

## Computer Engineering Area of Specialization in Computer Science Department

**Afsaneh Minaie**  
Assistant Professor  
[minaieaf@uvsc.edu](mailto:minaieaf@uvsc.edu)

**Reza Sanati-Mehrizi**  
Associate Professor  
[sanati@uvsc.edu](mailto:sanati@uvsc.edu)

Computing and Networking Sciences Department  
Utah Valley State College

### Abstract

In our computer science department at Utah Valley State College, there are four areas of specialization. These four areas of specialization are computer science, software engineering, networking, and computer engineering. In this curriculum, the students matriculate into the CNS department after successfully completing the requirements of 30 hours of core courses common to all computer science students. The students continue taking core courses until the first semester of their junior year, when they begin choosing their electives from different specialization areas.

Since our school does not offer a stand alone engineering program, the computer science department curriculum contains an area of specialization in computer engineering.

In this paper, we elaborate the detail content of the curriculum for our computer engineering area of specialization. In order to make our computer engineering area of specialization curriculum a viable one, we compare our curriculum with Brigham Young University (BYU) and University of Utah (UU) which have a well established program in computer engineering. An analysis and description of all curriculums is performed to establish similarities and differences. The major aspects taken into account in the comparison are the duration of the programs, special courses or activities of each curriculum, the differences in the student academia load and the curriculum flexibility.

### Introduction

For more than thirty years, the discipline of computer engineering has emerged from the fields of computer science and electrical engineering as a separate discipline<sup>1</sup>. Computer Engineering integrates computer science and electrical engineering as they relate to the design, implementation, and operation of digital computers. Several technical subjects are studied within this discipline, including electric and electronic (analog and digital) circuits, computer architecture, computer software (languages, algorithms, and data manipulations), and microprocessor (microcontroller) design. A computer engineer has a strong foundation in the theories and principles of computing, engineering and mathematics<sup>1</sup>. He applies these principles

to the design of hardware, networks, software, and computerized equipment and instruments to solve technical problems in diverse applications domains<sup>1</sup>. According to Computing Curricula: Computer Engineering Report (Ironman Draft 2004) computer engineers should satisfy the following three characteristics:

- “Possess the ability to design computer systems that include both hardware and software to solve novel engineering problems, subject to trade-offs involving a set of competing goals and constraints. In this context, “design” refers to a level of ability beyond “assembling” or “configuring” systems.
- Have a breadth of knowledge in mathematics and engineering sciences, associated with the broader scope of engineering and beyond that narrowly required for the field.
- Acquire and maintain a preparation for professional practice in engineering.”<sup>7</sup>

Utah Valley State College (UVSC) is located at Utah Valley, was founded in 1941. UVSC is a state college comprised of two interdependent divisions. The lower division embraces and preserves the philosophy and mission of a comprehensive community college, while the upper division consists of programs leading to baccalaureate degrees in areas of high community demand and interest<sup>4</sup>. Currently, UVSC offers 13 baccalaureate degrees. UVSC is the fastest growing college in the Utah System of Higher Education with over 23,000 students attending. The Bachelor of Science in Computer Science was one of the first Bachelor of Science programs which was approved in 1992 and implemented in 1993.<sup>4</sup>

The University of Utah (UU) is the oldest university west of the Mississippi river which was established in 1850. The University of Utah’s mission is threefold: teaching, research, and service. UU is one of the major public universities in the state of Utah. The UU offers 75 undergraduate degree programs, along with more than 38 teaching majors and minors, and over 90 graduate majors. School of Computing is ranked 29<sup>th</sup> nationwide and is the only ranked computing program in the state of Utah. The School of Computing and the Department of Electrical and Computer Engineering jointly offer a Bachelor of Science degree in Computer Engineering. Computer Engineering degree is accredited by ABET in 1998<sup>3</sup>.

