March 01, 2016

Handouts of the Graduate Faculty Council

Michigan Tech
Proposal for Ph.D. in Applied Physics

Department of Physics
Michigan Technological University
Houghton, MI 49931

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1. Date: February 23, 2016

2. Contacts:
   Yoke Khin Yap, Director of Graduate Studies – Engineering Physics
   John A. Jaszczak, former Director of Graduate Studies – Engineering Physics
   Ravi Pandey, Chair, Department of Physics

3. Approval for interdisciplinary programs
   Not Applicable.

4. General description and characteristics of program including learning goals
   The Department of Physics proposes a spin-off of its current “Ph.D. in Engineering Physics” to create a new, broadened program: “Ph.D. in Applied Physics”. The current “Ph.D. in Engineering Physics” program engages students to solve engineering-related problems by using the tools and principles of physics. The “Ph.D. in Applied Physics” will further broaden the scope of this program to help meet the needs of students seeking training in broader interdisciplinary areas of engineering and science, including nanotechnology, photonics, plasmonics, and biophysics. This degree will also provide a logical path for students who compete the M.S. in Applied Physics to continue toward a Ph.D., should they decide to further their studies and pursue research. The department is simultaneously proposing that the “Ph.D. in Engineering Physics” program be shelved, contingent upon this proposal being approved.

   The study of physics has generally been focused on the foundational disciplinary areas including, high-energy physics, atomic and molecular physics, astrophysics, and nuclear physics. During the past two decades, new branches of physics have gained increasing attention, particularly in those interface areas where traditional physics intersects with other applied disciplines. These include biophysics, physics at the nanoscale condensed matters, materials physics, optics/photonics, plasmonics, optoelectronics, etc. In order to fill such a void in the interdisciplinary program in physics at the Ph.D. level, we propose to spin off our current “Ph.D. in Engineering Physics” into a new program, “Ph.D. in Applied Physics”. This will broaden the scope of current engineering physics program to include new emerging physics areas.

   Learning Goals:

   **Learning Goal 1:** Students will demonstrate a mastery of the advanced coursework appropriate for their graduate program. This goal will primarily be demonstrated by passing the required coursework and the Qualifying Examination, as described below.

   **Learning Goal 2:** Students will develop and the capacity for and carry out both critical and independent thought in their chosen area (technical specialty) of applied physics research. This goal will primarily be demonstrated through annual research presentations, annual progress reports submitted to the graduate studies committee that include lists of presentations and publications, and through written and oral presentations for the Preliminary Exam, Dissertation, and Thesis Defense.
**Learning Goal 3:** Students will have the ability to communicate orally and in writing to demonstrate clear, logical, critical thinking. This goal will be demonstrated using the same measures as for Learning Goal 2.

5. **Rationale**

Much exciting research is now being done in new interdisciplinary branches of physics, including biophysics, physics at the nanoscale condensed matters, materials physics, optics/photonics, plasmonics, optoelectronics, etc. Most of the faculty members of the department have established research programs in these “frontier” areas of applied physics. The current Ph.D. degree in Physics at Michigan Tech focuses more on “traditional” branches of physics such as astrophysics, atomic & molecular physics, and condensed matter physics. Our Ph.D. in Engineering Physics enables students to solve engineering-related problems by applying the tools and principles of physics. The proposed spin-off program will broaden the focus of “engineering-related problems” to more interdisciplinary “application topics” that may involve engineering, as well as other branches of science (chemistry, biology, etc.).

The proposed spin-off program will offer the following advantages:

- Enables faculty in appropriate application areas where physics borders related engineering and science fields to more effectively recruit graduate students.
- Prepares a framework for future implementation of a more flexible and appropriate coursework requirement to meet the needs of student depending on their individual area of research.
- Enables graduate from our new M.S. degree in Applied Physics (started in Fall 2015) to continue the study in Ph.D. in Applied Physics, should they wish to do so.

6. **Discussion of related programs within the institution and at other institutions**

6.1. **Related programs within the institution**

Michigan Tech offers a M.S. degree in Physics, a relatively new M.S. Degree in Applied Physics, a Ph.D. degree in Physics, and a Ph.D. degree in Engineering Physics. All these programs are designed with their own unique yet related and overlapping curricula. As may be evident from the curriculum requirements described below, the new program is clearly a spin-off of the Ph.D. in Engineering Physics, maintaining the same curricular structure, but broadening the research areas from engineering-related to broader applications. The curriculum requirements of the spin-off program are also a seamless extension of the M.S. in Applied Physics (started from Fall 2015), making transition from this program to the new program a logical one for M.S. students in Applied Physics who wish to continue on toward a Ph.D. in Applied Physics.

The spin off program from “Ph.D. in Engineering Physics” to “Ph.D. in Applied Physics” will consolidate our M.S. and Ph.D. programs into two main streams: 1) Physics, and 2) Applied Physics.
6.2. Related programs at other institutions
There are several universities offering M.S. and Ph.D. level graduate programs in applied physics including:

University of Michigan (http://www-applied.physics.lsa.umich.edu/)
Columbia University (http://apam.columbia.edu/applied-physics#Programs),
Caltech (http://www.aph.caltech.edu/),
Stanford University (http://www.stanford.edu/dept/app-physics/cgi-bin/), and
Cornell University (http://www.aep.cornell.edu/).

All these universities emphasize new emerging areas of study, including:
• nanoscience/condensed matter/solid-state physics,
• laser/photonics/plasma physics,
• biophysics/medical physics.

