Proposal

Computer Engineering

Bachelor of Science Degree Program

University of Hawai`i

December 1, 2008
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Contents

I. What are the Objectives of the Program?

Computer engineering is an important profession in the information technology areas of computing and networking. A computer engineering program in the University of Hawai`i will significantly improve the University.

- It will be the only computer engineering program in the state of Hawai`i. Today, a student must go to the mainland to earn a computer engineering degree. A computer engineering program will support higher education in Hawai`i for information technology areas.

- The existence of a computer engineering program will demonstrate that there is attention to this area, and will help attract and retain good quality computer faculty to the University. The faculty will have strong research programs to expand the funded research enterprise, research applications, commercialization of intellectual property rights, and entrepreneurship.

- It will train a highly skilled, flexible, world-class labor force of computer engineers for Hawai`i's high technology companies. Local companies who are interested in employing our computer students include established companies such as Spirent and Lockheed-Martin, and start-up companies such as Sanjole.

- The additional degree program can increase enrollment in the University of Hawai`i.

The Departments of Electrical Engineering (EE) and Information and Computer Sciences (ICS) are proposing to offer a bachelor of science degree in computer engineering, and the program will eventually be accredited by ABET (www.abet.org), the national accreditation organization for engineering programs. The program will educate undergraduate students so they can design, analyze, and integrate hardware and software of computers. Hardware includes digital circuits, very large scale integrated (VLSI) circuits, computer aided design (CAD) of circuits, micro-processors, micro-controllers, high performance circuit design, and embedded systems; while software includes programming, data structures, algorithms, and elements of software engineering. The computer engineering program will focus on hardware and thus will differ from the broader BA and BS degrees offered by the Department of Information and Computer Sciences.

The computer engineering program will replace part of the Department of Electrical Engineering's existing undergraduate electrical engineering (EE) program. In particular, the EE undergraduate program consists of three Tracks: Computer, Electro-Physics, and Systems. The computer engineering program will replace the EE Computer Track program.

Once the computer engineering program is established, the Department will apply for accreditation with ABET. The application has a good chance of success since the electrical engineering undergraduate program has been accredited for many years.

Student learning objectives and outcomes are the same as for the existing EE Bachelor of Science program.

Undergraduate Program Educational Objectives

1. Computer Engineering Graduates should be engaged in the practice of computer engineering in industry, education, and public service.
2. Graduates should contribute to the technological and economic development of Hawaii, the United States, and beyond.
3. Graduates should be prepared for admission to top graduate programs.
4. Graduates should be motivated toward and engaged in continuous professional development, through individual effort and advanced professional education.
5. Graduates should provide technical leadership, with an understanding of the broader ethical and societal impact of technological developments, and the importance of diversity in the workforce.
6. The program will contribute to the development of diversity within the profession through the education of women, indigenous and other minority students.

Undergraduate Program Outcomes

All graduates of the Computer Engineering Program are expected to have:

1. Knowledge of probability and statistics, including examples relevant to Computer Engineering (program criteria). Knowledge of mathematics through discrete math, differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software. Knowledge of advanced mathematics, including differential equations (program criteria).
2. Demonstrated an ability to design and conduct experiments, as well as to interpret data.
3. Demonstrated an ability to design a system or component that meets a specified need.
4. Demonstrated an ability to function in a multi-disciplinary team.
5. Demonstrated an ability to identify, formulate and solve electrical engineering problems.
6. Understanding of professional and ethical responsibility.
7. Demonstrated an ability to communicate effectively (written and oral).
8. Demonstrated an understanding of the impact of engineering solutions in a global and societal context.
9. Recognition of the need for life-long learning.
10. Demonstrated knowledge of contemporary issues.
11. Demonstrated an ability to use the techniques, skills, and modern tools necessary for engineering practice.

The program outcomes are the achievement and abilities of our students at the time of graduation, while objectives are achievements and abilities of our alumni at least three years after graduation.

How the Undergraduate Program Outcomes map to the Undergraduate Program Educational Objectives is summarized in Appendix F.

II. Are the Program Objectives Appropriate Functions of the College and University?

In this section, the program's relationship to University and campus mission and development plans will be discussed. Also, evidence of continuing need for the program, and projections of career opportunities for graduates will be presented.

A. Relationship to University, campus, and college mission and development plans

A new program in computer engineering will be the first in the State of Hawaii. Students who have an interest in the field can remain at home for their studies. For many students, this is an affordable computer engineering education. This supports the University of Hawaii System's values of access, affordability, and excellence; the Manoa campus' mission of leadership, excellence and innovation in information technology; and the campus' strategic plan under the categories of economic development and technology.

For the above reasons, a program in computer engineering is relevant to the College's mission:

- Provide an accredited program of undergraduate engineering education to students at the University of Hawaiʻi at Mānoa.
- Assist the community in attracting students to higher educational opportunities in Science, Technology, Engineering and Mathematics (STEM) from K-12 institutions and community colleges, especially from Hawaiʻi.
- Provide continuing education and professional services to the engineering community in Hawaiʻi and wherever these services will enhance the growth of the College's overall capacity.
- Provide research and graduate education opportunities to students worldwide, within the context of a faculty driven extramurally funded research program that leverages the resources of the University of Hawaiʻi and its partners in Hawaiʻi; and participate in the growth of the technological workforce and technology-based industry in Hawaiʻi through student graduation and technology transfer.

B. Evidence of continuing need of the program

This is new program to replace the EE bachelor of science Computer Track. The EE Computer Track has been in existence for many years, and at least a third of the electrical engineering undergraduates have been in it. Since there is a consistent demand for this Track, there is a need for the computer engineering program.

Additional evidence can be found in Appendix D.2, which has copies of letters of support from local industry, and Appendix E, which is input from an EE student survey.

C. Projections of career opportunities for graduates

Computer engineering graduates will have the same opportunities as electrical engineering graduates from the Computer Track, and our graduates consistently find employment. There are Hawaii information technology companies and government agencies such as Lockheed-Martin, Camber Corporation, and Concentris Systems; and mainland companies such as Northrop-Grumman, Boeing, and Lockheed-Martin that are interested in computer graduates.

From EngineeringSalary.com, starting salaries of computer engineers is between $67,423 and $68,129 in Hawaii for companies with 50--250 employees. From the Economic Research Institute (www.erieri.com), a computer engineer in Honolulu, Hawaii has a salary of $88,542.

The next table has national employment statistics for computer engineer jobs from the US Department of Labor. As a comparison, statistics for civil and mechanical engineers are shown too.

United States Department of Labor Bureau of Labor Statistics Occupational Outlook Handbook 2008-09 Edition		
Occupation	**Employment Growth Over The Decade 2006-2016**	**Annual Mean Earnings May 2006**
Computer Hardware Engineer	5 %	$88,470
Computer Software Engineer -- Applications	45 %	$79,780
Computer Software Engineer -- Systems	28 %	$85,370
Electrical Engineer	6 %	$75,930
Civil Engineer	18 %	$68,600
Mechanical Engineer	4 %	$69,850

The next table is employment from the US Department of Labor for computer engineer jobs in Hawaii.