The Brigham Young University (BYU) is a private university located in Utah Valley. BYU was established in 1875. The university provides education in an atmosphere consistent with the ideas and principles of its sponsor, The Church of Jesus Christ of Latter-day Saints. More than 29,000 students are enrolled at BYU.<sup>2</sup>

## **Description of the undergraduate programs in UVSC, UU, and BYU**

### **Utah Valley State College**

In addition to the associate degrees, the Computing and Networking Sciences (CNS) department offers a Bachelor’s Degree in Computer Science with four areas of specialization which are Computer Science (traditional), Computer Engineering, Software Engineering and Computer Networking. The curriculum content for the Computer Science degree is based on the 2001 ACM Curriculum Report. The CNS department has 14 full time faculties. Half of the faculty has

earned a Ph.D. degree and the other half masters degrees. The Computer Science degree at UVSC is accredited by ABET in 2002 and currently has 869 students.

The Bachelor of Science in Computer Science program was one of the first Bachelor of Science programs implemented at UVSC in 1993. The program's goal has been to provide a quality program that meets accreditation standards while providing the students with a skill set that allows them to succeed in computing careers.<sup>6</sup>

Computing Curriculum – Computer Engineering draft 2004<sup>7</sup> specifies eighteen knowledge areas; sixteen of which relates directly to Computer Engineering and two relate to mathematics (probability and statistics, discrete structures). Comparing Computer Engineering area of specialization curriculum at UVSC with the knowledge areas specified in that draft, it can be seen that our curriculum addresses all the 18 areas specified.

To be considered for matriculation into upper division status for a Bachelor of Science degree in Computer Science, a student must do the following:

1. Complete a minimum of 30 hours of college credit
2. Earn a GPA of 2.5 or higher
3. Complete the following “prespecialization” courses:
  - ENGL 1010 Introduction to Writing
  - Math 1210 Calculus I
  - PHYS 2210 Physics for Scientists and Engineers I & Lab
  - CNS 1250 Object Oriented Programming I
  - CNS 1510 Unix Operating System
  - CNS 1380 Assembly Language & Computer Architecture
  - CNS 2300 Discrete Structures
  - CNS 2400 Object Oriented Data Structures

In order to graduate with a Computer Science degree, students must complete 123 semester hours of course work. The current curriculum consists of 30 hours of General Education and 10 hours of science requirements that must be taken by all the different areas of specialization. Math requirements consist of 17 hours which are listed below:

- CNS 2300 Discrete Structures I
- Math 1210 Calculus I
- Math 1220 Calculus II
- Math 2230 Principles of Statistics I & II

Computer science core requirements are 28 hours. Core requirements which are taken by all the areas of specialty are given below:

- CNS 1250 Object-Oriented Programming I
- CNS 1350 Object-Oriented Programming II
- CNS 1380 Assembly Language & Computer Architecture

- CNS 1510 Unix Operating Systems
- CNS 2400 Object-Oriented Data Structures
- CNS 2600 Fundamentals of Data Communications
- CNS 301R Invited Speakers Series
- CNS 3060 Operating Systems Theory
- CNS 3240 Introduction to Computational Theory
- CNS 3690 Advanced Topics in Data Communications

The following courses are required for the Computer Engineering area of specialty only:

- CNS 4260 Digital Simulations
- CNS 4380 Adv/High-performance Computer Architecture
- CNS 489R Undergraduate Research Project
- EENG 2750 Circuit Theory
- EENG 2740 Digital Design I
- EENG 3740 Digital Design II
- EENG 3750 Signals & Systems I
- EENG 3770 Signals & Systems II

Computer Engineering area of specialty takes a minimum of 15 credits from the following: (minimum of 6 credits must be EENG)

- EENG 4750 Digital Signal Processing
- EENG 4760 Semiconductor Devices
- EENG 4730 Embedded Systems
- CNS 3400 Software Engineering
- CNS 3520 Database Theory
- CNS 3670 Network Programming
- CNS 4470 Artificial Intelligence
- CNS 4510 Operating Systems Design

To summarize, the students in the Computer Engineering area of specialization take 30 hours of general education, 10 hours of Science, 17 hours of Math, 40 hours of computer science, 21 hours of engineering requirements, and 15 hours of electives.