7. Projections:
The number of students expected in the new program is expected to be six to seven students in the short term, which is the same as the number of students in or Engineering Physics Ph.D. program in recent years. Slightly higher enrollment may be possible, depending primarily on the number of faculty in the department and their fields of specialization. Some students are likely to change from the Ph.D. in Physics to the new Ph.D. in Applied Physics as may be appropriate to their research areas.

8. Scheduling plans (Extension, Evening, Regular)
Regular only.

9. Curriculum design
The framework for the curriculum of the new degree program is shown in the table below. For comparison, the curriculum requirements of the current Ph.D. in Engineering Physics and the M.S. in Applied Physics programs are also shown below. The new curriculum is the same as that of the Engineering Physics Ph.D. program with the following two changes:

1. This “Engineering” component of the Qualifying Exam will be change to an “Application” component, as follows:

For the current “Engineering” component qualifying examination:
“The engineering member(s) of the student's Advisory Committee shall formulate the engineering component of the Qualifying Examination that is two to three hours in length and appropriate to the student’s chosen area of engineering physics interest, focusing on fundamentals related to but not on the student's current research. The format of the engineering component of the Qualifying Examination shall be determined by the student's Advisory Committee.”
For the new “Application” component of the qualifying examination:
“The student's Advisory Committee shall formulate the application component of the Qualifying Examination that is two to three hours in length and appropriate to the student’s chosen area of applied physics interest, focusing on fundamentals related to but not on the student's current research. The format of the application component of the Qualifying Examination shall be determined by the student's Advisory Committee.”

2. Whereas the Engineering Physics Ph.D. program requires that a faculty member in engineering be a member of the student’s qualifying examination and advisory committee, there is no such specific requirement for the Applied Physics Ph.D. program. The qualifying examination and research advisory committee will be formed under the advice of the research advisor and the Applied Physics Graduate Studies committee, following the regulations of the Graduate School, and as deemed most appropriate for the student and the chosen area of research.

The spin-off program’s curriculum requirements are summarized here, along with those of the related Ph.D. in Engineering Physics, and the new M.S. in Applied Physics:

<table>
<thead>
<tr>
<th>Degree</th>
<th>Course Requirements Beyond Those of the Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. in Applied Physics</td>
<td>Core Courses:</td>
</tr>
<tr>
<td></td>
<td><em>(The same as those in the current Ph.D. in Engineering Physics program.)</em></td>
</tr>
<tr>
<td></td>
<td>PH5010 Journal Club (1 credit)</td>
</tr>
<tr>
<td></td>
<td>PH5110 Classical Mechanics (2 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5210 Electrodynamics I (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5310 Statistical Mechanics (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5320 Mathematical Physics (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5410 Quantum Mechanics I (3 credits)</td>
</tr>
<tr>
<td>Disciplinary Electives:</td>
<td><em>(The same as those in the current Ph.D. in Engineering Physics program, which already offer sufficient flexibility to cover the fundamental courses needed for applied physics research.)</em></td>
</tr>
<tr>
<td></td>
<td>Three courses at the 4000-level and higher, including a minimum of one course at the 5000-level or higher, in the student’s chosen area of specialization, and as approved by the student’s advisory committee. Additional courses may be required by the student’s advisory committee.</td>
</tr>
<tr>
<td>Research:</td>
<td>PH6999 Doctoral Research as required to complete doctoral research and credit requirements.</td>
</tr>
<tr>
<td>Qualifying Examination:</td>
<td><em>(The physics component is the same as for the Ph.D. in Engineering Physics. The engineering component of the Qualifying Exam will be changed into the application component as described earlier in this section.)</em></td>
</tr>
<tr>
<td></td>
<td>The Qualifying Exam will include both a physics component, and an application component as described above.</td>
</tr>
</tbody>
</table>
Comparison to related Michigan Tech graduate degrees in Physics:

<table>
<thead>
<tr>
<th>Degree</th>
<th>Course Requirements Beyond Those of the Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. in Engineering Physics</td>
<td><strong>Core Courses:</strong></td>
</tr>
<tr>
<td></td>
<td>PH5010 Journal Club (1 credit)</td>
</tr>
<tr>
<td></td>
<td>PH5110 Classical Mechanics (2 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5210 Electrodynamics I (3 credits)</td>
</tr>
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<td></td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>PH5410 Quantum Mechanics I (3 credits)</td>
</tr>
<tr>
<td></td>
<td><strong>Disciplinary Electives:</strong></td>
</tr>
<tr>
<td></td>
<td>Three courses at the 4000-level and higher, including a minimum of one course at the 5000-level or higher, in the student’s chosen area of specialization, and as approved by the student’s advisory committee. Additional courses may be required by the student’s advisory committee.</td>
</tr>
<tr>
<td></td>
<td><strong>Research:</strong></td>
</tr>
<tr>
<td></td>
<td>PH6999 Doctoral Research as required to complete doctoral research and credit requirements.</td>
</tr>
<tr>
<td></td>
<td><strong>Qualifying Examination:</strong></td>
</tr>
<tr>
<td></td>
<td>The physics component of the Qualifying Exam will cover three of the four following areas, to be chosen in advance, by the student: classical mechanics (including special relativity), electricity and magnetism, quantum mechanics, and general physics.</td>
</tr>
<tr>
<td></td>
<td>The engineering component of the Qualifying Exam is described earlier in this section.</td>
</tr>
<tr>
<td>M.S. in Applied Physics</td>
<td><strong>Core Courses:</strong></td>
</tr>
<tr>
<td>Thesis option A</td>
<td>Minimum of 10 PH credits at the 4000-level or higher including a minimum of 6 credits from the following list:</td>
</tr>
<tr>
<td>Report option B</td>
<td>PH5010 Journal Club (1 credit; required)</td>
</tr>
<tr>
<td>Coursework option D</td>
<td>PH5110 Classical Mechanics (2 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5210 Electrodynamics I (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5310 Statistical Mechanics (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5320 Mathematical Physics (3 credits)</td>
</tr>
<tr>
<td></td>
<td>PH5410 Quantum Mechanics I (3 credits)</td>
</tr>
<tr>
<td></td>
<td><strong>Application Electives</strong></td>
</tr>
<tr>
<td></td>
<td>Minimum 10 credits at the 4000-level and higher (including at least one course at the 5000-level or higher) from an Application Elective list; with approval of advisor.</td>
</tr>
<tr>
<td></td>
<td>Additional courses may be required by the student’s advisory committee under plans A and B.</td>
</tr>
<tr>
<td></td>
<td><strong>Research</strong></td>
</tr>
<tr>
<td></td>
<td>PH5999 Master’s Research</td>
</tr>
<tr>
<td></td>
<td>Minimum 6 credits for thesis degree (Thesis option)</td>
</tr>
<tr>
<td></td>
<td>Minimum 3 credits for report degree (Report option)</td>
</tr>
<tr>
<td></td>
<td>No research for coursework degree (Coursework option)</td>
</tr>
</tbody>
</table>
10. New course descriptions

