PROGRAM ABSTRACT - Form A

Proposed Degree Title: **Computer Engineering, B.S. in Dept of Computer Science & Information Systems**

COLLEGE: **College of Science and Mathematics** Proposed Implementation Date **August 2019**

About the A-Form.

Background: New baccalaureate and graduate-level degrees must be approved by the Chancellor's Office. Every January, CSU campuses send updated University Academic Master Plans (or UAMPs) to the Chancellor's Office, which are then approved by the Board of Trustees at their March meeting. When the Board of Trustees approves a campus request to add a new program to the UAMP, it authorizes the campus to submit a formal proposal to the Chancellor's Office for establishing such a degree program.

Purpose: The A-Form is used to propose the addition of a new baccalaureate or graduate degree to the UAMP.

Process: After review by the appropriate college curriculum or planning committee in the Spring semester, A-Forms are sent to Academic Programs at the beginning of the Summer. The forms are distributed to key University officers (including all members of Provost's Council and the President's Cabinet) over the Summer for information dissemination, review and feedback. The feedback received as a result of this distribution is provided to proposers as it is received during the Summer (to inform development of the program proposal) and to the Budget and Long-range Planning Committee (BLP) at the beginning of the Fall semester.

Outcomes: BLP reviews the A-Forms and the feedback collected by Academic Programs, and makes recommendations as to whether programs should be added to the next UAMP. Placement of a program on the UAMP is the campus-level authorization to proposers to submit a complete new program proposal (via a P-Form). Comments from BLP are sent back to the proposal originator to inform the final design and plan for the proposed program. The A-Form, Summer reviewer feedback, and BLP comments are additionally used to prepare a summary statement for the Chancellor's Office, which is required for any addition to the UAMP.

Directions.

- Fill in the degree title, college and implementation date above.
- Attach a program abstract addressing items 1-5 to this form.
- Identify the program proposer and obtain the department chair or program director signature below.
- Submit the abstract and the Form A to the college curriculum or planning committee. (Check with the college for submission deadlines.)

1. Description: Briefly describe the essential features of the curriculum that will be developed.

   - If the new degree is currently offered as an option in an existing degree program, give a rationale for the conversion.
   - If the new degree program is not commonly offered as a bachelor's or master's degree, provide a compelling academic rationale explaining how the proposed subject area constitutes a coherent, integrated degree major that has potential value to students.

2. Mission: How will this program benefit the college, university, region and/or state? How is it aligned with the College and University Mission and Vision?

3. Demand: What evidence is there of adequate student demand for this program?

[Note that Board of Trustees classifies Anthropology, Art, Biology, Chemistry, Economics, English, Foreign Languages, Geography, Geology, History, Mathematics, Music, Philosophy, Physics, Political Science, Psychology, Sociology, Speech/Communication and Theatre Arts/Drama as "Broad Foundation Programs" for which societal need and student demand are not "the preeminent criteria" for offering baccalaureate programs.]

Preliminary evidence of adequate student demand for the proposed program should include

(i) A list of other CSU campuses currently offering the proposed degree major program (see the CSU Mentor website at http://www2.assist.org/browseAreas.do),
(ii) A list of neighboring institutions, public or private, currently offering the proposed degree major program,
(iii) Information indicating substantial regional demand for individuals who have earned this degree (contact the Career Center for assistance), and
(iv) Information indicating adequate student interest in the proposed program (e.g., numbers of minors, existing programs at feeder community colleges, or results of student surveys).

Graduate degree program proposals must also include the number of declared undergraduate majors and the degree production over the preceding three years for the corresponding baccalaureate program.

4. Resources: Give preliminary estimates of the following resources needed to implement the program:

- Additional faculty positions;
- Additional resources required for program administration (e.g., release time for a Chair or Director);
- Additional staff support;
- Additional space requirements; and
- Additional specialized equipment and materials other than those expected to be provided by the Library and Instructional and Information Technology Services (IITS).

Note that in the course of reviewing the A-Form over the Summer, the Library and IITS will estimate additional library, information technology and academic computing resources needed for implementation. Indicate whether there are any unusual aspects of the curriculum design that need to be taken into account in the preparation of the Library and IITS estimates.

If there are recognized accrediting bodies in the program area, what are the accreditation criteria and how necessary is accreditation?