United States Department of Labor Occupational Employment Statistics (OES) Hawaii, May 2008		
Occupation	**Employment**	**Annual Mean Wage**
Computer Hardware Engineer	110	$74,020
Computer Software Engineer -- Applications	740	$74,740
Computer Software Engineer -- Systems	410	$86,420
Electrical Engineer	680	$74,640
Civil Engineer	1740	$75,270
Mechanical Engineer	500	$83,220

The following table has Hawaii employment statistics from the report "Innovation and technology in Hawaii: an economic and workforce profile" which was prepared by The Center for Regional Economic Preparedness for The Hawaii Science & Technology Institute in October 2008.

Description	**2002 Jobs**	**2007 Jobs**	**2012 Jobs**	**Projected Annual New Tech Jobs**	**Avg. Annual Total Jobs Available (Including New and Vacant Jobs)**
Computer Software Engineer--Applications	302	386	477	16	30
Computer Software Engineer--Systems	341	419	442	15	25
Electrical Engineers	567	319	372	5	30

Appendix D has input that the Department received from industry.

III. How is the Program Organized to Meet its Objectives?

The Departments of Electrical Engineering (EE) and Information and Computer Sciences (ICS) will jointly offer the program. However, the program will be within the College of Engineering, and will satisfy the College's course requirements for the following reasons:

- It is an engineering program.
- The electrical engineering, bachelor of science curriculum has three "Tracks" (options): Computer, Electro-Physics, and Systems. The computer engineering, bachelor of science curriculum will replace the electrical engineering, bachelor of science Computer Track. In other words, the Computer Track will cease to be an option in the electrical engineering curriculum once the computer engineering curriculum is offered.
- The bulk of the required courses are EE courses (the exception being ICS 141)
- It is expected that computer engineering students want an engineering degree.
- It is expected that students who would be in the Computer Track option in the current electrical engineering program will be computer engineering students.

The purpose of a joint program is to facilitate coordination of pre-requisites courses for upper division technical electives. Note that there are 6 credits of technical electives that can be taken either in EE or ICS. Also there may be students who are normally ICS students but who have a strong interest in computer hardware. Then the program must be coordinated among the departments for a smooth transition from the ICS program into the computer engineering program. For example, an alternative to the programming course requirements of EE 160, EE 205, EE 367, and EE 367L is the set of courses ICS 111, ICS 211, and ICS 212 (see Section III.A).

A. Curriculum organization and requirements

A.1 Bachelor of Science Degree

The BS degree program requires a minimum of 124 credit hours. The departmental requirements consist of 65 credit hours of required lower division basic courses and upper division advanced courses. There are also 6 credit hours of upper division technical electives.

All electives are subject to the approval of an advisor. Enrollment in EE courses requires a grade of C (not C-) or better in all prerequisite courses.

Students must complete the College of Engineering requirements, which satisfy the University General Education Core Requirements.

Subsections III.A.2 and III.A.3 have the course requirements. How the courses map to the Undergraduate Program Outcomes (see Section I) is given in Appendix G.

A.2 College of Engineering and University General Requirements

The table below lists the course requirements for the College of Engineering that is common to all engineering majors. It totals 51 credit hours. It indicates per course, the number of credits and how the course satisfies the University General Education Core requirements (GEC). General Education Core requirements include

- 6 credits of Global and Multicultural Perspectives (FG);
- 3 credits of Symbolic Reasoning (FS);
- 3 credits of Written Communication (FW);
- 6 credits from Arts (DA), Humanities (DH), and Literatures (DL);
- 6 credits from Social Sciences (DS); and
- 7 credits of Natural Science in Physical Science (DP) and Laboratory (DY).

Courses	**GEC**	**Credits**
Written Communication		
ENG 100 Composition I or approved FW course	FW	3
Arts, Humanities and Literature		
SP 251 Principles of Effective Public Speaking	DA	3
One 3-credit elective of DH or DL	DH or DL	3
Social Sciences		
ECON 120 Introduction to Economics, ECON 130 Principles of Microeconomics, or ECON 131 Principles of Macroeconomics	DS	3
One 3-credit elective of DS	DS	3
Global and Multicultural Perspectives		
Two approved 3-credit FG electives	FG	6
Symbolic		
MATH 241 Calculus I	FS	4
MATH 242 Calculus II		4
MATH 243 Calculus III		3
MATH 244 Calculus IV		3
Natural Sciences		
CHEM 161/161L, and 162 General Chemistry/Lab	DP/DY	3/1/3
PHYS 170/170L General Physics I/Lab (4/1)	DP/DY	4/1
PHYS 272/272L General Physics II/Lab (3/1)	DP/DY	3/1
Total Credits		51

In addition, a student must complete the Focus Graduation Requirements:

- One Hawaiian, Asian, and Pacific Issues (H) course.
- One Contemporary Ethical Issues (E) course
- One Oral Communication (O) course
- Five Writing Intensive (W) courses

The Hawaiian or Second Language is not required for the engineering degree.

The undergraduate curricula are designed to be completed in eight semesters.

To receive a bachelor of science degree in engineering, a student must adhere to the following:

1. Complete the course work for one of the engineering curricula, which also satisfies all UH Manoa requirements;
2. Maintain a minimum GPA of 2.0 for all registered credit hours; and
3. Maintain a minimum GPA of 2.0 for all upper division courses (numbered 300-499) in mathematics, science, and engineering.

A.3 Department Requirements

Design Experience Statement

A key aspect of a computer engineering education is a significant and meaningful design experience that is integrated throughout the curriculum. The design experience is necessary to prepare students in becoming professionals.

At UH Manoa, the computer engineering curriculum assigns design credits to each course. A student graduating in electrical engineering is required to have a minimum of sixteen design credits with three design credits coming from EE 496, the Capstone Design Project. Students can check their progress in obtaining design credits by checking with their advisor and looking at design credits and the Curriculum Flow Chart. EE 496 places significant design responsibility on the students as they must plan and execute a major design problem. In order to prepare students for EE 496, students must take at least one credit of EE 296, Sophomore Project course and two credits of EE 396, Junior Project course. The project courses help students in getting design experience outside the classroom as they learn engineering concepts in the classroom. The project courses and capstone project give students opportunities to work in teams, develop leadership skills, and work on open ended design projects similar to industrial experience.