No new courses are necessary and none are proposed.

11. Model schedule demonstrating completion time:

Year 1 - (assuming Fall matriculation)
- September: Qualifying Examination (Free Shot)
- 2-3 Physics courses each semester (9 credits).
- Funding via a Teaching Assistantship. 20 hours of work/week, typically in introductory Physics Labs.
- January: Qualifying Examination (First Shot)
- Spring of Year 1- Select a research Advisor
- Summer of Year 1- Begin research.

Year 2 1-2 courses/semester.
- Divide remaining time between research and teaching (if still on GTA).
- September- retake un-passed Qualifying Examination sections if necessary
- Annual progress report and oral presentation

Year 3
- Elective coursework.
- Emphasis on research and, if still on GTA, teaching (if still on GTA).
- Take Preliminary Exam in the fall or winter.
- Annual progress report and oral presentation

Years 4 & 5
- Research
- Submit co-authored manuscripts for publication in refereed journals, in collaboration with your research advisor.
- Attended and presented talks and/or posters at national meetings and at Michigan Tech graduate research events.
- Annual progress report and oral presentation
- Write and defend thesis.

12. Library and other learning resources

No additional library or learning resources are required.
13. Faculty Resumes

All graduate faculty in physics may participate in this program. Names of individual faculty and links to their resumes may be found at the following link: http://www.mtu.edu/gradschool/administration/dean/locator/?raw=true&search_type=department &departments=SA-PH&linked=yes

14. Description of available/needed equipment.

A wide variety of equipment is available in the department and across campus for the diversity of applied research that is currently being conducted in Engineering Physics Ph.D. areas. Facilities available in physics are highlighted here: http://www.mtu.edu/physics/facilities/research/
Core facilities available campus-wide are highlighted here: http://www.mtu.edu/research/administration/vpr-office/core-facilities/
No additional equipment is required for the purposes of this proposal.

15. Program costs, years 1, 2, and 3.

Since this is a spin-off proposal with anticipated shelving of the current program that it will replace, there are no additional program costs beyond our existing Engineering Physics Ph.D. program.

16. Space

No additional space is required to accommodate the new graduate degree program.

17. Policies, regulations and rules

None besides curricular requirements outlined above, and those of the Graduate School.

18. Accreditation requirements

Not applicable.

19. Planned implementation date

Fall semester of 2016.
Appendix: Criteria for Financial Evaluation of Proposed Academic Program

I. Relation to University Strategic Plan
   a. Relation of program to the university's educational and research goals.
      As does the current program Ph.D. in Engineering Physics, which this spin off
      proposal is intended to replace, the Ph.D. in Applied Physics degree supports the
      university’s strategic plan’s GOAL 2 to provide a “distinctive and rigorous action-
      based learning experience grounded in science, engineering, technology,
      sustainability, business, and an understanding of the social and cultural contexts of
      our contemporary world,” and in particular to further support the second and third
      criteria under subgoal 2.1:
         • promote mutual appreciation and collaborative opportunities across
           academic disciplines
         • continually review and update existing programs and develop new offerings
           in emerging disciplinary and interdisciplinary areas.
      The new program also supports subgoal 2.3 criteria
         • expand Ph.D. and master’s enrollments, degrees awarded, and scholarly
           productivity

      The program will also further support the following criteria of GOAL 3: Research,
      scholarship, entrepreneurship, innovation, and creative work that promotes a
      sustainable, just, and prosperous world.
         3.1 Growth in research, scholarship, and creativity.
            • increase external support for research, scholarly, and creative
              activities;
            • encourage and support interdisciplinary activities

   b. Consistency with the university's resource allocation criteria.

      No new resources are being requested for this program.

II. Impact on University Enrollment
   a. Projected number of students in the program.
      Based on enrollments in the Ph.D. in Engineering Physics enrollments in the past 5
      years, we anticipate an average enrollment of 9 students enrolled (out of
      approximately 40 Ph.D. students advised by physics faculty).

   b. Source of new students; in particular, will the students be drawn from existing
      programs, or will they be students who would otherwise not have come to MTU?