5. Relation to Existing Programs: Describe the potential effect on existing programs (e.g., enrollment changes, opportunities for collaboration, resources).

REVIEW PROCESS

1. _____ 10/28/14
Originator (Please Print and Sign) Date

2. _____ 10/28/14
Program/Department Director/Chair* – if applicable Date

3. _____
College Curriculum/Planning Committee* Date

4. _____ 10/30/14
College Dean (or Designee)* Date

5. _____
Date received in Academic Programs

* Signature indicates support that the proposed program moves forward for consideration for placement on the UAMP.

1. Description: Briefly describe the essential features of the curriculum that will be developed.

Computer Engineering is a blend of computer science and electrical engineering that focuses on the integration of software and hardware. The computer science background provides the background for software and computers, while the engineering background provides the background for building physical devices. They use their expertise in computer architecture, operating systems, embedded systems, software, networking, electric and integrated circuits, signal processing, and semiconductor devices and integrate computer hardware and software to analyze and solve problems. They research, design, and implement hardware and software for general-purpose computers as well as special-purpose devices such as cell phones, x-ray machines, alarm systems, digital video recorders, routers, keyboards, printers, and appliances. For example, a computer engineer could investigate ways to create embedded systems for cell phones for faster video processing with lower power usage due to the limited hardware and power resources. Computer engineering is a broad and growing field due to the pace of technological advances.

A Computer Engineer must possess a solid basis in computer science, mathematics, sciences, and engineering. It is expected that a curriculum team consisting of faculty from Computer Science, along with representatives from industry, faculty from CSM departments, and faculty consultants from thriving Computer Engineering programs would assist in the development of the curriculum, and that existing courses would be modified or utilized as much as feasible. It is also expected that the curriculum would meet the requirements of ABET (Accreditation Board for Engineering and Technology, see http://www.abet.org/eac-criteria-2014-2015). As stated on their website http://www.abet.org/why-accreditation-matters, "Simply put, accreditation is value. Reaching into our public, private, and professional lives, accreditation is proof that a collegiate program has met certain standards necessary to produce graduates who are ready to enter their professions. Students who graduate from accredited programs have access to enhanced opportunities in employment; licensure, registration and certification; graduate education and global mobility."

2. Mission: How will this program benefit the college, university, region and/or state? How is it aligned with the College and University Mission and Vision?

The Mission of the College of Science and Mathematics states:
The College of Science and Mathematics will build and sustain a supportive and inspiring undergraduate and Master's level educational environment where excellent instruction, interdisciplinary and collaborative research, innovation and creative endeavors provide students with the foundational knowledge and skills needed to meet technological challenges in a rapidly evolving world.

The Vision of CSUSM states, in part:
Students will select from a growing array of specialized programs responsive to state and regional needs.

A Computer Engineering degree would prepare students *to meet technological challenges in a rapidly evolving world* and allow students to *select from a growing array of specialized programs responsive to state and regional needs.*

Computer engineers are equipped to use their skills in areas involving the integration of hardware and software that arise in diverse areas such as signal detection (e.g., using filters to reduce noise and improve detection of signals in radar, mobile communications, sonar, and seismology), accurate and robust image processing (e.g., target and scene detection or visual positioning and tracking, using the points, lines, and surfaces in images while accommodating image rotation, transformation, and zooming), embedded systems offline or real-time improvements to video content (e.g., enhancing sharpness, contrast, and colors by reducing degradation due to compression or transmission errors), pattern recognition such as facial recognition for access control, mug shots, and security monitoring (e.g., accommodating non-ideal circumstances such as expressions or poses), trusted cloud computing (e.g., efficiency and security in shared resources such as storage, hardware, and software, broad network access), business systems (e.g., online banking with synchronization of transactions, data warehousing, bank services interface, phone and web applications, bank operations, cybersecurity, customer database, …), radar technology (surveillance and tracking, data compression, real-time processing, low-circuit technology, application to medical improvements for accurate vital sign monitoring).

