RESEARCH AND CAPSTONE PROJECTS IN ENGINEERING AND ENGINEERING TECHNOLOGY

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Abstract *— Here are presented topics for research and capstone projects in engineering and engineering technology for undergraduate students. Robust student-based undergraduate research models are being developed by Daytona State College faculty to develop innovative and effective models to encourage participation of more undergraduate students in research programs. The objective is to create models for promoting research opportunities for Engineering and Technology (E&T) undergraduate students. Student engagement through undergraduate research and capstone projects is being conducted at Utah Valley University. At the Connecticut College of Technology, a statewide consortium of community colleges and universities, there is being administered an undergraduate research / capstone project funded through the National Science Foundation called the Life Support and Sustainable Living program. And the University of Arkansas – Little Rock is integrating undergraduate research for green energy education centered on a photovoltaic test station.*

Index Terms – Capstone projects in engineering and engineering technology, engineering and engineering technology education, engineering and engineering technology pedagogy, undergraduate research in engineering and engineering technology,

ROBUST STUDENT-BASED UNDERGRADUATE RESEARCH MODELS

Traditional models for encouraging undergraduate participation in research projects are based primarily on the undergraduate experiences and recollections of faculty members. Today, we still rely on traditional methods and models to encourage undergraduate students of the New Millennium to conduct research. Relatively low numbers of undergraduate students currently entering Engineering and Technology (E&T) research programs, coupled with a lack of college faculty experience with undergraduate participation in their research projects, suggests that these students are not getting the message that they are perceived as valued researchers. The ultimate goal of this study is to create models for promoting research opportunities for E&T undergraduate students. The anticipated outcomes of this study are increased participation of E&T undergraduates in research, achieving more success in research programs, and eventually increased participation of more prepared students in graduate studies. [1]

STUDENT ENGAGEMENT THROUGH UNDERGRADUATE RESEARCH AND CAPSTONE PROJECTS

Student engagement through undergraduate research and capstone projects is being conducted at Utah Valley University. Student engagement involves team building, inquiry learning, project learning and problem- solving in the context of the classroom, laboratory, community, and internships. The principles are applicable to all sizes and types of institutions of higher education, even if the application methods are different. While most projects are developed as team efforts, individual projects are also encouraged. For example, an annual Technology Fair for the associate degree at Utah Valley University highlights the student projects in robotics and mechatronics, some of which have been requested by industry. At the senior level projects teams are created with students with different sub-discipline interests or with students from different engineering disciplines to address industry initiated projects. A teaching innovation center provides training to faculty in student engagement in the classroom and laboratories. For example, the students in the automotive technology program conduct research on automobile performance and then modify a test vehicle to compete in speed races at the Bonneville Salt Flats in Utah. Students in the land surveying program travel to Israel to complete a 3-D survey of an archeological site. The College of Technology and Computing creates Applied Research Clusters to bring together faculty and students for research projects. The UVU Business Resource Center provides a place for student incubators to help students conduct research and commercialize products. Undergraduate research and capstone projects help to prepare students to be more productive in the future work and interests and can be achieved at any institution of higher education. [2]

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UNDERGRADUATE RESEARCH/ CAPSTONE PROJECT

At the Connecticut College of Technology, a statewide consortium of community colleges and universities, there is being administered an undergraduate research / capstone project funded through the National Science Foundation called the Life Support and Sustainable Living (LSSL) program. The LSSL has engaged over 300 students in over sixty industry sponsored research projects that included the creation of a new wheel chair design, development of both an apnea monitor and a bowel sound stethoscope for premature infants, drones and similar projects that responded to industry requests. Several of the projects are pending patents and include the students involved in the project on the patents. All of the community college students involved in the project have successfully continued their education in engineering at four year partner universities. The LSSL was also recognized nationally at the HiTec Conference in 2012 as an innovative model for undergraduate education. [3]

UNDERGRADUDATE RESEARCH ON PHOTOVOLTAIC ENGINEERING

The University of Arkansas – Little Rock had received a CCLI grant from NSF under the title: Development of Novel Learning Materials for Green Energy Education Centered around a Photovoltaic (PV) Test Station. Integration of undergraduate research was one of the intellectual merits of the proposal. Eight undergraduates participated in the completion of the project. The students were involved in various aspects of the project including literature search, power point generation, experimental verifications of labs, research related to micro inverter design, and also acted as focus group. Six undergraduate senior projects were completed through their innovative work on the project. The projects included MPPT controller design based on panel's Thevenin's model, microcontroller implementation of the controller, PC based maximum power point tracker, and applications to solar cooler, and a PV powered refrigerator. The undergraduate research focused on improving power quality of solar inverters. Solar inverters require a Total harmonic Distortion (THD) of less than five percent for grid connectivity. With that goal in mind, the undergraduates researched various methods of reducing THD in a cost effective way. They have developed two methodologies. One approach is based on comparison of a sinusoid against a complex signal to produce the PWM signal with reduced harmonics. The method provides a wide baseband at a lower switching frequency compared to sine-triangle PWM. The difficulty with the comparison method is the generation of the arbitrary waveform. A set of data points computed by solving nonlinear equations needs to be generated for the arbitrary function generator. To eliminate this difficulty, a closed form solution that could be programmed into an ordinary microcontroller has been investigated. These devices are cheap and the results could be very effective in designing MPPT integrated solar inverters. An undergraduate was introduced to this analytical approach and she has been able to find solutions to eliminate lower order harmonics while controlling the fundamental amplitude. She has used the PIC microcontroller to generate the PWM signals and to control the fundamental amplitude. Since 2012, there have been eight publications on undergraduate research at international conferences with undergraduates as coauthors in two of which the undergraduate is the first author. The students received credit of the work through special topics. [4]

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