      We anticipate that most of the enrollment in this program will come from the
      existing program in physics, primarily the Ph.D. in Engineering Physics, but also
      from Ph.D. in Physics. Current students will be given the option, in consultation
      with their research advisors, to change to the new program.
c. What is the likely correlation between demand for the new program and existing enrollment patterns at MTU?
With the shelving of the Ph.D. in Engineering Physics, new students will be accepted in to the new program likely at the same rate that we have been accepting new students into the old program. With the broadened scope of the new program, some students who are in or would likely enroll in the Ph.D. in Physics may also select the new program. We expect that overall growth of Ph.D. students in the department will remain near current levels, but can grow if/when external funding grows.

III.

a. What is the current enrollment in the unit (2015-2016)?

Undergraduate Majors: 58
- B.S. Physics .................. 38
- B.A. Physics .................. 7
- B.S. Applied Physics .......... 13

Graduate Students: 41
- M.S. Physics .................. 2
- M.S. Applied Physics .......... 3
- Ph.D. Physics .................. 24
- Ph.D. Engineering Physics .... 6
- Ph.D. Atmospheric Physics .... 6

IV. Impact on Resources Required by Department in Which the Program is housed. This would include, but not be limited to:
   a. Faculty lines. As a spin-off program with planned shelving of its parent program, this new program will be supported through existing faculty lines.
   b. Faculty and student labs, including ongoing maintenance. None anticipated.
   c. Advising. No changes relative to our current programs.
   d. Assessment. No changes relative to our current programs.

V. Impact on Resources Required By other Units within the University. This analysis would include, but not necessarily be limited to, the impacts on:
   a. Other academic (e.g., Gen Ed) units with regard to faculty, labs and assessment. (NOTE: The current Student to Faculty ratio for the university as a whole is approximately 12:1 per Institutional Analysis.)
   No changes.
   b. Information Technology, the Library, central administration and career planning with respect to the impact on the need for computing services, library resources, advising, record keeping, development of employer relations etc.
   No changes.
VI. Assessment of the ability to obtain the necessary resources assuming requested funds are obtained
   a. For high demand fields (e.g., business fields, etc.), will it be possible to fill allocated lines.

       No additional resources are requested associated with this program.

VII. Past proposals. Has the department initiated any other new degree programs in the last five years? Yes, M.S. in Applied Physics started in Fall 2015; B.A. in Physics started in Fall 2012.
       If so:
       a. Describe the extent to which the new program has met the original goals with respect to:
          1. Enrollment:
             B.A. Physics- current enrollment is 7.
             M.S. in Physics- This program is brand new, so it is too early to tell.
          2. Costs: not applicable- no additional costs were expected
          3. New faculty: not applicable- none requested
          4. Other resources required for the program: not applicable- none requested
       b. How have degree programs added in the past five years affected total enrollment in the department?
          B.A. in Physics- This new program helps to stabilize our overall undergraduate enrollment and gives students flexibility, especially for secondary education certification majors. Average enrollment in SPA programs has been 5 to 6 students.
          M.S. in Physics- This program is brand new, so it is too early to tell.

VIII. Departmental Budget contribution (From the 2014-15 Compendium)
       a. What is the department's total general fund budget?

             $2,703,942 + $526,829 (grad student transfer) = $3,230,771

       b. How much tuition does the department generate? This information should be provided for both the credit hours taught by the department and the number of credit hours taken by the department's majors.

             Undergraduate Credits: 9,101
             Graduate Credits: 675

             Based on in-state tuition rates, this generates an estimated $4,931,790.

             Estimated tuition revenue from majors:
             Undergraduate: 58 majors × 31.5 credits × $478/credit = $873,306
             Graduate: 675 credits × $861.5/credit = $581,512.50
IX. How do the benefits from this program compare to other alternatives that are currently under consideration or development. Will approval and allocation of resources to this program preclude the development of other programs?

No other alternatives are being considered as this program is a spin-off that broadens our successful Ph.D. in Engineering Physics, which will be shelved. No new impacts on other programs are expected.
**Graduate Teaching Assistant Training**

GTA work responsibilities are diverse depending on the roles they play

Graders or Lab Preparatory help: closely supervised; minimal interaction with students

Lab teaching assistant: closely supervised - substantial interaction with students

Recitation instructor: closely supervised – substantial interaction with students

Instructor of record: guided by a course coordinator – substantial interaction with students; carry major responsibilities

**Survey of GTA Training in Departments**

Departments with GTAs were surveyed: Most departments (13/17) have formal training (few hours to 2 weeks before classes). Mathematics, Humanities, Chemistry, Physics, and MEEM have many GTAs and extensive formal mentoring programs in place. The remaining 4 departments have faculty mentoring of individual TAs.

**Course of Action Being Considered**

I. Develop a list of proficiencies (in **disciplinary knowledge**, **pedagogy**, **English proficiency** and **acculturation**) for each role (grader, lab instructor, recitation instructor, instructor of record), that GTAs, both domestic and international, must achieve. A faculty/staff committee would help with this process.

II. Identify (or develop) resources on campus that satisfy the proficiencies. The University (CTL and IPS) has in place many formal and informal courses and other mechanisms to satisfy these requirements.

III. Ask departments to clarify how GTAs will satisfy training requirements in a timely manner. Departments may decide to take advantage of the extensive formal and informal training/mentoring/courses they have in place to satisfy most, if not all, of the requirements. Alternatively, departments can use the University offerings to satisfy the GTA requirements in pedagogy, English proficiency and acculturation training.

IV. Track and document (at the University or department level?) completion of appropriate training before serving as GTAs.

**University Resources Available**

1) **Disciplinary knowledge**: Academic departments: discipline-specific orientation programs; formal mentoring programs; required courses; informal faculty mentoring.
2) **Pedagogy**: Center for Teaching and Learning (CTL): Courses (ED0510 and ED5100); University Teaching and Learning Seminars (UTLs, 4-hour modules on specific instructional topics such as Instructional Basics, Grading, Learner-centered classroom, etc.); workshops.