3. Demand:

The following CSU and UC campuses offer a Bachelor of Science in Computer Engineering:

- Cal Poly San Luis Obispo
- California Polytechnic University, Pomona
- CSU Bakersfield
- CSU Chico
- CSU East Bay
- CSU Fresno
- CSU Fullerton
- CSU Long Beach
- CSU Northridge
- CSU Sacramento
- CSU San Bernardino
- San Jose State University
- San Diego State University
- UC Davis
- UC Irvine
- UC Santa Barbara
- UC Santa Clara
- UC San Diego

Figures 1, 2, and 3 show preliminary evidence of substantial demand for Computer Engineers. The regional demand for Computer Engineering will be closely explored in a feasibility study that would be commissioned after the approval of the proposal, and the cost of the study would be funded by external sources, such as industry partners.

Figure 1 shows that the demand for computer engineers (Computer Hardware Engineer) has grown from 73,370 in 2008 to 79,580 in 2012, according to a congressional report on STEM workforce trends.

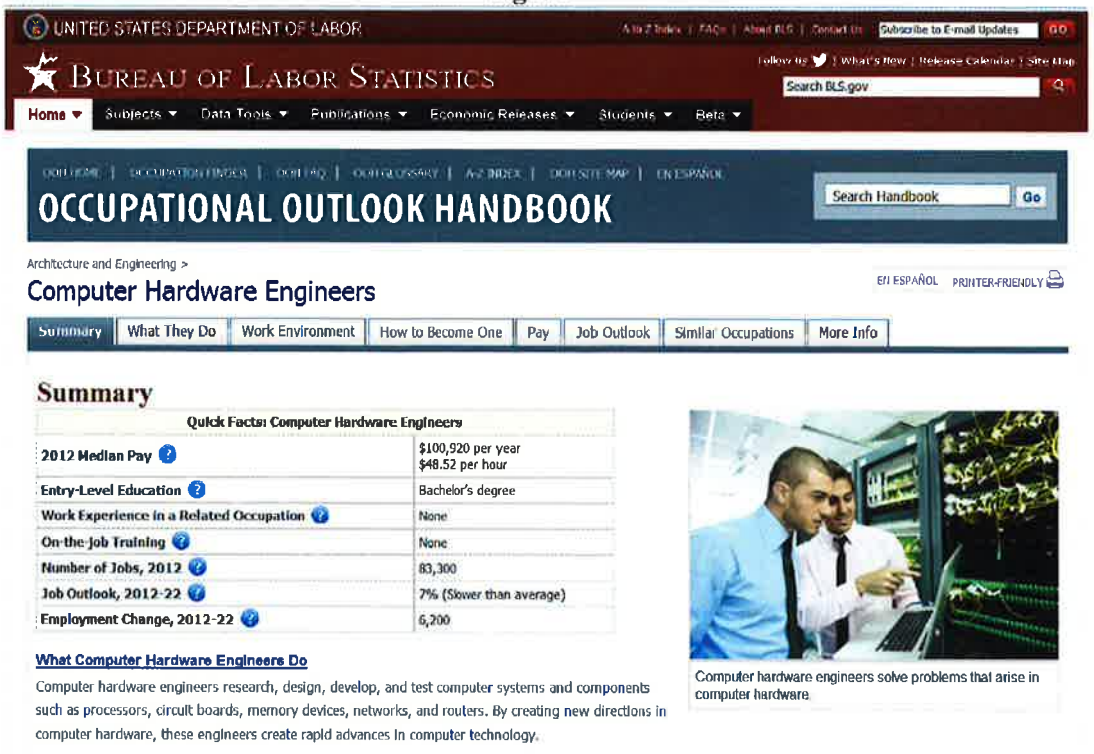
Figure 1.

	Employment, 2008	Employment, 2012	Employment Change, Number	Employment Change, CAGR
Engineers				
Aerospace Engineers	67,800	80,420	12,620	4.4%
Agricultural Engineers	2,640	2,470	-170	-1.7%
Biomedical Engineers	15,220	18,810	3,590	5.4%
Chemical Engineers	30,970	32,190	1,220	1.0%
Civil Engineers	261,360	258,100	-3,260	-0.3%
Computer Hardware Engineers	73,370	79,580	6,210	2.1%
Electrical Engineers	154,670	160,560	5,890	0.9%
Electronics Engineers, except Computer	139,930	134,960	-4,970	-0.9%

Source: The U.S. Science and Engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment; Congressional Research Report, John F. Sargent, Jr. Februrary 19, 2014

Figure 2 indicates that the Bureau of Labor and Statistics provides a 7% growth outlook for Computer Engineers (categorized as Computer Hardwar Engineers) from 2012-2020.