Courses

Students must complete a total of 72 credit hours:

Courses	**Credits**
*Programming and Data Structures**	
EE 160 Programming for Engineers	4
EE 205 Object-Oriented Programming	3
EE 367/367L Computer Data Structures and Algorithms/Lab	3/1
Circuits	
EE 211 Basic Circuit Analysis I	4
EE 213 Basic Circuit Analysis II	4
EE 260 Introduction to Digital Design	4
EE 323/323L Microelectronic Circuits I/Lab	3/1
EE 366 CMOS VLSI Design	4
Mathematics	
EE 315 Signal and Systems Analysis	3
EE 342 EE Probability and Statistics	3
ICS 141 Discrete Mathematics for Computer Science I	3
MATH 307 Linear Algebra and Differential Equations	3
Physics	
EE 324 Physical Electronics	3
EE 371 Engineering Electromagnetics I	3
PHYS 274 General Physics III	3
Computer Organization	
EE 361/361L Digital Systems and Computer Design/Lab	3/1
Engineering Breadth	
Engineering Breadth is satisfied by CEE 270 Applied Mechanics I, ME 311 Thermodynamics, or a CEE, ME, OE, or BE course that is at the 300 level or higher. It may also be satisfied by a physical or biological science course that is at the 300 level or higher and approved by the department's undergraduate curriculum committee.	3
Project Courses	
EE 296 Sophomore Projects	1
EE 396 Junior Projects	2
EE 496 Senior Capstone Design	3
Technical Electives	
6 credits of technical electives may be chosen from the list in **	6
Ethics Course	
EE 495 Ethics in Electrical Engineering	1
Total Credits	72

*The set of courses EE 160, EE 205, and EE 367/367L may be substituted with the set of courses

- ICS 111 Introduction to Computer Science I (3)
- ICS 211 Introduction to Computer Science II (3)

- ICS 212 Program Structure (3)

**Technical Electives is a requirement of a minimum of 6 credits

- all from the following list of EE and ICS upper division courses; or 6 credits from the list and 3 credits of any EE upper division course(s), excluding EE project courses EE 396 and EE 496:
    - EE 344 Networking I (or ICS 451)
    - EE 449 Computer Communication Networks (or or ICS 451)
    - EE 461 Computer Architecture (or ICS 431)
    - EE 467 Object Oriented Software Engineering (or ICS 413)
    - EE 468 Introduction to Operating Systems (or ICS 412)
    - EE 469 Wireless Data Networks
    - EE 491 Special Topics in Electrical Engineering (E, F, G).
    - ICS 311 Algorithms
    - ICS 313 Programming Language Theory
    - ICS 321 Data Storage & Retrieval
    - ICS 413 Software Engineering I
    - ICS 414 Software Engineering II
    - ICS 415 Introduction to Programming on the Web
    - ICS 421 Database Systems
    - ICS 424 Application Frameworks
    - ICS 425 Computer Security and Ethics
    - ICS 426 Computer System Security
    - ICS 432 Concurrent and High-Performance Programming
    - ICS 441 Theory of Computation
    - ICS 442 Analytical Models and Methods
    - ICS 461 Artificial Intelligence I
    - ICS 463 Human Computer Interaction I
    - ICS 464 Introduction to Cognitive Science
    - ICS 465 Introduction to Hypermedia
    - ICS 466 Design for Mobile Devices
    - ICS 481 Introduction to Computer Graphics

Note that most of the ICS technical electives have ICS 311 and or ICS 313 as pre-requisites. ICS 311 and 313 require ICS 241 Discrete Mathematics for Computer Science II. Since ICS 241 is a lower division course, it will not be counted as a technical elective for the computer engineering program. It will be an additional 3 credits of course work outside the program. So ICS technical electives will lead to more credits to complete the program.

B. Admission policies

There is no additional admission policy to the computer engineering program other than the admission policy into the College of Engineering and University of Hawaii at Manoa.

Requirements for admission to UH Manoa are described in the front of the *Catalog*. High school students applying to the College of Engineering should have completed high school course work including Mathematics up to at least trigonometry, with preference for pre-calculus or high school calculus, and one year of high school chemistry and physics with a special emphasis on grades in these courses (B or better preferred). Students are encouraged to take Advanced Placement courses in these subject areas while in high school and to submit AP scores, but this is not required. The college also uses aptitude tests and high school records in its screening procedure.

Freshmen students who do not meet the admission requirements are encouraged to enroll at one of the UH system Community Colleges in order to complete course or grade requirements. These students may subsequently apply to the College of Engineering for admission as transfer students. Transfer students must have completed ENG 100, MATH 241 and 242, PHYS 170/170L, and CHEM 161/161L and 162 or their equivalents and have an overall cumulative GPA of 3.0 or higher.

A pre-engineering (PREN) classification was created in the Colleges of Arts and Sciences. Students who have not met the admissions requirements directly into an engineering major have the option of enrolling at UHM in pre-engineering. Pre-engineering students are not in the College of Engineering, however, being classified as PREN allows the College of Engineering Student Academic Services (SAS) staff to track the progress of these students. SAS offers advising for PREN students, includes them on the email lists for announcements of college activities, and PREN students may register for lower division (100 and 200 level) engineering courses without special overrides provided they meet the prerequisites.

The computer engineering program will accept courses offered by the community colleges that fulfill the program's requirements. These courses include pre-engineering courses such as EE 160, EE 211, EE 213, and EE 260; science and math courses such as PHYS 170, PHYS 170L, CHEM 161, CHEM 161L, CHEM 162, MATH 241, MATH 242, MATH 243, and MATH 244; and other courses.

C. Advising and counseling

Student Services
College of Engineering
Holmes 250
2540 Dole Street 96822
Tel: (808) 956 8404

All students in the College of Engineering must receive approval of their program of courses from their advisors prior to registration each semester.

Updated curriculum check sheets summarizing all of the requirements for each undergraduate curriculum are available in the College's Student Academic Services Office.

Undergraduate engineering students who are unusually well-qualified academically are encouraged to participate in the UH Manoa Honors Programs.

An orientation session for new students is held each semester before classes begin. Incoming students receive approval of their program of courses at that time. In addition, incoming students with waived course work (e.g., advanced placement examination) must still fulfill credit hour requirements and should contact the College's Student Academic Services Office for more information.

IV. Who Will Enroll in the Program?

Undergraduates who are in the EE Computer Track are the type of students who are expected to enroll in the computer engineering program. The enrollment of EE undergraduates since 2000 has varied between 250 to 330. About a third or more of the students are in the Computer Track, so we estimate that there will be between 84 to 110 computer engineering students.

There may also be computer science students who have a strong interest in hardware. In addition, high school students who want a computer engineering degree could enroll in the program rather than going to the mainland.

Appendix E has positive results of a survey from EE undergraduates about the proposed program.

V. What Resources are Required for Program Implementation and First Cycle Operation?

The computer engineering bachelor of science degree program has course requirements that are similar to the electrical engineering bachelor of science degree program under the Computer Track. The core requirements are the same except that there is now ICS 141 (3 credits) Discrete Math. Since the

Department of Information and Computer Sciences has agreed that the computer engineering undergraduates can take ICS 141, there will be no additional resources needed to implement the first cycle of operation. The computer engineering program also allows students to take upper division electives from courses in both Electrical Engineering (EE) and Information and Computer Sciences (ICS).

The following are the current resources available for the computer engineering program.

