Expected Outcome 1: Electricity and Magnetism

Students will demonstrate an understanding of Electricity and Magnetism at the intermediate level and advanced level. Representative topics include: electrostatics, the Laplace and Poisson equations and their solutions, magnetostatics, dipoles and multipole moment expansion, Faraday's Law, scalar and vector potentials, gauge conditions, Maxwell equation, Poynting's Theorem and electromagnetic waves and their interaction with matter.

Assessment Method: Graduate Doctoral Exam

The Physics Department holds a written Graduate Doctoral Examination (GDE) in the beginning of every Fall semester, with a second retake session in the beginning of each spring semester. The GDE consists of three four-hour examinations. Each examination consists of six problems, with only five of the six problems graded. (Each student chooses the five problems they wish to submit.) Physics Department faculty write the examination problems. The problems are at the intermediate to advanced level. Each problem is graded by two faculty (generally the author of the problem and another faculty member) on a 20 point scale. One of the four-hour examinations covers Electricity and Magnetism at the intermediate to advanced level.

Findings:

Eight students received an MS degree in Physics between Summer 2013 and Spring 2014. Five of the eight students took the GDE. Their scores on their respective Electricity and Magnetism subsections of the GDE are tabulated below. The qualitative categories are based on examination results over many years, and the collective opinions of the faculty

<table>
<thead>
<tr>
<th>GDE Electricity and Magnetism</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Score</td>
<td>76-99</td>
<td>60-75</td>
<td>50-59</td>
<td>36-49</td>
<td>10-35</td>
</tr>
<tr>
<td>Fraction of 2013-14 M.S. Recipients</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Number of 2013-14 M.S. Recipients</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Use of Findings for Improvement

The substantial fraction of Ph.D. student whose Electricity and Magnetism scores were Fair or Poor is cause for concern. If this pattern persists for several years, the Graduate Faculty of the department will take action.
Expected Outcome 2: Quantum Mechanics

Students will demonstrate an understanding of Quantum Mechanics at the intermediate level and advanced level. Representative topics include: matrix mechanics, Schrödinger equation and its solutions in one to three dimensions, interpretation and mathematical properties of wave functions, operator methods, creation and annihilation operators, perturbative solutions, angular momentum, spin, parity, the Pauli exclusion principle and its consequences for solid state physics, atomic spectra, blackbody radiation, energy and angular momentum quantization, atomic structure, second quantization.

Assessment Method: Graduate Doctoral Exam

The Physics Department holds a written Graduate Doctoral Examination (GDE) in the beginning of every Fall semester, with a second retake session in the beginning of each spring semester. The GDE consists of three four-hour examinations. Each examination consists of six problems, with only five of the six problems graded. (Each student chooses the five problems they wish to submit.) Physics Department faculty write the examination problems. The problems are at the intermediate to advanced level. Each problem is graded by two faculty (generally the author of the problem and another faculty member) on a 20 point scale. One of the four-hour examinations covers Quantum Mechanics at the intermediate to advanced level. Not all M.S. students take the GDE.

Findings

Eight students received an MS degree in Physics between Summer 2013 and Spring 2014. Five of the eight students took the GDE. Their scores on their respective Quantum Mechanics subsection of the GDE are tabulated below. The qualitative categories are based on examination results over many years, and the collective opinions of the faculty.

<table>
<thead>
<tr>
<th>GDE Quantum Mechanics</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Score</td>
<td>76-99</td>
<td>60-75</td>
<td>50-59</td>
<td>36-49</td>
<td>10-35</td>
</tr>
<tr>
<td>Fraction of 2013-14 M.S. Recipients</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Number of 2013-14 M.S. Recipients</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Use of Findings for Improvement

The substantial fraction of Ph.D. student whose Quantum Mechanics scores were Fair or Poor is cause for concern. If this pattern persists for several years, the Graduate Faculty of the department will take action.
Expected Outcome 3: Research Results

A portion of the M.S. recipients will have demonstrated an ability to contribute to original research.

Assessment Method: Publication of Research Results in Refereed Journals

Co-authorship by an M.S. recipient on articles in refereed journals is assumed to be a good indication of the ability of the student to contribute to original research.

Findings

Of the eight students who received M.S. degrees between Summer 2013 and Spring 2014, two (25%) have been coauthors on research papers. This is a reasonable fraction, given that the M.S. degree is predominately focused on course-work.

Use of Findings for Improvement

The Graduate Faculty will pursue further efforts to involve M.S. students in research.