

- Completion of a PhD thesis on a topic closely related to *PSE*. The appropriateness of the thesis topic will be approved by the *GPSE* Program Committee.
  or
- Completion of at least a 1-semester research project on a topic approved by the *GPSE* Program Committee. The course credits for the research project may count towards the 14 credits required for the certificate.

4. Participation in the *GPSE* Annual Research Symposium on at least one occasion to report on the results of *PSE* related thesis research or a *PSE* related research project. *(Required)*

The Annual Research Symposium will provide graduate students with an opportunity to present the results of their research in talks and poster sessions and interact with *GPSE* faculty and students.

III. Admission to the Graduate Certificate in PSE

Students applying for admission to the GPSE must be enrolled in a graduate degree-granting program at the University of Michigan. Admission to the GPSE may be granted at any time. The admission procedure is:

1. Submit application form obtained from the MIPSE website: https://mipse.umich.edu/certificate.php. (Send to Prof. Mark Kushner, mjkush@umich.edu.)

2. Letter of support from current advisor. (Send to Prof. Mark Kushner, mjkush@umich.edu.)

3. If the student is currently in a Rackham graduate program, submit the form *Dual Degree/Program Application* obtained from:

http://www.rackham.umich.edu/students/navigate-degree/dual-joint-degree-programs
http://www.rackham.umich.edu/downloads/oard-dual-joint-6010-election-form.pdf
The PSE program code is 01977.