A. Faculty

The following is a list of the faculty in the Department of Electrical Engineering. Faculty who are in the Computer Track are starred "***".

- GURDAL ARSLAN, Ph.D., University of Illinois at Urbana-Champaign. Distributed Systems, Markov Decision Problems, Nonlinear and Robust Control, Game Theory, Learning and Adaptive control. OLGA BORIC-LUBECKE, Ph.D., University of California at Los Angeles, RFIC's for Wireless Communications, Millimeter-Wave and Microwave Devices, Circuits and Systems, and Biomedical Applications.
- *** TEP DOBRY, Ph.D., University of California at Berkeley, Digital Electronics, Computer Architecture
- *** YING-FEI DONG, Ph.D., University of Minnesota at Twin Cities, Computer Networks, Distributed Systems, System Architecture and Performance Evaluation, especially in Multimedia Streaming, Networking Security, Secure Internet Service, Resource Management in Multimedia Streaming, Broadband Networks, and Distributed Applications.
- N. T. GAARDER, Ph.D., Stanford University, Communication and Information Theory
- DAVID GARMIRE, Ph.D., University of California-Berkeley, Micro-Electro-Mechanical Systems (MEMS), Computer Aided Design for MEMS, Computer Vision, and Computational Biology
- JAMES W. HOLM-KENNEDY, Ph.D., University of Minnesota, Photonics and Physical Electronics: Wavelength Management Devices, Microspectrometers, Beam Management Devices, Routing Devices, Micro optics, demux WDM, Solid-State Devices, Sensors (including Biosensors)
- ANDERS HOST-MADSEN, Ph.D., Technical University of Denmark, Communications Signal Processing, CDMA Communications, Multi-user Communication Equalization
- ANTHONY KUH, Ph.D., Princeton University, Communications, Neural Networks, Signal Processing
- YINGBIN LIANG, Ph.D., University of Illinois at Urbana-Champaign, Information Security, Wireless Communications and Networks, and Information Theory
- VICTOR M. LUBECKE, Ph.D., California Institute of Technology, MEMS, microwave/terahertz radio, remote sensing, and biomedical applications.
- *** LUCA MACCHIARULO, Ph.D., Politecnico di Torino, Design Automation, Digital Circuit, VLSI design.
- VINOD MALHOTRA, Ph.D., Colorado State University. Solid State Electronics, Optoelectronic Materials and Devices, ECR Plasma Enhanced Chemical Vapor Deposition

- AARON OHTA, Ph.D., University of California at Berkeley, Design, fabrication, and application of microelectromechanical systems (MEMS), biomedical microdevices, microfluidics, and optofluidics.
- TODD REED, Ph.D. University of Minnesota, Signal, Image and Image Sequence Processing, Multidimensional Digital Signal Processing, and Computer Vision
- *** GALEN SASAKI, Ph.D., Illinois at Urbana-Champaign, Communication Networks, Optimization Algorithms, Network Performance Evaluation
- NARAYANA PRASAD SANTHANAM, Ph.D., University of California at San Diego, Information theory, statistical learning and signal processing. In particular, a lot of focus is on problems with large alphabets, reflecting requirements for modern applications in data processing, biology, and business.
- WAYNE A. SHIROMA, Ph.D., University of Colorado at Boulder, Microwave, Millimeter-wave, and Quasi-Optical Electronics, Active Integrated Antennas
- VASSILIS L. SYRMOS, Ph.D., Georgia Institute of Technology, Control Systems, Linear System Theory, Numerical Analysis
- JAMES R. YEE, Ph.D., Massachusetts Institute of Technology, Computer Communication Networks, Network Optimization, Stochastic Models
- *** DAVID Y.Y. YUN, Ph.D., Massachusetts Institute of Technology, High Performance Computing and Communications, Resource Management by Planning and Scheduling, Image and Design Intelligence, Intelligent Information Technology
- *** XIANGRONG ZHOU, Ph.D., University of Maryland at College Park, embedded systems, computer architecture, hardware/software co-design and reconfigurable computing platforms

The following is a list of the faculty in the Department of faculty in the Department of Information and Computer Sciences.

- NORIKO ASATO, Ph.D., Purdue University, Library & Information Science Program
- KYUNGIM BAEK, Ph.D., Colorado State University, Computer Vision; Computational Models And Mechanisms Of Visual Perception; Bayesian Methods; Machine Learning; Neural Computation
- EDO BIAGIONI, Ph.D., Chapel Hill, North Carolina, Wireless Sensor Networks
- KIM BINSTED, Ph.D., Edinburgh University, Embedded Systems, Computational Astrobiology, Entertaining and Affective Intelligent Interfaces
- HENRI CASANOVA, Ph.D., University of Tennessee, Knoxville, Parallel And Distributed Computing, Grid Computing, Theoretical And Practical Aspects Of Scheduling ,Modeling And Simulation Of Computing Platforms
- DAVID CHIN, Ph.D., Univ. of California, Berkeley, Artificial Intelligence, User Modeling, Computer Game Design.
- MARTHA CROSBY, Ph.D., University of Hawaii, Human Computer Interaction, Interface Design, Cognitive Science
- RICH GAZAN, Ph.D., University of California, Los Angeles, Social Aspects of Information Technology
- VIOLET HARADA, Ed.D. University of Hawaii, Library & Information Science Program
- CURTIS IKEHARA, Ph.D., University of Hawaii, Human-Computer Interaction, Robotics

- STEPHEN ITOGA, Ph.D., University of California at Los Angeles, Computer Graphics, Animation, Knowledge Based Systems
- PETER JACSO, Ph.D., Eötvös Lóránd University, Budapest, Library & Information Science Program
- PHILIP JOHNSON, Ph.D., University of Massachusetts, Amherst, Software Engineering, Computer Supported Cooperative Work, And Artificial Intelligence
- REBECCA KNUTH, Ph.D., Indiana, University, Library & Information Science Program
- DIANE NAHL, Ph.D., University of Hawaii, Library & Information Science Program
- DAVID PAGER, Ph.D., London, Compiler Theory
- GUYLAINE POISSON, Ph.D., University of Quebec-Montreal Bioinformatics, Artificial Neural Networks, Biodiversity Bioinformatics, Machine Learning, Genome assembly and annotation
- LUZ QUIROGA, Ph.D., Indiana University, ICS and Library & Information Science Program, Information Architecture, Filtering Systems
- NANCY REED, Ph.D., University of Minnesota, Minneapolis, Intelligence, Autonomous Agents, Cognitive Modeling, Diagnosis, Expert Systems, Knowledge-Based Systems, Knowledge Acquisition, Medical Informatics, And Real-Time Systems
- SCOTT ROBERTSON, Ph.D., Yale, Human-Computer Interaction, Robotics, Digital Democracy
- JAN STELOVSKY, DrTechSc, Multimedia Design, Software Engineering
- SUSANNA STILL, Ph.D., ETH (Swiss Federal Technical University) Zurich, Switzerland, Active learning and optimal predictions, Analysis of animal communication sounds, Unsupervised learning / Cluster analysis, Computational Neuroscience, Bioinformatics, Foundations of Information Theory, Time series analysis.
- KAZUO SUGIHARA, Ph.D.,Algorithms, Computer Security
- DAN SUTHERS, Ph.D., University of Massachusetts, Design Of Educational Technologies For Collaborative Learning And Online Learning Communities
- ANDREW B. WERTHEIMER, Ph.D., University of Wisconsin-Madison, Library & Information Science Program

B. Library resources (including an evaluation of current resources and an estimate of the cost of additional resources required)

The library resources for computer engineering include publications available in the University library, mainly in the UH Manoa Hamilton Library and in the University of Hawai`i databases. The present resources available in the UH library appear to be adequate for the Computer Engineering program including publications from the important professional societies, the IEEE (Institute of Electrical and Electronic Engineers) and ACM (Association for Computing Machinery).