ED0510: 1-credit, 7-week long. Covers course preparation, educational testing and evaluation, instructional strategies, motivating students, institutional resources.

ED5100: 1-credit, 7-week long. Covers instructional planning, delivery, and assessment in a higher education context (course syllabi, teaching portfolios, and teaching philosophy statements).

3) **Language assessment and training**: CTL: TOEFL > 79 for admitted students. Speaking assessment is conducted by CTL and the results (strong, acceptable, marginal, weak) communicated to departments. Follow-up activities by departments is not prescribed.

International Graduate Student Communication and Cultural Center (IGSC3): individual mentoring/coaching; teaching practice, acculturation training, communication practice and pronunciation assistance.

IESL conversation partners - program open to students, faculty and staff to practice communications one-on-one in an informal setting.

4) **Acculturation Training**: International Programs and Services (IPS) and Humanities Department

Rights and Responsibilities: Mandatory for all international students; taken during grad student orientation.

Life at Michigan Tech: a series of 3 seminars offered at the beginning of Fall and Spring semesters (Academic and social norms and shocking American culture; Getting ready for Winter; Winter Welcome Party).

New course being developed with funding from the State of Michigan; working name: Cultural adjustment and student expectations at Michigan Tech.
GTA Proficiencies

Background
The course of action shown below is in response to questions by the Board of Trustees regarding proficiencies required by GTAs at Michigan Tech and how the satisfactory accomplishment of proficiencies are being tracked.

Course of Action Being Considered
I. Develop a list of proficiencies (in disciplinary knowledge, pedagogy, English proficiency and acculturation) for each role (grader, lab instructor, recitation instructor, instructor of record) that GTAs, both domestic and international, must achieve.

II. Identify (or develop) resources on campus that satisfy the proficiencies. The University (CTL and IPS) has in place many formal and informal courses and other mechanisms to satisfy these requirements.

III. Ask departments to clarify how GTAs will satisfy training requirements in a timely manner. Departments may decide to take advantage of the extensive formal and informal training/mentoring/courses they have in place to satisfy most, if not all, of the requirements. Alternatively, departments can use the University offerings to satisfy the GTA requirements in pedagogy, English proficiency and acculturation training.

IV. Track and document (at the University or department level?) completion of appropriate training before serving as GTAs.

Table 1. Draft of required disciplinary knowledge graduate students in instructional roles. Departments need to complete “Disciplinary Knowledge” and “Methods to Satisfy Proficiencies” in Table 1.

<table>
<thead>
<tr>
<th>Role</th>
<th>Disciplinary knowledge</th>
<th>Method to Satisfy Proficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grader/Lab Prep</strong></td>
<td>- Knowledge of …</td>
<td>- Performance in undergrad and grad courses at a high level</td>
</tr>
<tr>
<td></td>
<td>- Safety relevant to position</td>
<td>- Successful completion of class taught (or equivalent)</td>
</tr>
<tr>
<td>Minimal direct student contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lab Teaching Assistant</strong></td>
<td>- Knowledge of …</td>
<td>- Above requirements, plus:</td>
</tr>
<tr>
<td></td>
<td>- Knowledge of safety, emergency classroom procedures and equipment safety</td>
<td>- Successful completion of disciplinary material at least one step beyond class taught</td>
</tr>
<tr>
<td>Instructional context/policies well defined. Closely supervised</td>
<td></td>
<td>- Safety certification</td>
</tr>
<tr>
<td><strong>Recitation Instructor</strong></td>
<td>- Above plus …</td>
<td>- Above requirements, plus:</td>
</tr>
<tr>
<td>Marginal flexibility in defining instructional context/policies. Closely supervised</td>
<td></td>
<td>- Completion of Bachelor’s degree in discipline</td>
</tr>
<tr>
<td><strong>Instructor of Record</strong></td>
<td>- Above plus …</td>
<td>- Above requirements, plus:</td>
</tr>
<tr>
<td>Instructional context/policies defined only by curriculum/program</td>
<td></td>
<td>- Degree higher than students being taught (e.g. Master’s degree to teach students in a BS program)</td>
</tr>
</tbody>
</table>
Table 2. Draft of required pedagogical proficiencies for graduate students in instructional roles

