

## **Work in Progress: Blending Contemporary Research in Sustainability and Fundamental Skills for Graduate Success into a Team-Taught, Introductory Graduate Course**

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### **Abstract**

A team-taught graduate course titled, “EGR501: Topics in Sustainability” is required for all students pursuing a Master of Science in Engineering (M.S.E.) degree at Northern Arizona University. In the past, the course tended toward a seminar presentation style, with minimal technical depth and a light work load for the graduate students. This was due in part to the range of academic disciplines represented in the course, with instructors afraid of alienating students outside their own discipline. As with many team-taught courses, EGR501 also suffered from a lack of responsibility or accountability to any one instructor. Several department chairs and EGR501 instructors were dissatisfied with the result. The group therefore designed a new overall course structure, set of learning objectives, and instructional guidelines that would ensure specific skill development and a graduate level of work, while encouraging instructors to be pedagogically creative and to provide contemporary content. Instructors now design and submit potential modules and receive extra workload compensation for participating in the course. In addition, a course coordinator has overall responsibility for the course and tracks students’ progress throughout the semester. The result has been an improvement in instructor motivation and attitudes, the quality of student products, and student preparation for successful graduate careers.

### **Overall Course Structure**

An example overall course structure follows. Each instructor has a three-week module to discuss a specific topic related to sustainability at the graduate level. The remaining weeks are devoted to an overview of sustainability, soft skill development, and project presentations.

- *Weeks 1-2:* Introduction; Panel discussion: “What is Sustainability?”; Student project selection and planning.
- *Weeks 3-5:* Module #1 – Power Generation Techniques (Mechanical Engineering). Analysis of technical, economic, political, social, and environmental aspects of different power generation techniques. Recent innovations, current events. Life-cycle analysis.
- *Weeks 6-8:* Module #2 – Power Transmission Grid (Electrical Engineering). Challenges and emerging areas of research related to power transmission, including effects of renewable generation, efficiency improvements and behavior modification. Computer simulations of power flow in different situations. Review of recent research papers.
- *Weeks 9-11:* Module #3 – Mega-Resources (Civil & Environmental Engineering). Delineating and managing critical resource systems (Colorado River as an example). Field trip to Hoover Dam, meetings with Las Vegas water authority.
- *Weeks 12-14:* Module #4 – Sustainable Informatics (Computer Science). Techniques to manage and analyze large amounts of data, with applications to sustainability research.

- *Week 15:* Team project presentations and final reports.

## **Learning Objectives**

The following learning objectives were developed by the department chairs and course instructors. The EGR501 students are expected to:

- Develop an appropriate research question related to sustainability.
- Conduct a high quality literature review related to sustainability research.
- Utilize project management techniques to successfully complete a research project in the area of sustainability.
- Write effective technical papers, both individually and in teams.
- Produce effective technical presentations.
- Demonstrate an understanding of and ability to utilize a variety of research techniques (e.g., analytical, numerical, and experimental) to analyze sustainability issues.
- Demonstrate a deep understanding of several important sustainability issues, including the economic, environmental, social, and legal aspects of these issues.

## **Instructional Guidelines**

The following guidelines were provided to potential EGR501 instructors:

- Each module should have graduate level technical learning objectives related to a topic in sustainability.
- Each module should require a graduate level workload, with several hours of coursework each week.
- Each module should address effective research skills.
- Each module's assignments should be due before the first class of the following module.
- One module should require an individual report (with guidelines on effective technical reports); one module should require a technical presentation (with guidelines); one module should involve advanced simulation software (demonstrate an understanding of limitations); one module should include a field trip; consider assigning a technical poster.

## **Additional Modifications**

Although the students performed considerably better after implementing the above structure, concerns remain, and additional modifications have been proposed. Instructors still fear alienating students outside of their discipline, so the topics and workload are still low for a graduate course. The instructors could discuss their modules with each other and the department chairs, to get feedback on ways to strengthen the content without alienating other disciplines. The students had difficulty managing their research projects and producing high quality results, even with the feedback mechanisms. The students might be more motivated by useful projects (for community or service organizations, for example) and by periodic face-to-face project status updates with instructors or their customers.