AC 2011-608: COMPUTER ENGINEERING TECHNOLOGY PROGRAM - A CURRICULUM INNOVATION INITIATIVE

Omer Farook, Purdue University Calumet

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Professor OMER FAROOK is a member of the faculty of the Electrical and Computer Engineering Technology at Purdue University Calumet. Professor Farook received the Diploma of Licentiate in Mechanical Engineering and BSME in 1970 and 1972 respectively. He further received BSEE and MSEE in 1978 and 1983 respectively from Illinois Institute of Technology. Professor Farook's current interests are in the areas of Embedded System Design, Hardware Software Interfacing, Digital Communication, Networking, Image processing and Biometrics, C++, PHP and Java Languages. He has a keen interest in pedagogy and instruction delivery methods related to Distance learning.

Chandra R.Sekhar, Purdue University, Calumet (Department of Tech)nology

Chandra R. Sekhar, Purdue University Calumet Professor Chandra R. Sekhar is a member of the faculty of the Electrical and Computer Engineering Technology at Purdue University Calumet. Professor Sekhar earned a Bachelor's Degree in Chemistry from the University of Madras (India), a Diploma in Instrumentation from Madras Institute of Technology and Master's Degree in Electrical Engineering from University of Pennsylvania. Professor Sekhar's primary teaching and research focus is in the areas of Biomedical and Process Control Instrumentation and Clinical Engineering.

jai p agrawal, Purdue University Calumet

JAI AGRAWAL is a Professor in Electrical and Computer Engineering Technology at Purdue University Calumet. He received his Ph.D. in Electrical Engineering from University of Illinois, Chicago, in 1991, dissertation in Power Electronics. M.S. and B.S. also in Electrical Engineering from Indian Institute of Technology Kanpur, India in 1970 and 1968 respectively. His expertise includes analog and digital electronics design, power electronics, nanophotonics and optical/wireless networking systems. He has designed several models of high frequency oscilloscopes and other electronic test and measuring instruments as an entrepreneur. He has delivered invited short courses in Penang, Malaysia and Singapore. He is also the author of a textbook in Power Electronics, published by Prentice-Hall Inc. His professional career is equally divided in academia and industry. He has authored several research papers in IEEE journals and conferences. His current research is focused on renewable energy technology, smart energy grid.

Dr. Essaid Bouktache, Purdue University, Calumet (Tech)
Prof. Ashfaq Ahmed, Purdue University, Calumet (Tech)
Dr. Hassan Moghbelli, Isfahan University of Technology, Department of Electrical and Computer Engineering, and Texas A&M University, Department of Mathematics

Hassan Moghbelli received his BS, in electrical engineering from Iran University of Science and Technology (IUST) in 1973, his MS in electrical engineering from Oklahoma State University in 1978, and his PhD in electrical engineering with specialization in electrical drives and power electronics from University of Missouri-Columbia (UMC) in 1989. Dr. Moghbelli was an instructor at Isfahan University of Technology (IUT) from 1978-1984, an assistant professor at Purdue University Calumet (PUC) from 1989-1993, and an associate professor in IUT and IUST from 1989-2002. He has done several projects in the area of electrical drives, power electronics, and hybrid electric vehicles. He served as the Head of School of Railway Engineering at IUST from 2000-2002. He served as a consultant at Northern Indiana Commuter Transportation District from 1991-1993 and at Isfahan and Tehran Regional Metro Companies from 1993-2002. He has directed several projects in the area of electric vehicles, hybrid electric vehicles. He also was a research associate in the Advanced Vehicle Systems Research Program in the department of Electrical Engineering at Texas A&M University from 2002 to 2004. Furthermore, he successfully implemented the Hybrid Electric Vehicles on a Saypa mini bus which was funded by Ministry of Industry in Iran. He was a senior lecturer in Math department at TAMU during 2004-2006. He joined the Math and Science Department at Texas A&M at Qatar in January of 2007 and he is working on NPRP2 research project for Qatar Foundation. His research interests are mainly the control, electric drive train, power electronics, hybrid electric vehicles, CNG vehicles, alternative energy, and power systems. He has published more than 95 scientific papers in these areas. He is a member of SAE, ASME, and IEEE.