C. Physical resources (space, equipment, etc.)

The existing resources of the Department of Electrical Engineering will be sufficient for the computer engineering program because it already supports the EE Computer Track. The Department of Electrical Engineering has the following instructional laboratories

- Holmes 357: Basic circuits laboratory
- Holmes 358: Intermediate circuits laboratory
- Holmes 386: Communications, controls, and networking laboratory
- Holmes 387: EE computer laboratory
- Holmes 451: Computer hardware laboratory
- Holmes 458: Photonics and optics laboratory
- Physical Electronics Laboratory (PEL)

Detailed descriptions of the EE laboratories are presented in Appendix A.

The Department of Information and Computer Sciences has the following instructional laboratories

- POST 306: Adaptive Multimodal Interaction Laboratory
- POST 307: Collaborative Software Development Lab
- POST 318A: Computer Lab I
- POST 319: Computer Lab II
- POST 309: Laboratory for Interactive Learning Technologies
- POST 318A: Robotics Lab
- POST 311 & 326: UH Dell Cluster

Detailed descriptions of the ICS laboratories are presented in Appendix B.

D. Additional resources required (staff, graduate assistantships, etc.)

No additional resources are required for the following reasons. We anticipate that the students that would have been in the EE Computer Track will be the computer engineering students. The Department of Electrical Engineering has enough resources for the EE Computer Track students.

In addition, the Department of Information and Computer Sciences (ICS) will provide the resources for

- *ICS 141 Discrete Mathematics for Computer Science I*: We expect that the number of additional students for that course will be about on average 10 per semester. It is anticipated that this increase in students will not require additional resources because about two sections of ICS 141 are offered per semester. If the enrollment too large for the current resources, we have the following alternatives:
    - Have MATH 301 Introduction to Discrete Mathematics be alternative to ICS 141
    - Introduce a new EE course on discrete math and have it be an alternative to ICS 141.

- *Some of the upper division technical elective courses*: Though computer engineering students could take as many as 6 credits of upper division ICS courses as technical electives, we anticipate they will likely take 3 credits or 0 credits. We believe that this will be the case because computer engineering students will be for the most part following the electrical engineering curriculum. Thus, their lower division courses will be a better match as pre-requisites for upper division EE courses (in the computer are) than ICS courses. In addition, even those students who choose to take ICS courses will be spread over a number of ICS courses, making a limited impact on enrollment on any specific course. Thus, the Department of ICS will not require additional resources for the new computer engineering program.

Thus, the Department of ICS will not require additional resources to accommodate the computer engineering students.

At some point in the *far distant future*, the computer engineering program may become so popular that enrollment may overwhelm the current resources. For example, if the computer engineering program increases enrollment by 80-100 students, essentially double our anticipated enrollment, then the current resources may be overwhelmed. We do not anticipate that this will ever be the case. However, in the very remote chance that it does happen then we have the following options that do not require additional resources:

- Limit the number of EE lecture and laboratory courses that are writing intensive so these courses and laboratories can have larger enrollments.
- Limit enrollment in the computer engineering program. (We prefer not to go this route since we believe that increased enrollment in the computer engineering program is good for the University.)

Note that if this ever happens, it will be in the far distant future and the economic climate may be much better than it is today. Thus, we shall consider all options that are available at that time. However, we have at least two options that do not require additional resources.

Note that the computer engineering program could improve cost efficiencies by facilitating the cross-listing of courses between the Departments of Electrical Engineering and Information and Computer Sciences.

E. Estimate of additional position counts and budget implementation for first five years of program

No additional resources are required for the Departments of Electrical Engineering and Information and Computer Sciences as explained in Section D.

VI. How Efficient Will the Program Be?

It is anticipated that students in the existing EE Computer Track program will be the type of students who will be in the Computer Engineering bachelor of science program. Therefore, to determine the efficiency of the program, we will study the efficiency of the program for EE Computer Track students.

The number of Computer Track students in the EE program is a little more than a third. Since the Computer Track is one of the Tracks in the EE program, it has little more than its share of EE students. So we anticipate that the Student Semester Hours (SSH) and cost per major for the Computer Engineering program to be a little more than a third for the EE program. The average class size should be about the same as the EE program. The SSH/faculty should be higher than for the EE program. The table below has estimates of the SSH, Cost per major, SSH/faculty, and average class size for the computer engineering program based on data from the EE program for the academic year 2007-08. For comparison it also has the data for the EE, mechanical engineering and civil and environmental engineering programs.

	Academic Year 2007-2008 Electrical Engineering	Academic Year 2007-2008 Mechanical Engineering	Academic Year 2007-2008 Civil and Environmental Engineering	Estimated for Computer Engineering
SSH	4,006	2,455	4,307	> 1336
Cost per major	$2,542,689	$1,397,131	$2,244,271	> $847,563
SSH/faculty	211	223	227	> 211
Average class size	21	26	28.5	21

VII. How Will Effectiveness of the Program be Demonstrated?

The computer engineering program will be evaluated using the assessments used by the Department of Electrical Engineering with appropriate modifications for the Computer Engineering program. The Department has the following assessments:

- EE Course assessments: Every semester, the Department administers a student survey of all EE courses to determine the effectiveness of the course and its instructor. It also administers a student survey to determine the effectiveness of the course in achieving educational program outcomes.
- Student Advisory Board: The Department has a Student Advisory Board made up of volunteer representatives of the undergraduates. Every year they compose a student survey that is administered to all students in the Department. They provide a written report of the results of the survey.
- Industrial Advisory Board: The Department has an Industrial Advisory Board made up of representatives from industry. They provide feedback from employers of our graduates about the undergraduate program. The Board meets once every two years unless they request additional meetings. The meetings cover an overview of the program including laboratory tours, and meetings with students. The Board provides a written report about the program to the Department.
- Alumni Surveys: The Department has begun administering an alumni survey to assess if the graduates have achieved the educational objectives. The survey will be conducted every couple of years.
- Senior Project Report Assessments: The Computer Engineering program will require a 3 credit EE 496 Senior Project which is the capstone design course. The Department has faculty members assessing the quality of a sample of projects every semester.
- Performance Rubrics on EE Courses: The Department is in the process of implementing an assessment process of measuring the performance of students over a collection of EE courses. The courses cover the educational program outcomes. The evaluation will be done by the instructor for the course.