<table>
<thead>
<tr>
<th>Role</th>
<th>Pedagogy Proficiencies</th>
<th>Method to Satisfy Proficiencies</th>
</tr>
</thead>
</table>
| Grader/Lab Prep               | • Articulate appropriate relationships between grading, student motivation and self-assessment  
<pre><code>                             |   • Identify effective methods of maintaining grading consistency. (Rubrics, etc.)            | • CTL – UTL 2                                                                                   |
</code></pre>
<p>| Minimal direct student contact| • Efficiently provide useful feedback to students on tests and written assignments      |   OR                                                                                             | • Equivalent training within academic unit                                                      |
|                               | • Use techniques to deter cheating and/or plagiarism on assessments                    |                                                                                                  |                                                                                                  |
|                               | • Show Understanding of FERPA as it relates to student work                            |                                                                                                  |                                                                                                  |
|                               |                                                                                       |                                                                                                  |                                                                                                  |
| Lab Teaching Assistant        | • Apply classroom management strategies and best practices.                           | • CTL – UTL 1 and UTL 2                                                                         |                                                                                                  |
| Instructional context/policies well defined. Closely supervised. | • Apply a basic understanding of student motivation when interacting with students in and out of class. | OR                                                                                             | • Equivalent training within academic unit                                                      |
|                               | • Locate and comply with university and federal regulations regarding instruction and safety |                                                                                                  |                                                                                                  |
| Recitation Instructor         | • Effectively prepare/present content considering media, pace, and audience.           | • CTL – ED0510 (includes UTL 1 and UTL 2 plus additional content)                                 |                                                                                                  |
| Marginal flexibility in defining instructional context/policies. Closely supervised | • Implement appropriate active learning techniques to accomplish specific goals in a classroom. | OR                                                                                             | • Equivalent training within academic unit                                                      |
|                               | • Aggregate student feedback to address student concerns in real time during class.     |                                                                                                  |                                                                                                  |
| Instructor of Record          | • Create and publish an interactive Canvas course (class content, pre-lecture quizzes, feedback surveys, discussion boards, etc.) | • CTL – ED0510 and ED5100                                                                          |                                                                                                  |
| Instructional context/policies defined only by curriculum/program | • Communicate learning and assignment expectations: Syllabus, assignment descriptions, grading criteria rubrics and examples | OR                                                                                             | • Equivalent training within academic unit                                                      |
|                               | • Develop assignment-assessment-feedback cycles to support course learning outcomes |                                                                                                  |                                                                                                  |
|                               | • Use best practices for group activities and peer review                              |                                                                                                  |                                                                                                  |
|                               | • Use online resources to support student learning while observing copyright law and fair use principles |                                                                                                  |                                                                                                  |</p>
<table>
<thead>
<tr>
<th>Role</th>
<th>English language proficiencies</th>
<th>Method to Satisfy Proficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grader/Lab Prep</td>
<td>• Able to communicate in English</td>
<td>• TOEFL score meets or exceeds admission requirements</td>
</tr>
<tr>
<td>Minimal direct student contact</td>
<td></td>
<td>• Language Assessed in Testing Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• IGSC3 recommended to gain confidence in English communication</td>
</tr>
<tr>
<td>Lab Teaching Assistant</td>
<td>• Student’s English is generally understandable but contains some pronunciation and/or structural differences.</td>
<td>• TOEFL score meets or exceeds admission requirements</td>
</tr>
<tr>
<td>Instructional context/policies well defined. Closely supervised.</td>
<td>• Student demonstrates acceptable listening comprehension by providing appropriate responses to assessment questions.</td>
<td>• Language Assessed in Testing Center at “Acceptable” level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• IGSC3 recommended to improve communication skills and gain confidence presenting in the lab and interacting with students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If language assessment is not “Acceptable”, repeat Language Assessment after completing IGSC3</td>
</tr>
<tr>
<td>Recitation Instructor</td>
<td>• Student’s accented English is easy to understand.</td>
<td>• TOEFL score meets or exceeds admission requirements</td>
</tr>
<tr>
<td>Marginal flexibility in defining instructional context/policies. Closely supervised.</td>
<td>• Student demonstrates strong listening comprehension by providing thorough, informative responses to assessment questions.</td>
<td>• Language Assessed in Testing Center at “Strong” level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• IGSC3 recommended to support communication skills of instructional role</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If language assessment is not “Strong”, repeat Language Assessment after completing IGSC3</td>
</tr>
<tr>
<td>Instructor of Record</td>
<td>• Student’s accented English is easy to understand.</td>
<td>• TOEFL score meets or exceeds admission requirements</td>
</tr>
<tr>
<td>Instructional context/policies defined only by curriculum/program</td>
<td>• Student demonstrates strong listening comprehension by providing thorough, informative responses to assessment questions.</td>
<td>• Language Assessment in Testing Center at “Strong” level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• IGSC3 recommended to support communication skills of instructional role</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If language assessment is not “Strong”, repeat Language Assessment after completing IGSC3</td>
</tr>
<tr>
<td>Role</td>
<td>Acculturation proficiencies</td>
<td>Method to Satisfy Proficiencies</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>All graduate students</strong></td>
<td>• Setting expectations in graduate school</td>
<td>• Campus Clarity (online Title IX course)</td>
</tr>
<tr>
<td></td>
<td>• Expectations of graduate students</td>
<td>• Graduate School orientation OR online CITI course for basic RCR training</td>
</tr>
<tr>
<td></td>
<td>• Academic integrity at Michigan Tech</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Responsible conduct for research training (basic - plagiarism, mentor/mentee expectations, responsible data collection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Title IX training</td>
<td></td>
</tr>
<tr>
<td><strong>International graduate students</strong></td>
<td>• Rights and responsibilities (immigration requirements and US expectations)</td>
<td>• Life @ Michigan Tech seminar</td>
</tr>
<tr>
<td></td>
<td>• Academic and social norms in the US</td>
<td>• Workshops being developed: Cultural adjustment and student expectations at Michigan Tech</td>
</tr>
<tr>
<td></td>
<td>• Winter in the Keweenaw</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Discussion based Title IX training that incorporates differences between other cultures and the US</td>
<td></td>
</tr>
</tbody>
</table>
Graduate Programs Review and Assessment

I. **Graduate Program Self-Review**
   Started
   - How many students?
   - Completion and attrition rates?
   - Qualifying examinations?
   - Time to completion?
   - How are students supported?
   - Student publications?

II. **Articulate graduate learning outcomes and outline assessment methods**
   - Articulate graduate learning outcomes (GLOs) Spring 2016
     - Demonstrate mastery of the subject matter
     - Demonstrate advanced research skills
     - Make an original and substantial contribution to the discipline
     - Demonstrate effective oral and written communication skills

   - Map GLOs to potential measures Spring 2016

   - Develop Assessment rubric (Deficient; Satisfactory; Excellent) Spring 2016

   - Gather data Starting Fall 2016

   - Analyze data for formative evaluation Every year at department retreat?