Computer Engineering Technology Program
- A Curriculum Innovation Initiative

Abstract

The proposed Computer Engineering Technology program is designed to meet industry's over-whelming need for employees with an in-depth knowledge of both hardware and software. There is a shortage of individuals who could implement hardware-software integration in design and development. The proposed degree curriculum plan will bridge the gap between these two disciplines, and will provide the students a solid foundation in each. The proposed curriculum will integrate the knowledge in the areas of electronics, computer and software with intensive classroom and laboratory experiences.

From a software perspective, the proposed curriculum would draw its resources and would include most of the existing courses from the Computer Science curriculum within the department of Mathematics, Computer Science, & Statistics . Students will gain proficiency in software design and development using programming languages currently used in industry. The proposed curriculum would allow the students to draw courses from the areas like Algorithms, Image Processing, Distributed Systems, Automata and Computability, Database systems, Computer Graphics, Artificial Intelligence and Numerical Analysis. Students learn industry standard approaches to application software development as well as state-of-the-art problem solving techniques.

The hardware focus of the proposed curriculum would draw its resources from the Electrical and Computer Engineering Technology curriculum. The curriculum provides a fresh look at Electrical Engineering Technology curriculum from the perspective of System Design. It examines the subject areas that prepares the student to pursue the discipline of System Design from at least four different perspectives; via: 1) PLD/FPGA centric system design, 2) Microcontroller based Embedded System Design, 3) PC based Network-oriented Distributed System Design and 4) DSP based Real-time Processing based System Design[1]. The hardware focus is in the areas of PLD design, Analog Electronics Embedded System design, Electronic fabrication, Biomedical Electronics, Computer Networking, Distributed Systems and Digital Signal Processing (DSP) .

This proposed plan emphasizes on both disciplines (Electrical and Computer Engineering Technology and Computer Science), along with a solid math, science and general education background, to enable industry ready students to tackle the challenges of the future. The proposed integrated curriculum would empower the students to embark upon the path of a Life Long Learning.

Introduction (from the Job Market's perspective)

The following extract from US Department of Labor, Occupational Outlook Handbook illustrates and endorses the validity of this proposal from an unbiased third party[2].

"Computer software engineers are projected to be one of the fastest-growing occupations from 2004 to 2014. Rapid employment growth in the computer systems design and related services industry, which employs the greatest number of computer software engineers, should result in very good opportunities for those college graduates with at least a bachelor's degree in computer engineering or computer science and practical experience working with computers. Employers will continue to seek computer professionals with strong programming, systems analysis, interpersonal, and business skills. …….

Employment of computer software engineers is expected to increase much faster than the average for all occupations, as businesses and other organizations adopt and integrate new technologies and seek to maximize the efficiency of their computer systems. Competition among businesses will continue to create an incentive for increasingly sophisticated technological innovations, and organizations will need more computer software engineers to implement these changes. In addition to jobs created through employment growth, many job openings will result annually from the need to replace workers who move into managerial positions, transfer to other occupations, or leave the labor force.

Demand for computer software engineers will increase as computer networking continues to grow. For example, the expanding integration of Internet technologies and the explosive growth in electronic commerce—doing business on the Internet—have resulted in rising demand for computer software engineers who can develop Internet, intranet, and World Wide Web applications. Likewise, expanding electronic data-processing systems in business, telecommunications, government, and other settings continue to become more sophisticated and complex. Growing numbers of systems software engineers will be needed to implement, safeguard, and update systems and resolve problems. Consulting opportunities for computer software engineers also should continue to grow as businesses seek help to manage, upgrade, and customize their increasingly complicated computer systems.

New growth areas will continue to arise from rapidly evolving technologies. The increasing uses of the Internet, the proliferation of Web sites, and mobile technology such as the wireless Internet have created a demand for a wide variety of new products. As individuals and businesses rely more on hand-held computers and wireless networks, it will be necessary to integrate current computer systems with this new, more mobile technology. Also, information security concerns have given rise to new software needs. Concerns over "cyber security" should result in businesses and government continuing to invest heavily in software that protects their networks and vital electronic infrastructure from attack. The expansion of this technology in the next 10 years will lead to an increased need for computer engineers to design and develop the software and systems to run these new applications and integrate them into older systems."

