

## Curriculum Outline

### *Integrative Graduate Education and Training (IGERT) in Nanostructured Solar Cells: Materials, Processes, and Devices*

**An opportunity for graduate students in science and engineering at the University of South Dakota, South Dakota State University, and the South Dakota School of Mines and Technology.**

Key elements of the South Dakota IGERT include:

1. Interdisciplinary, cross-campus research rotations for graduate students;
2. Advanced thematic coursework designed for students with diverse academic backgrounds;
3. A student-guided seminar series and symposium;
4. Exposure to the global nature and context of solar energy research with an opportunity for international collaboration;
5. Internships at the National Renewable Energy Laboratory (NREL);
6. Internships in the solar-energy private sector; and
7. Educational outreach to K-16 students, with emphasis on outreach to Native American students

## Expectations

### Background

The student will begin the program with an interdisciplinary background of coursework described in Appendix A or will make up any deficiencies in the first year of the program.

### Dissertation Research

The student will choose a primary research advisor, a secondary research advisor on a different campus in a different discipline, and a collaborative research project, involving both research groups. Examples, of potential research projects are listed in Tables 1-4 in Appendix B. At least one semester will be spent pursuing the project on-site in the secondary advisors laboratory. The secondary advisor will serve on the student's Dissertation Committee. Results of the collaboration must make a substantive contribution to the dissertation.

The student will engage in an approved research internship (national lab or private sector) relevant to the theme of Nanostructured Solar Cells. Results of the collaboration must make a substantive contribution to the dissertation.

### Coursework

The curriculum for each of the IGERT PhD programs includes three electives which may be chosen from outside the primary program or discipline. The elective **courses**, listed in Table 5, are offered at least biennially and are appropriate for students with an undergraduate degree

in one of the relevant disciplines, coupled with some common background preparation described above. IGERT students will be advised to choose advanced courses which best relate to their interdisciplinary dissertation project. All three electives must be chosen from the list in Table 5 and at least two must come from an alternate discipline.

<b>Table 5: Currently Available Advanced Interdisciplinary PhD courses</b>			
<b>Materials Chemistry</b>	<b>Electrical Engineering</b>	<b>Materials Engineering and Science</b>	<b>Nanoscience and Nanoengineering</b>
<ul style="list-style-type: none"> <li>• Synthesis and Characterization of Nanostructured Materials</li> <li>• Applications of Nanostructured Materials</li> <li>• Solid State Chemistry or Solid State Physics</li> <li>• Luminescent Materials</li> <li>• Electrochemistry</li> <li>• Polymer Chemistry</li> <li>• Science &amp; Ethics</li> </ul>	<ul style="list-style-type: none"> <li>• Photovoltaics</li> <li>• Advanced Electronic Materials</li> <li>• Electric Properties of Materials</li> </ul>	<ul style="list-style-type: none"> <li>• Interfacial Phenomena</li> <li>• Oxidation and Corrosion of Metals</li> <li>• Polymer Chemistry</li> <li>• Fundamentals of Materials Engineering</li> <li>• Condensed Matter Physics</li> <li>• Chemistry of Materials</li> </ul>	<ul style="list-style-type: none"> <li>• Nanomaterials for Photovoltaics</li> <li>• Nanophotonics</li> <li>• Nanophotonic Materials</li> <li>• Nanomaterials</li> <li>• Theory and Application of Nanomaterials</li> <li>• Characterization of Nanomaterials</li> </ul>

**Educational Outreach**

The student will design and execute a substantive project in educational outreach. He or she will disseminate the results of that outreach through peer-reviewed publication or through presentation at a professional meeting of national scope. The projects require a formal proposal (3 page limit) and pre-approval by both research advisors and by the Outreach Coordinator, Andrew Sykes.