   - Submit (brief) Assessment Reports to Grad School Annually, after data analysis
HLC Standards

2.E.1. Students are offered guidance in the ethical use of information resources.

3.A.1. Courses and programs are current and require levels of performance by students appropriate to the degree or certificate awarded.

3.A.2. The institution articulates and differentiates learning goals for its undergraduate, graduate, post-baccalaureate, post-graduate, and certificate programs.

3.A.3. The institution’s program quality and learning goals are consistent across all modes of delivery and all locations.

3.B.3. Every degree program offered by the institution engages students in collecting, analyzing, and communicating information; in mastering modes of inquiry or creative work; and in developing skills adaptable to changing environments.

4.A.1. The institution maintains a practice of regular program reviews.

4.A.6. The institution evaluates the success of its graduates. The institution assures that the degree or certificate programs it represents as preparation for advanced study or employment accomplish these purposes. For all programs, the institution looks to indicators it deems appropriate to its mission, such as employment rates, admission rates to advanced degree programs, and participation rates in fellowships, internships, and special programs (e.g., Peace Corps and Americorps).

4.B. The institution demonstrates a commitment to educational achievement and improvement through ongoing assessment of student learning.

Including: clearly stated goals for student learning that are assessed, use of assessment information to improve student learning, assessment processes and methodologies reflect good practice, substantial participation of faculty and other instructional staff members.

4.C. The institution demonstrates a commitment to educational improvement through ongoing attention to retention, persistence, and completion rates in its degree and certificate programs.

5.C.2. The institution links its processes for assessment of student learning, evaluation of operations, planning, and budgeting.
## Graduate Learning Outcomes (GLOs) PhD

<table>
<thead>
<tr>
<th>GLO</th>
<th>Potential Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Demonstrate mastery of the subject matter</td>
<td>Grades in graduate courses, Qualifying exams, Research proposal, Dissertation &amp; defense</td>
</tr>
<tr>
<td>2) Demonstrate advanced research skills</td>
<td>Research proposal, Dissertation, Dissertation defense</td>
</tr>
<tr>
<td>• Design a research project</td>
<td></td>
</tr>
<tr>
<td>• Execute a research project</td>
<td></td>
</tr>
<tr>
<td>• Master application of existing methodologies and techniques</td>
<td></td>
</tr>
<tr>
<td>• Critically analyze &amp; evaluate one’s own findings and those of others</td>
<td></td>
</tr>
<tr>
<td>3) Make an original and substantial contribution to the discipline</td>
<td>Research proposal, Dissertation, Peer-reviewed publications, Conference presentations</td>
</tr>
<tr>
<td>• Think originally and independently to develop concepts and methodologies</td>
<td></td>
</tr>
<tr>
<td>• Identify new research opportunities within one’s field</td>
<td></td>
</tr>
<tr>
<td>4) Demonstrate professional skills</td>
<td>Qualifying exams, Research proposal, Dissertation &amp; defense, Teaching, Seminars, Conference presentations, Exit surveys</td>
</tr>
<tr>
<td>• Effective oral and written communication skills</td>
<td></td>
</tr>
<tr>
<td>• Follow ethical guidelines for field</td>
<td></td>
</tr>
<tr>
<td>5) Optional Departmental GLO(s)</td>
<td></td>
</tr>
</tbody>
</table>

## Graduate Learning Outcomes (GLOs) Research MS

<table>
<thead>
<tr>
<th>GLO</th>
<th>Potential measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Demonstrate proficiency of the subject matter</td>
<td>Grades in graduate courses, Thesis &amp; Defense</td>
</tr>
<tr>
<td>2) Demonstrate research skills</td>
<td>Thesis</td>
</tr>
<tr>
<td>• Execute a research project</td>
<td></td>
</tr>
<tr>
<td>• Apply existing research methodologies and techniques</td>
<td></td>
</tr>
<tr>
<td>• Critically analyze &amp; evaluate one’s own findings and those of others</td>
<td></td>
</tr>
<tr>
<td>3) Make a contribution to the discipline</td>
<td>Thesis, Peer-reviewed publications, Conference presentations</td>
</tr>
<tr>
<td>4) Demonstrate professional skills</td>
<td>Thesis &amp; Defense, Teaching, Seminars, Conference presentations, Exit surveys</td>
</tr>
<tr>
<td>• Effective oral and written communication skills</td>
<td></td>
</tr>
<tr>
<td>• Follow ethical guidelines for field</td>
<td></td>
</tr>
<tr>
<td>5) Optional Departmental GLO(s)</td>
<td></td>
</tr>
</tbody>
</table>

1 The possible measurements listed are intended only as starting points rather than an exhaustive list. Programs are expected to identify assessment measures most appropriate for their discipline. Use of both qualitative and quantitative (direct / indirect) measures is encouraged.
Lumina Degree Qualifications Profile for (coursework) MS

Potential method for setting learning goals for coursework-only/professional Masters Degrees.

NOTE: this is provided as reference only, we need to confer with the HLC on some points (e.g. can we have different goals for people earning the “same” degree, as coursework/report/thesis are not distinguished on the diploma).

Report: https://www.luminafoundation.org/resources/dqp
Website: http://degreeprofile.org/

Master’s Coursework (Lumina framework): Programs would fill these in as part of developing their departmental goals. Programs should be referred to the DQP document for examples of what students should be able to do after completing a Master’s degree, and adapt statements as needed.