The Department of Electrical Engineering will apply for the Computer Engineering program to be accredited by ABET, which is the national accreditation organization for engineering programs. Demonstrating effective assessment of student performance is a large part of achieving accreditation.

We anticipate that the annual number of graduates in the Computer Engineering program will be about the same as the graduates from the existing EE Computer Track. As mentioned in Section IV, we anticipate 84 to 110 Computer Engineering undergraduates. Assuming the students take 4.5 years to graduate, the number of graduates per year is anticipated to be 20 to 24.

We will also survey our graduates to determine where they get their initial employment after graduation.

Note that we have mappings of Undergraduate Program Outcomes to Undergraduate Program Educational Objectives in Appendix F, and courses to Undergraduate Program Outcomes in Appendix G.

Appendix A. Department of Electrical Engineering Instructional Laboratories

The following are descriptions of the instructional laboratories for the Department of Electrical Engineering:

- Holmes 357: Basic circuits laboratory
- Holmes 358: Intermediate circuits laboratory
- Holmes 386: Communications, controls, and networking laboratory
- Holmes 387: EE computer laboratory
- Holmes 451: Computer hardware laboratory
- Holmes 458: Photonics and optics laboratory
- Physical Electronics Laboratory (PEL)

EE Basic Circuits Laboratory
Holmes Hall 357

Courses

- **EE 211 Basic Circuit Analysis I (4)** (3 Lec, 1 3-hr Lab) Linear passive circuits, time domain analysis, transient and steady-state responses, phasors, impedance and admittance; power and energy, frequency responses, resonance. Pre-requisite: MATH 243 (or concurrent) and PHYS 272 (or concurrent), or consent.
- **EE 213 Basic Circuit Analysis II (4)** (3 Lec, 1 3-hr Lab) Laplace transforms and their application to circuits, Fourier transforms and their applications to circuits, frequency selective circuits, introduction to and design of active filters, convolution, and state space analysis of circuits. Pre-requisite: EE 211 or consent. Co-requisite: MATH 244.

Equipment

- 10 lab benches for a capacity of 20 students
- Lab bench equipment
  - Agilent 15 MHz Function / Arbitrary Waveform Generator
  - Fluke 45 Dual Display Multimeter
  - GW-Instek Laboratory DC Power Supply
  - Tektronix Two Channel Color Digital Phosphor Oscilloscope
  - Analog Multimeter
  - PC:
    - 12 OptiPlex GX280 Pentium 4
      - 3.20 GHz 512 MB of Ram
      - 17" LCD 1280x1024 Res
  - Software:
    - Microsoft Office
    - Matlab 7.0.1
    - OrCAD 10.3
    - IntelliCAD 2001

EE Intermediate Circuits Laboratory
Holmes Hall 358

Courses

- **EE 323L Microelectronic Circuits I Lab (1)** (1 3-hr Lab) Experiments on linear and logic properties of diodes and transistor networks. Pre-requisite: EE 213. Co-requisite: EE 323.
- **EE 326L Microelectronic Circuits II Lab (1)** (1 3-hr Lab) Laboratory for EE 326, experiments on linear and analog electronics. Pre-requisite: EE 323L. Co-requisite: EE 326

Equipment

- 10 lab benches for a capacity of 20 students
- Lab bench equipment
  - Tektronix Two Channel Digital Storage Oscilloscope
  - Agilent 20 MHz Function / Arbitrary Waveform Generator
  - GW-Instek Laboratory DC Power Supply
  - Fluke Digital Multimeter
  - PC:
    - 10 OptiPlex GX280 Pentium 4
      - 3.20GHz 512MB RAM
      - 17" CRT Monitor
  - Software:
    - Microsoft Office
    - Matlab
    - Orcad PSpice

EE Communications, Controls, and Networking Lab
Holmes Hall 386

Courses

- **EE 341L Communication Systems Lab (1)** (1 3-hr Lab) Experiments illustrating the basic principles of communication systems. Pre-requisite: EE 315. Co-requisite: EE 341.
- **EE 344 Networking I (4) (3 Lec, 1 3-hr Lab)** Covers 4 semesters from the Cisco Networking Academy plus supplementary material; hands-on experience with routers and switches; prepares students for the CCNA. Topics include TCP/IP, LANs, WANs, routing protocols, network security; PPP; ISDN, frame relay. Pre-requisite: EE 160 or consent.
- **EE 351L Linear Feedback-Control Systems Lab (1)** (1 3-hr Lab) Provides experience in applying theoretical tools to analyze linear systems. Extensive use is made of computer-aided analysis and design packages study system performance. Pre-requisite: EE 315. Co-requisite: EE 351.

Equipment

- 10 lab benches for a capacity of 20 students
- Lab bench equipment (4)
  - Universal Power Module
  - Agilent Triple Output Power Supply
  - HP 15 MHz Function / Arbitrary Waveform Generator

- Sony Tektronix Arbitrary Function Generator
- Fluke 45 Dual Display Multimeter
- Tektronix 100 MHz Digital Storage Oscilloscope
- Agilent ESA-E Series Spectrum Analyzer
- 9 2600 Cisco routers
- 6 1700 Cisco routers
- 5 2900 Cisco switches
- 1 3550 Cisco Layer 3 switch
- Access to Cisco's remote lab NetLab
- PC:
  - 10 Pentium 4 Processor
    - 1.8GHz, 256MB 133MHz SDRAM
    - 15" LCD Flat Panel Display
- Software:
  - Microsoft Office
  - Matlab
  - Orcad PSPice

EE Computer Laboratory
Holmes Hall 387

Holmes 387 is the computer laboratory for the department. During the regular spring and fall semesters, it is open M-F: 8am-9pm, Sat: 11am-3pm.