### **University of Utah**

Computer engineering program at UU is designed with the following objectives:

- “To give students through an undergraduate education grounded in the principles and applications of computer and engineering sciences, the ability to solve computer engineering problems.
- To prepare students for competent, responsible, and rewarding careers in the computer engineering profession.

- To prepare students who choose to continue on to graduate school for admission and successful completion of a graduate degree.”<sup>3</sup>

The School of Computing and the Department of Electrical and Computer Engineering jointly offer a Bachelor of Science degree in Computer Engineering. The Computer Engineering program at UU begins with a pair of two-course sequences. One sequence consists of introductory computer science classes and the other consists of introductory electrical engineering classes. Students must complete a minimum of 123 semester hours of course work to graduate.<sup>3</sup>

- The General Education requirements for the program is 18 hours which consists of the following:
  - 2 Fine Arts courses
  - 2 Humanities courses
  - 2 Social Sciences
 Out of the above 6 courses, one should be an Ethics course and 2 should be upper division.
- A minimum of eight math and science courses must be taken
- A minimum of 23 computer engineering classes must be taken

The following computer science and electrical engineering courses are required (Core Courses):<sup>3</sup>

- Computer Science Core Courses
  - CPSC 1010                    Introduction to Unix
  - CPSC 2010/2020           Introduction to Computer Science
  - CPSC 2100                   Discrete Mathematics
  - CPSC 3500                   Software Practice
  - CPSC 3810                   Computer Architecture
  - CPSC 3991                   Junior Seminar
  - CPSC 4400                   Computer Systems
- Electrical Engineering Core Courses
  - ECE 1000                    Introduction to Electrical Engineering
  - ECE 1020                    EE Problem Solving with Matlab
  - ECE 2000                    Electric Circuits
  - ECE 2100                    Electronics
  - ECE 3700                    Digital Design
  - ECE 3710                    Computer Design Lab
  - ECE 3720                    Interfacing Microprocessors & Microcontrollers

In addition to the above computer science and electrical engineering core courses which are required, six additional computer science or electrical engineering courses must be taken as technical electives.

To be considered for admission to full major status, a student must have:<sup>3</sup>

- An average grade of at least 3.0 and a minimum grade of C- in all of the following classes:
  - Math 1210/1220 or 1210/1250
  - Physics 2210
  - Computer Science 2010/2020
  - Electrical Engineering 1000/1020
  - University English Writing requirements
- A cumulative grade point average of 2.3 or higher

To summarize, total credits required to graduate with a Computer Engineering degree is 123 at UU which consists of 18 hours of General Education, 8 math and science courses, 23 computer engineering courses plus six technical electives.

### **Brigham Young University**

The BS degree in Computer Engineering was approved by the university in 1994. Computer Engineering program is accredited by ABET (Accreditation Board for Engineering and Technology). The department of Electrical Engineering and Computer Engineering has 24 faculty, 100 graduate students and 800 undergraduate students. Students who declare Computer Engineering as a major are first designated preprofessional until they submit an application for acceptance to the professional program.<sup>2</sup>

Requirement for admission to the Professional Program is a GPA of 2.8 or better in the preprofessional courses which are listed below:

ECEn 191	Freshman Seminar
Math 112	Calculus I
Math 113	Calculus II
Phscs 121	Physics I
Phscs 220	Physics II

After acceptance to the Professional Program, they need to complete the following supporting courses:

- Chem 105 (Gen College Chem) or Chem 111 (Principles of Chemistry)
- CS 142 Intro. Comp Prog.
- CS 235 Foundation of Computer Science I
- CS 236 Foundation of Computer Science II
- CS 240 Advanced Programming
- ECEn 124 Introduction to Computing Systems
- Engl 312 Persuasive Writing or 316 (Technical Writing)
- Math 334 Ordinary Differential Equations
- Math 343 Linear Algebra
- Phscs 281 Prin of Solid State Physics

- Stat 441 Intro. To Probability

Complete the following professional requirements:

- ECEn 212 Circuit Analysis & Lab
- ECEn 224 Fund. Of Digital Systems
- ECEN 313 Elect Circuit Design I
- ECEn 317 Electronics Lab I
- ECEn 380 Signals and Systems
- ECEn 490 Team Design Project