Program's Goals

The program's goals is a 5 years (2 + 2 + 1) 3-degrees plan that would offer students Associate, Bachelor and Master degree. The plan of study includes courses in the areas of Electronics, Hardware, Software, Firmware, Networking, Algorithms Design, Image Processing, Distributed Systems, Automat and Computability, Database systems, Computer Graphics, Artificial Intelligence, Numerical Analysis and DSP. This integrated unified approach provides a road map

in the form of curriculum that utilizes the same tools which industry is employing. This approach to curriculum bridges the gap that exists between the classroom practices and industrial practices. This unified approach would deliver students with career-bound knowledge essential for the industry.

Time line for a student in the Program Curriculum:

- 2 years in the program **Associate of Science** degree.
- 4 years in the program **Bachelor degree with a Minor in Computer Science**.
- 5 years in the program **Masters in Technology** by selecting courses from both Electrical and Computer Engineering Technology program and Computer Science.

Another projected goal is to offer courses on line in a Virtual Class room setting thereby taping into the student market that does not have access to traditional University. Currently a number of ECET designated courses are being offered in Distance Learning Format. This proposal has got Global scope and could be marketed to International students.

Proposed methodology and plan of work

1. Methodology

The following citation[3] illustrates the popularly accepted Methodology that would be used as the guideline in defining the **Electrical Engineering Technology Program with minor in Computer Science.**

"Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software. The term *software engineering* was popularized during the 1968 NATO Software Engineering Conference (held in Garmisch, Germany) by its chairman F.L. Bauer, and has been in widespread use since. The discipline of software engineering encompasses knowledge, tools, and methods for defining software requirements, and performing software design, software construction, software testing, and software maintenance tasks.[2] Software engineering also draws on knowledge from fields such as computer engineering, computer science, management, mathematics, project management, quality management, software ergonomics, and systems engineering.[2]

As of 2004, the U. S. Bureau of Labor Statistics counts 760,840 software engineers holding jobs in the U.S.; for comparison, in the U.S. there are some 1.4 million practitioners employed in all other engineering disciplines combined.[3] The term software engineer is used very liberally in the corporate world. Very few of the practicing software engineers actually hold engineering degrees from accredited universities. There are estimated to be about 1.5 million practitioners in the E.U., Asia, and elsewhere. SE pioneers include Barry Boehm, Fred Brooks, C. A. R. Hoare, and David Parnas."

2. Program's Administration

The administration of the Program is based upon the following criteria.

1) The program meets ABET accreditation.
2) Identifying the program's strengths which has similarities with our respective departments.
3) Conduct market surveys with Employers to keep the currency of the curriculum..
4) Curriculum design for the program is through input from faculty of both the programs.
5) The currency of the program is maintain by two coordinators one from each department.

Proposal's Pedagogy

The underpinning pedagogy of the proposal is derived in having a curriculum that provides the perspective of System Design based upon the following four design methodologies via: 1) PLD/FPGA centric system design, 2) Microcontroller based Embedded System Design, 3) PC based Network-oriented Distributed System Design and 4) DSP based Real-time Processing based System Design[1]. The curriculum provides a totally fresh look at Electrical Engineering Technology curriculum from the perspective of System Design. Another unique approach is to offer a two-course sequence in different subject areas that will has provide the pedagogical framework for the students to master the subject area before moving on to next area of emphasis. Typically the first course introduces the basic frame work for the subject area followed by the next course which applies the principles in tangible physical realization.

Academic Impact

The faculty of Electrical Engineering Technology Program and Computer Science Program meets on a regular basis to keep the currency of this Program. The general consensus of the faculty is that, such a program is beneficial and unique. The program's financial impact on the academic units has been minimal, as this proposal does not call for additional faculty. The proposed curriculum provides opportunities to the faculty member of both academic units for collaborating in research and future curriculum design.

Program's Outcome

This Program produces a viable inter-departmental and inter-school program of study. The curriculum is presented in Appendix A. The curriculum provides the students an integrated curriculum that ensures employability in diverse industries. This curriculum brings students to our University who otherwise would go elsewhere.