Computers and Other Hardware

- 5 each Pentium 4 Processor 3.4GHz, 1024MB PC2700 SDRAM
  - 19" LCD Flat Panel Dispay
  - MS WindowsXP
  - Matlab, OfficeXP, PowerLAN X-Windows, Adobe Acrobat, MS Visual Studio .Net, Agilent ADS, Orcad PSPice, MicroWave Office, Apollo Photonics, Xilinx ISE Foundation 5.1, Altera Quartus II and ModelSim, MPLAB, Logicworks, Veriwell, and many more

- 4 each Pentium 4 Processor 3.0GHz, 512MB PC1200 SDRAM
  - LCD Flat Panel Dispay
  - MS Windows2000
  - Matlab, OfficeXP, PowerLAN X-Windows, Adobe Acrobat, MS Visual Studio .Net, Agilent ADS, Orcad PSPice, Routersim, MicroWave Office, Apollo Photonics, Xilinx ISE Foundation 5.1, Altera Quartus II and ModelSim, MPLAB, Logicworks, Veriwell, and many more

- 6 each Pentium 4 Processor 2.40GHz, 384MB PC1200 SDRAM
  - 18" UltraSharp LCD Flat Panel Display
  - MS WindowsXP
  - Matlab, OfficeXP, PowerLAN X-Windows, Adobe Acrobat, MS Visual Studio .Net, Agilent ADS, Orcad PSPice, MicroWave Office, Apollo Photonics, Xilinx ISE Foundation 5.1, Altera Quartus II and ModelSim, MPLAB,

Logicworks, Veriwell, and many more

- 2 each Pentium 4 Processor 1.6GHz, 256MB 133MHz SDRAM
    - 19" CRT Monitor
    - Matlab, OfficeXP, Exceed Xwindows, Adobe Acrobat, MS Visual C++

- 6 each Sun Blade 100 500-MHz 64-bit UltraSPARC-IIe, 256-KB External Cache ;384-MB RAM
    - 19" CRT Monitor
    - Solaris 9, Sun Workshop Compilers (C, Fortran, etc.), Matlab, StarOffice, Opera, direct access to UNIX server software (listed below)

- 10 network and power ports for laptop users (DHCP not available yet, but soon)

- Flatbed Scanner with Automatic Document Feeder

- HP 5M LaserJet printer

- One station is a "Desktop Publishing Station" with HP scanner software, CorelDRAW Graphics Suite 12, Paint Shop Pro 9

Software on UNIX Servers

- Cadence (electronic design)
- Synopsys (electronic design)
- Opnet (network modeling)
- Allegro Common LISP (object-oriented software development)
- Xilinx (for programmable logic devices)
- Verilog
- Sun compilers
- GNU compilers
- LaTeX
- Prolog
- Perl

EE Computer Hardware Laboratory
Holmes Hall 451

Courses

- **EE 260 Introduction to Digital Design.** Introduction to the design of digital systems with an emphasis on design methods and the implementation and use of fundamental digital components such as logic gates, EPROMs, flip flops, and registers. Design range from small to moderate size digital circuits. There is a 3 hour lab per week.

- **EE 361L Digital Systems and Computer Design Lab.** Laboratory for 361, experiments on digital systems and interfacing including PIC micro-controllers, FPGAs, and implementation of a MIPS processor on an FPGA. It is a 1 credit, 3 hour lab per week.

Equipment

- 10 lab benches for a capacity of 20 students
- Lab bench equipment
    - Tektronix 2225 Two Channel 50 MHz Oscilloscope
    - HP 3312A Function Generator
    - HP 6205C Dual DC Power Supply
    - Fluke 45 Dual Display Multimeter
    - Gateway PC Pentium IV 1.4 GHz, 256 MB PC800 RDRAM
    - Software: Microsoft Office, Logicworks, Xilinx Web Pack, Veriwell simulator for verilog HDL, MPLAB for PIC processors and PICSTART programmer
- Other equipment
    - EPROM programmer
    - UV light source to erase EPROMs
    - 6 XESS XSA-100 development boards with the Xilinx 100K SPARTAN II FPGA
    - 2 XESS XSA-50 development boards with the Xilinx 50K Spartan II FPGA
    - 3 PICSTART programmers for PIC processors

Appendix B. Department of Information and Computer Sciences Instructional and Research Laboratories

The following are descriptions of the instructional laboratories for the Department of Information and Computer Sciences:

- POST 306: Adaptive Multimodal Interaction Laboratory
- POST 307: Collaborative Software Development Lab
- POST 318A: Computer Lab I
- POST 319: Computer Lab II
- POST 314: Innovative Computation Lab
- POST 309: Laboratory for Interactive Learning Technologies
- POST 318A: Robotics Lab
- POST 311 & 326: UH Dell Cluster

ICS Adaptive Multimodal Interaction Laboratory
POST 306

http://www2.hawaii.edu/~amilab/

Research

Adaptive Multimodal Interaction Laboratory (AMI) – The goal of the AMI Laboratory is to create a methodology to improve learning and task performance by optimizing the human-computer interface based on the user's cognitive state derived from passive physiological sensors.

Equipment

3 Eye tracking systems
2 Portable custom designed physiological sensor system which detects galvanic skin response, blood flow, peripheral temperature and movement pressures.

ICS Collaborative Software Development Laboratory
POST 307

http://csdl.ics.hawaii.edu/

Research

Collaborative Software Development Laboratory - The mission of CSDL is to provide a physical, organizational, technological, and intellectual environment conducive to collaborative development of world-class software engineering skills. Through research, education, and technology transfer, we pursue this mission for the benefit of CSDL members, our affiliates, and the Hawaiian, U.S., and international software development communities. .

Software

- SCLC - Source Code Line Counter, University of Hawaii Edition
- Eclipse Screen Recorder - Creates a Quicktime movie from Eclipse screen snapshots.
- Jupiter - Provides a code review plugin for Eclipse
- HackyLoadTest - Supports load testing for the hackystat system.
- BCML - An extensible tool providing calculatation of metrics for java byte code class files in directories or jar files, and report with html format.
- JBlanket - A tool to support assessment and improvement of method-level unit test coverage.
- Hackystat - A web service and sensor-based system for automated collection and analysis of software engineering product and process data.
- VCommerce - A web-enabled simulation environment for exploring the design, implementation, and evaluation of electronic commerce sites and associated entrepreneurial issues.
- javaJAM - A web-enabled collaborative tool for assisting developers with reviewing and discussing Java software source, documentation, and comments.

- LEAP - A tool that enables software developer improvement, both as an author of work products and as a reviewer of other people's work products.
- LOCC - An extensible tool providing measurements of total and incremental size for various work products, including Java source code and ASCII text.
- JavaWizard - A tool providing automatic code checking for Java. Designed to find programmer errors in syntactically legal Java source code.
- Defmacs - An Emacs-based tool for in-process defect recording.
- Brie - A curriculum module containing a benchmark inspection experiment and a high quality training package for simple formal technical review.
- JavaCount - A tool for counting Java source lines of code. (Superseded by LOCC.)
- CSRS - A tool for collaborative software review.
- Egret - A tool providing a client-server-agent framework for implementation of domain-specific, collaborative, hypertext systems.
- AEN - A system that helps users learn how to build collaborative systems using Egret.
- Shemacs - A tool implementing synchronous multi-user support for the Emacs editor.
- CSDL/Baseline - The CSDL software development process description.
- Defsys/Dsb - An Emacs-based tool suite for building large Emacs Lisp systems (similar to "make") and automatic design documentation generation (similar to "javadoc").
- Flashmail - A tool providing real-time information on the workstation state of each group member, and a simple pop-up message mechanism for intra-group communication.
- FTR Archive - A service to the software engineering community providing on-line access to publications, trainers, and tools for formal technical review.
- PTP - An example "Personal Thesis Process"
- SIRO - The Web Site for the "Software Inspection and Review Organization", a service provided by CSDL.
- Web-Bib - A tool providing automatic generation of indexed HTML pages from a BibTex source file.