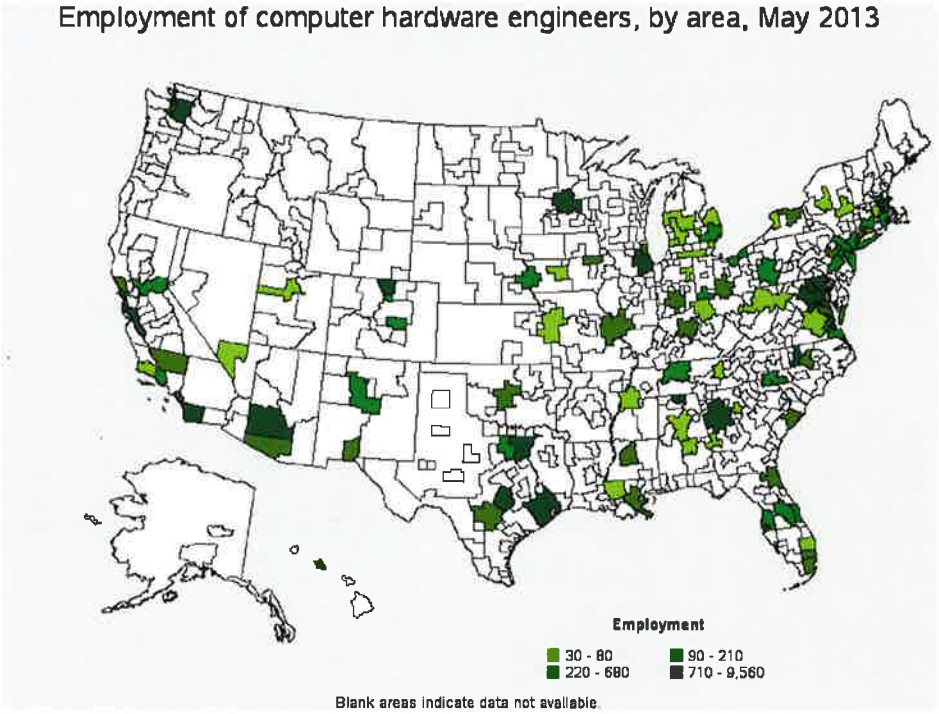
Figure 2.



Source: http://www.bls.gov/ooh/architecture-and-engineering/computer-hardware-engineers.htm

Figure 3 is a map of the concentration of computer engineers (categorized as Computer Hardware Engineers by the Bureau of Labor and Statistics). The dark green region in the lower portion of California indicates a high concentration in the San Diego-Carlsbad-San Marcos region (which is one of the regions defined by the BLS).

Figure 3.



Source: http://www.bls.gov/oes/current/oes172061.htm (MAY 2013)

Figure 4 shows that the San Diego-Carlsbad-San Marcos region has one of the highest concentrations of computer engineers (categorized as Computer Hardware Engineers by the Bureau of Labor and Statistics), which suggests a robust market in the local area.

Figure 4.

Metropolitan areas with the highest employment level in this occupation:

Metropolitan area	Employment (1)	Employment per thousand jobs	Location quotient (9)	Hourly mean wage	Annual mean wage (2)
San Jose-Sunnyvale-Santa Clara, CA	9,560	10.28	17.55	$64.62	$134,400
San Diego-Carlsbad-San Marcos, CA	3,780	2.93	5.00	$45.06	$93,730
Austin-Round Rock-San Marcos, TX	3,750	4.39	7.49	$48.64	$101,180
Dallas-Plano-Irving, TX Metropolitan Division	3,350	1.56	2.66	$48.93	$101,770
Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division	3,320	1.40	2.39	$55.16	$114,740
Santa Ana-Anaheim-Irvine, CA Metropolitan Division	3,270	2.25	3.84	$52.34	$108,860
Baltimore-Towson, MD	2,180	1.70	2.90	$55.43	$115,280
Boston-Cambridge-Quincy, MA NECTA Division	2,010	1.15	1.96	$54.94	$114,260
Phoenix-Mesa-Glendale, AZ	1,860	1.04	1.78	$52.64	$109,490
San Francisco-San Mateo-Redwood City, CA Metropolitan Division	1,560	1.49	2.55	$57.63	$119,870

4. Resources:

The resources for Computer Engineering (e.g., faculty, support staff, equipment, and laboratory space) will be closely explored in a feasibility study that would be commissioned after the approval of the proposal, and the cost of the study would be funded by external sources, such as donors and industry partners. This includes the impact of the degree on supporting majors (e.g., Mathematics and Physics).