Bibliography

[1] **"Electrical And Computer Engineering Technology Curriculum From The System Design's Perspective"**,
Omer Farook, Chandra R. Sekhar, Jai P. Agrawal, Essaid Bouktache, Ashfaq Ahmed: Purdue University Calumet, Hammond, IN 46323.
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Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition *"Engineering Education Reaches New Heights"*, June 20-23, 2004, Salt Lake City, Utah.

[2] **"U.S. Department of Labor Bureau of Labor Statistics' Occupational Outlook Handbook",** http://www.bls.gov/oco/ocos267.htm

[3] **wikipedia** http://en.wikipedia.org/wiki/Software_engineering

[4] **"IEEE Standard Glossary of Software Engineering Terminology,"** IEEE std 610.12-1990, 1990.

[5] **"Guide to the Software Engineering Body of Knowledge"** http://www.computer.org/portal/web/swebok.

[6] **" Bureau of Labor Statistics, U.S. Department of Labor"**, *USDL 05-2145: Occupational Employment and Wages, November 2004*, Table 1.

Appendix A

PLAN OF STUDY
Electrical & Computer Engineering Technology
Department of Engineering Technology

SEM	GR	CR	SEMESTER 1
		1	ECET 100 Freshman Experience
		3	ECET 109 Introduction to CPLD and VHDL
		3	ECET 110 Computer System Architecture and C^{++} Programming
		3	MA 147 Algebra & Trig for Technology I
		3	ENGL 104 English Composition I
		3	COM 114 Fund of Speech Communication
		16	

SEM	GR	CR	SEMESTER 2
		4	ECET 102 Electrical Circuits I
		4	ECET 159 CPLD Applications and VHDL
		3	ECET 265 Computer Networks
		3	ECET 210 Struct C^{++} Prog for Electromechanical Systems
		3	MA 148 Algebra & Trig for Technology II
		17	

SEM	GR	CR	SEMESTER 3
		4	ECET 152 Electrical Circuits II
		4	ECET 154 Analog Electronics I
		4	ECET 209 Intro to Embedded System
		4	MA 219 Calculus for Technology I
		3	SOC 100 Introduction to Sociology
		19	

SEM	GR	CR	SEMESTER 4
		2	ECET 296 Electronic System Fabrication
		3	ECET 217 Intro to Process Control
		4	ECET 212 Electrical Power & Machinery
		3	ECET Elective
		4	PHYS 220 General Physics
		3	CS 123 Programming I: Java
		19	**(TOTAL AS: 71 Credits)**

ASSOCIATE OF SCIENCE DEGREE in COMPUTER ENGINEERING TECHNOLOGY Awarded

SEM	GR	CR	SEMESTER 5
		3	MA 222 Calculus for Technology II
		4	ECET 456 Multiprocessor Embedded System Design
		4	ECET 384 Mathematical Methods for Digital Signal Processing
		4	ECET 303 Digital Communications Systems
		3	CS 223 – Computer Architecture and Assembly Language
		18	

SEM	GR	CR	SEMESTER 6
		3	ENGL 220 Technical Report Writing
		3	ECET 392 Digital Signal Processing Systems Design
		3	ECET 397 ENG. Proj. Mgt.
		3/4	ECET Elective
		3	CS 275 – Data Structures
		15/16	

SEM	GR	CR	SEMESTER 7
		1	ECET 490 Senior Design Project, Phase I
		3	Communication Selective
		3/4	ECET Elective [1]
		3	CS 302 – Operating Systems CS 332 – Algorithms Design / CS 3 Languages /
		3	Humanities Selective
		13/14	

SEM	GR	CR	SEMESTER 8
		2	ECET 491 Senior Design Project, Phase II
		3/4	ECET Elective
		3	Humanities/Social Science Selective
		3/4	ECET Elective
		3	One 400 level Computer Science course / CS 332 – Algorithms Design / CS 316 – Programming Languages
		14/16	**(TOTAL BS: 128/135 Credits)**

BACHELOR OF SCIENCE DEGREE in COMPUTER ENGINEERING TECHNOLOGY WITH
MINAR IN COMPUTER SCIENCE
AWARDED

With the following CS required courses embedded

CS 123 – Programming I: Java	3
CS 223 – Computer Architecture and Assembly Language	3
CS 275 – Data Structures	3
CS 302 – Operating Systems	3
One 400 level Computer Science course / CS 332 – Algorithms Design / CS 316 – Programming Languages	3