Complete at least 24 hours from the following advanced program and technical electives:

- Complete at least 2 hours from the following courses:
  - ECEn 360 Transmission Lines and Fields
  - ECEn 361 Transmission Lines and Fields Lab
  - ECEn 362 Transmission Line Fund. For High-Speed Digital Systems
- Complete at least three of the following courses:
  - ECEn 324 Computer Architecture
  - ECEn 425 Real-Time and Embedded Systems
  - ECEn 427 Computer Input/Output Devices
  - ECEn 451 Intro to Digital VLSI Circuits
- Complete at least two of the following courses:
  - CS 345 Operating Systems Design
  - CS 428 Software System Design & Implementation
  - CS 431 Intro to Compilers
  - CS 452 Database Modeling Concepts
  - CS 455 Computer Graphics
  - CS 456 Interactive Software
  - CS 460 Computer Communications
  - CS 462 Distributed Systems
  - CS 470 Intro to Artificial Intelligence
  - CS 472 Machine Learning

Total credits required to graduate with a Computer Engineering degree is 128 credits which consists of 24 hours of General Education, 14 hours of Religion and 90 hours of Major requirements.

## Summary and Conclusion

There are several observations to be made regarding the comparison of the programs. One observation is that the curriculum of the computer engineering at UU and BYU programs are more flexible than UVSC because of the variety of elective courses offered toward the end of the programs. Also, UVSC requires 4 math courses whereas both BYU and UU require 6. Duration for graduation for all programs is almost the same (four years). The number of credits required for graduation for all three programs are close to each other with BYU leading with 128, followed by UVSC and UU each with 123 credit hours. There are significantly fewer General Education requirements at UU compared to UVSC and BYU. BYU students are required to take 14 hours of religion courses.

Another observation concerning UU's curriculum is that it is more balanced in regard to the number of computer science and electrical engineering courses taken, whereas UVSC leans more toward computer science courses and BYU more toward electrical engineering courses.

Finally, the degree awarded at UVSC is a computer science degree with emphasis in computer engineering, whereas, UU and BYU award computer engineering degrees.

As can be seen from the curriculum comparisons of the BYU, UU, and UVSC, one can conclude that having an area of specialization in Computer Engineering in the Computer Science department is a viable option for schools that can not have engineering programs.

## References

- [1] Impagliazzo, John, et. al. Computer Engineering Computing Curricula, SIGCSE 2003, Reno, Nevada, Feb. 2003.
- [2] <http://www.ee.byu.edu>, BYU – Department of Electrical and Computer Engineering, access on January, 2004.
- [3] <http://www.ece.utah.edu>, UU – Electrical and Computer Engineering Department, access on January 2004.
- [4] <http://www.uvsc.edu>, UVSC – Department of Computing and Networking Sciences, access on December 2003.
- [5] Manokhoon, Kitti and Fazil Najafi, Civil Engineering Curriculum at the University of Florida and the Mahanakorn University of Technology, Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition, 2003.
- [6] Computer Science Program Self Study for the 2002-2003 ABET Accreditation Cycle, Computing and Networking Sciences Department, Utah Valley State College, 2002.
- [7] <http://www.eng.auburn.edu/ece/ccce>, Computing Curricula - Computer Engineering Report (Ironman Draft), access on March 2004.

## **Biographical Information**

**AFSANEH MINAIE** is an assistant professor in the Computing and Networking Sciences Department at Utah Valley State College. She received a B.S., M.S. and Ph.D. all in Electrical Engineering from University of Oklahoma in 1981, 1984 and 1989 respectively. Her current interests are in Computer Architecture, Embedded Systems, Digital Signal Processing, Digital Design, and Computer Interfacing.

**REZA SANATI MEHRIZY** is an associate professor of the Computing and Networking Sciences Dept. at Utah Valley State College, Orem, Utah. He received his MS and PhD in Computer Science from University of Oklahoma, Norman, Oklahoma. His research focuses on diverse areas such as: Database Design, Data Structures, Artificial Intelligence, Robotics, and Computer Integrated Manufacturing.