- Specialized Knowledge
- Broad and Integrative Knowledge
- Intellectual Skills (rather than being completely independent from the other 4 proficiencies, these can be seen as skills to be practiced within those other contexts)
  - Analytic Inquiry
  - Information Resources
  - Engaging Diverse Perspectives
  - Ethical Reasoning
  - Quantitative Fluency
  - Communication Fluency
- Applied and Collaborative Learning
- Civic and Global Learning

For articulations of what is expected after completing a Master’s degree (according to the Lumina framework) for each of the above, see: http://degreeprofile.org/grid-viewer/
Appendix A

*Templates: Evaluation forms and Rubric*
Evaluation of PhD GLOs - Qualifying exam written and oral

Student name _____________________

Committee decisions

GLO1: Demonstrate mastery of the subject matter
Circle one: Deficient Satisfactory Excellent

GLO4: Demonstrate professional skills (effective written communication)
Circle one: Deficient Satisfactory Excellent

GLO4: Demonstrate professional skills (effective oral communication)
Circle one: Deficient Satisfactory Excellent

Overall Determination: Pass Provisional Pass Fail

Faculty signatures Date
Evaluation of PhD GLOs - Dissertation and dissertation defense

Student name _____________________

Committee decisions

GLO1: Demonstrate mastery of the subject matter

Circle one:    Deficient   Satisfactory   Excellent

GLO2: Demonstrate advanced research skills

Circle one:    Deficient   Satisfactory   Excellent

GLO3: Make an original and substantial contribution to the discipline

Circle one:    Deficient   Satisfactory   Excellent

GLO4: Demonstrate professional skills

Circle one:    Deficient   Satisfactory   Excellent

Overall Determination:   Pass   Provisional Pass   Fail

Faculty signatures       Date
<table>
<thead>
<tr>
<th>University GLO</th>
<th>Departmental sub-component</th>
<th>Deficient</th>
<th>Satisfactory</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Demonstrates mastery of the subject matter</td>
<td>Synthesizes existing knowledge</td>
<td>Gaps in basic knowledge. Does not understand basic concepts or conventions. Misunderstands or misses relevant literature. Misrepresents or misuses sources.</td>
<td>Displays a solid understanding of the field. Adequate exploration of interesting issues and connections.</td>
<td>Demonstrates thorough mastery as well as creativity in drawing on multiple sources. Synthetic and interdisciplinary. Demonstrates a deep understanding of relevant literatures</td>
</tr>
<tr>
<td>2 - Demonstrates advanced research skills</td>
<td>Mastered application of existing methodologies and techniques</td>
<td>Misapplies techniques or uses non-standard methods without adequate rationalization. Does not recognize limitations of data / techniques were applicable.</td>
<td>Uses appropriate, theory, methods and techniques. Appropriately explains limitations of data / techniques were applicable.</td>
<td>Suggests and utilizes improvements to standard methods and techniques. Limitations are thoroughly and competently discussed.</td>
</tr>
<tr>
<td></td>
<td>Critically analyzes and evaluate their own findings and those of others</td>
<td>Relies on others to suggest data that are relevant to solving a problem of interest. Follows instructions for routine procedures, without experimentation. Does not recognize improbable results.</td>
<td>Literature review is adequate but not critical. Identifies weaknesses in own work but discussion is not comprehensive.</td>
<td>Provides critical evaluation of previous works. Identifies and corrects weaknesses or flaws in referenced work. Identifies and discusses shortcomings in own work.</td>
</tr>
<tr>
<td>3 - Make an original and substantial contribution to the discipline</td>
<td>Think originally &amp; independently to develop concepts and methodologies</td>
<td>No independent research. Question or problem is trivial, weak, unoriginal, or previously solved.</td>
<td>Argument is strong, comprehensive, and coherent. Has some original ideas, insights, and observations.</td>
<td>Has a compelling question or problem. Project is original, ambitious, creative, and thoughtful. Asks or addresses new / important questions.</td>
</tr>
<tr>
<td>4 - Demonstrates professional skills</td>
<td>Displays effective written communication skills</td>
<td>Academic writing lacks structure and organization. Writing has frequent spelling and grammatical errors. Illustrations poorly selected or illegible.</td>
<td>Writing is adequate. Structure and organization are sufficient. Illustrations legible, technically correct, and appropriate.</td>
<td>Concise, elegant, engaging. Technical content and graphic design of illustrations well planned / executed.</td>
</tr>
<tr>
<td>...oral communication skills</td>
<td></td>
<td>Unorganized or unable to articulate an argument. Does not grasp intent of questions</td>
<td>Clear &amp; coherent. Engages appropriate audiences. Grasps intent.</td>
<td>Compelling, persuasive, and accessible to multiple audiences. Articulately addresses questions.</td>
</tr>
</tbody>
</table>
Appendix B: Resources


Cornell University Graduate School

- Doctoral Proficiencies: http://gradschool.cornell.edu/academics/learning-assessment/doctoral-proficiencies
- Research Masters Proficiencies: http://gradschool.cornell.edu/academics/learning-assessment/research-masters-proficiencies
  - Assessment metrics for the Atmospheric Sciences http://gradschool.cornell.edu/sites/gradschool.cornell.edu/files/assessment/Atmospheric.pdf

Rutgers Graduate School – New Brunswick

- Ph.D. Programs: http://gsnb.rutgers.edu/about/phd-degree-learning-goals-and-assessment
- Master’s Programs: http://gsnb.rutgers.edu/about/master%E2%80%99s-degree-learning-goals-and-assessments
  - Mathematics Ph.D.: http://www.math.rutgers.edu/grad/phd_requirements/LearningGoals.html

University of Northern Iowa

- Student Learning Outcomes and Assessment Plans (click on the colleges in the left-side navigation to see files by program/level) https://www.uni.edu/assessment/plans/