IGERT students will receive explicit training in educational outreach. They will enroll for one credit hour in XXXX 592 *Special Topics: Educational Outreach*. The students may choose to execute the projects within the framework of existing programs, which include opportunities to:

- teach in the South Dakota Governors Camp on the USD campus (reaching ~25 middle school students per year);
- teach in the TRIO Programs Upward Bound or Math and Science Initiative (engaging Native American High School Students on the USD campus, reaching ~40 students/year);
- serve as instructors and teaching assistants in SDSU/ Flandreau Indian High School Summer workshops (reaching ~100 students and teachers/year in a six week program);
- serve as instructors for the SDSM&T GEAR Up summer program for Native American high school students (reaching ~100 students/year in a eight-week program);

- work as teaching assistants or as visiting instructors at Sinte Gleska University;
- work with the Northern Plains Undergraduate Research Center to conduct training workshops and laboratory demonstrations for classes at Sinte Gleska University and Nebraska Indian Community College.

These programs provide immersive opportunities rarely available to graduate students. Those who intend to pursue an academic career will find the experience invaluable as they contemplate the tri-partite mission (teaching, research, and service) of university faculty.

### **Networking, Governance, and Professional Development**

IGERT student will participate substantively in the professional societies most relevant to their primary discipline.

They will participate in the SD-IGERT Student Governance Committee whose primary functions are:

1. orientation assistance for new students
2. communication of student concerns to IGERT Directors

Under the auspices of the Student Seminar Committee, IGERT students will participate in organization of a Nanostructured Solar Cells seminar series and an End-of-Summer Symposium. They will participate in issuing invitations and hosting seminar visitors.

Students may elect to participate in an annual proposal writing workshop where they will receive advice regarding preparation of NSF-EAPSI proposals for international collaboration.

### **Other**

The student will complete the PhD degree requirement for his or her academic program.

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**Appendix A Part I:** Expected common undergraduate preparation. Highlighted areas will require remediation, ideally as part of the Masters curriculum.

Course	Materials Chemistry	Electrical Engineering	Materials & Metallurgical Engineering	Nano Science & Engineering (Physics student)
1) One (1) year General Chemistry	Required as part of undergrad curriculum	Required as part of undergrad curriculum	Usual as part of undergrad curriculum	Usual as part of undergrad curriculum
2) One (1) Year Organic Chemistry	Required as part of undergrad curriculum	Usually absent in undergrad preparation	Usually absent in undergrad preparation	Usually absent in undergrad preparation
3) Multi-variable Calculus (Calc III)	Required as part of undergrad curriculum	Required as part of undergrad curriculum	Required as part of undergrad curriculum	Required as part of undergrad curriculum
4) Ordinary & Partial Diff Equ	Significant Exposure in Physical Chemistry I & II. Common elective.	Required as part of undergrad curriculum	ODE required as part of undergrad curriculum; PDE is absent in undergrad preparation	Required as part of undergrad curriculum
5) One (1)Year University Physics	Required as part of undergrad curriculum	Required as part of undergrad curriculum	Required as part of undergrad curriculum	Required as part of undergrad curriculum
6) Quantum Mech or Modern Physics	Common elective in undergraduate curriculum. Significant exposure in Phys Chem II.	Absent in undergrad preparation	Usually absent in undergrad preparation	Required as part of undergrad curriculum
7) One (1) semester electrical circuits	Some exposure in Instrumental Analysis	Required as part of undergrad curriculum	Usually absent in undergrad preparation	Common elective in undergraduate curriculum
8) Electronic Materials or Solid State Physics	Some exposure in Inorganic Chemistry	Required as part of undergrad curriculum	Usually absent in undergrad preparation	Common elective in undergraduate curriculum
9) Thermo-dynamics	Required as part of undergraduate curriculum	Required as part of undergraduate curriculum	Required as part of undergraduate curriculum	Required as part of undergraduate curriculum
10) B.S. in Chemistry, Physics, EE, or other relevant engineering	BS or MS in Chemistry	BS or MS in Electrical Engineering	BS or MS in Materials or closely related field	BS or MS in Physics, EE, or closely related field.