The funding for faculty, staff, infrastructure, equipment and supplies, laboratory space, and all other related resources will be funded entirely by a combination of federal grants and donations from industry as well as private foundations for the first five years of the degree. It is expected that the program will be supported by student enrollment growth from Year 5 and beyond and that the program will continue to seek external resources. Any P-form that results will reaffirm these two premises.

As mentioned earlier (in Part 1), it is expected that a curriculum team consisting of faculty from Computer Science, Physics, along with representatives from industry and faculty consultants from thriving Computer Engineering programs would assist in the development of an ABET-accredited curriculum, and that existing courses would be modified or utilized as much as feasible.

The additional majors in Computer Engineering would require several additional tenure-track faculty to teach the additional upper-division courses for the computer science and engineering curricula.

It is expected that release time for the Chair of the department may need to be increased due to the additional managerial workload associated with scheduling courses, hiring lecturers, and interfacing with campus and community entities.

It is expected that several new dedicated laboratories would be needed to house servers, computer networks, and electronic equipment for the new or additional core computer science and engineering curricula that accompany the new degree. Also, it is expected that additional support would be needed for the STEM Center to improve retention of Computer Engineers. The publication "The Engineer of 2020: Visions of Engineering in the New Century (National Academy of Engineering, p. 42) states that

> "Retention of entering freshmen to completion of their engineering degrees could increase the number of engineers graduating in a given year by as much as 40 percent. Curricular adjustments that engage students in the creativity of engineering early in their engineering education and application of new pedagogical knowledge about the way different people learn have been shown to markedly enhance retention. The engineering education establishment should embrace research in engineering education as a valued activity for engineering faculty as a means to enhance and personalize the connection to undergraduate students."

Access to electrical engineering curriculum with labs and support with the STEM Center would be two critical factors in providing a quality curriculum with retention.

It is expected that the department would need an Instructional Support Technician to manage the additional servers and computer networks, as well maintain or service the electronic equipment associated with the new degree. A single Academic Support Coordinator (ASC) currently serves the CS and Physics Departments, and therefore works 50% time for each. It is expected that each department will have a single full-time ASC for several years prior to the launching of the new degree.

Regarding library resources, there are several quality online per-reviewed, open access journals, or journals that can be obtained through the campus subscription ScienceDirect, such as:

- Journal of Electrical and Computer Engineering
- Journal of Computer Engineering and Information Technology
- International Journal of Computer Engineering Research
- International Journal of Electrical and Computer Engineering
- Advances in Electrical and Computer Engineering
- Computer Engineering and Applications Journal

5. Relation to Existing Programs: Computer Engineering majors would be required to satisfy the usual General Education courses (basic skills of oral and written communication; mathematics and natural science, arts and humanities, and social sciences).The obvious impact is that students who would have enrolled at another university to pursue an engineering degree would increase the demand for supporting courses for the major (such as mathematics and physics). This is a typical by-product of attracting new STEM majors to a university. At many universities[1], a computer engineering major would be required to take courses in Math (Calculus I, II, and III, linear algebra, and differential equations) and Physics (physics of mechanics and sound and physics of electromagnetism and optics which would satisfy the B1/B3 requirement). At CSUSM, the Biology course GES 103 could be used to satisfy the B2 Life Science requirement. This could translate to additional sections of these courses for engineering majors. However, the additional sections would provide students more flexibility in meeting patterns and times for enrolling in courses.

   Also, there is the possibility that the Computer Engineering degree could siphon some students from the Computer Science degree, but its effect on Computer Science is unknown. However, it is proposed that both degrees reside in the same department. Also, it should be mentioned that Computer Science is increasingly evolving into a specialized field so that universities are increasingly offering specialized degrees such as Software Engineering and Computer Engineering.

[1] *http://www.csun.edu/catalog/academics/ece/programs/bs-computer-engineering/*
http://www.fullerton.edu/ecs/cpe/undergrad/degreereq/mathsciencereq.asp
http://www.fresnostate.edu/catalog/subjects/elect-computer-engineering/cmp-e.html