ICS Computer Lab I & II
POST 318A & 319

Classrooms

- Computer Lab I - 32 computer systems with large screen projections system
- Computer Lab II - 32 computer systems with large screen projections system.

Software

- Virtual PC 2004
- Visual Studio 2005 Professional
- Access 2007
- OneNote 2007
- Project Professional 2007
- Visio Professional 2007
- Exchange Server 2003 Enterprise

- SharePoint Designer 2007
- InfoPath 2007
- MSDN Library
- WinXP Pro w/ SP2 (Download ONLY)
- Windows XP Professional (Single User) 64bit
- Windows Server 2003 Standard Edition
- Windows Server 2003 Enterprise Edition
- Windows Vista Business

ICS Laboratory for Interactive Learning Technologies POST 309

http://lilt.ics.hawaii.edu/lilt/

Research

Laboratory for Interactive Learning Technologies (LILT) pursues a diverse portfolio of cognitive science, human-computer interaction, and social science approaches to technology-supported learning. Currently LILT has a strong focus on studying how technology affordances support social processes of learning, ranging from the meaning-making dialogues of small groups to supporting reflective practice in online communities.

Software

- Alvis is a new breed of algorithm visualization technology that supports the rapid construction and interactive presentation of "low fidelity" algorithm visualizations, engaging students and instructors in meaningful conversations about algorithms.
- Belvedere is software for constructing and reflecting on diagrams of one's ideas, such as evidence maps and concept maps. Belvedere is designed to help support problem-based collaborative learning scenarios in which middle-school and high-school students learn critical inquiry skills.
- COLER provides a web-based environment in which students collaborate while constructing solutions to entity-relationship modeling problems. COLER explores a new approach to coaching collaboration based primarily on tracking students' participation and recognizing differences between students' individual and group solutions.
- disCourse supports project-based online courses in which students can post and discuss documents created by themselves or others. It is an offspring of Kukakuka (below).
- Kukakuka is a web-based environment for discussion of web pages. Discussion groups and threads are associated with web pages. Each thread's page is always visible when reading and posting messages within the thread. Kukakuka is being designed with the objectives of being easy to use and running within any web browser.
- Pink is a web-based environment for anchored threaded discussion of various types of documents, both online and offline. In addition to being organized in topic threads, notes also reference portions of the document being discussed to enable easy reference and retrieval.

ICS Robotics Lab
POST 306

Courses

ICS 461 Artificial Intelligence I (3) Survey of artificial intelligence: natural language processing, vision and robotics, expert systems. Emphasis on fundamental concepts: search, planning, and problem solving, logic, knowledge representation.

Equipment

- 10 Lego Mindstorm Robotics Systems
- 1 Teleoperated Robot
- Test Equipment
- 2 PC based Digital Oscilloscopes
- 2 Multimeters
- Prototype Development Systems

ICS UH Dell Cluster
POST 311 & 326

Mission

The goal of the UH Dell Cluster project is to provide a high performance computing resource for University of Hawai`i researchers and their affiliates. Although the cluster is hosted by the Information and Computer Sciences Department, its use is open to all UH researchers.

Classes

ICS 491: Concurrent and High-Performance Programming – The class covers the art of writing concurrent programs, meaning programs that are designed to do multiple things at once, typically using multi-threading. The course will develop proficiency in multi-threaded programming in C and in Java, and in debugging and performance tuning of these multi-threaded programs on multi-processor and multi-core architectures. The course will also cover computing on cluster platforms, which are the most popular high-performance computing platforms today.

Equipment

- Dell Super Computer with approximately 1.3 teraflops of computing power.
- The UH Dell cluster is composed of 96 compute nodes and 3 service nodes. Each node has the following specifications:
- Dual 3.2GHz Intel Xeon Processors
- 4GB of RAM
- Dual Gigabit Ethernet ports
- 36GB hard drives for local scratch space
- The cluster has 15TBytes of shared redundant storage, accessible by all nodes

Software

The UH Dell cluster runs Linux (kernel 2.4.21-20.ELsmp) and its software configuration is managed with ROCKS. Below are highlights of important software components.

- Batch Scheduler
- Platform Lava(TM) v6.1 (a version of the well-known LSF batch scheduler).
- MPI1
- MPICH v1.2.5.
- FORTRAN
- Intel Fortran Compiler 8.1.

Appendix C. EE 205 Object-Oriented Programming

The Department of Electrical Engineering has been offering an object-oriented programming course under a 3-credit special topics course EE 491F. The course will be offered as a regular course under EE 205 Object-Oriented Programming at the sophomore level beginning Fall 2009. The next subsections have the syllabus and justification.

C.1 Syllabus

Designation: New

Catalog Description: EE 205 Object-Oriented Programming(3). Second level programming course for Computer Engineers. Introduces the object-oriented programming paradigm focusing on the definition and use of classes along with fundamentals of object-oriented design in a modern object-oriented laguage such as C++. Other topics include complex data structures, simple searching and sorting techniques and an introduction to software engineering issues.

Credits: 3

Pre-and Co-requisites: Pre-requisites: EE160 – Programming for Engineers, or instructor consent.

Class/Lab Schedule: 2 lecture hours and 2 lab hours per week.

Topics Covered:
- Programming in C and C++ - control structures, functions, arrays, pointers. (3 hours)
- Introduction to Software Engineering - life cycle: analysis, design, implementation and maintenance.(2 hours)
- Object-Oriented programming model – encapsulation, information hiding, polymorphism, inheritance. (3 hours)
- C++/Object-Oriented concepts – classes, information hiding, encapsulation.(4 hours)
- Simple linked data structures – linked lists, stacks, queues. (3 hours)
- C++/Object-Oriented concepts – operator overloading (3 hours)
- C++/Object-Oriented concepts - inheritance, and polymorphism.(3 hours)
- C++ - templates, streams and stream I/O. (3 hours)
- C++ - File processing, string class, string stream processing . (3 hours)
- C++ - legacy code topics, standard template library. (3 hours)
- Fundamental computing algorithms – simple searching and sorting (linear and binary search, selection and insertion sort). (6 hours)
- Projects, exams and review. (6 hours)

Text Book and Other Required Materials: “C++ How to Program” by H.M. Deitel and P.J. Deitel.

Course Objectives and Their Relationship to Program Objectives:
A student should understand (i) object-oriented programming concepts and techniques, (ii) the principles of software engineering in object-oriented languages, and (iii) the fundamentals of programming in C++. A student should be able to design and implement object-oriented software to solve moderately complex problems. A student should master modern tools for computer-aided software engineering (CASE) and be able to write good program documentation. [Program Objectives this course addresses: A, B, and D.]

Course Outcomes and Their Relationship to Program Outcomes:
The following are the course outcomes and the subset of Program Outcomes (numbered 1-11 in square braces "[ ]") they address:

- Design and implement structured, robust, maintainable object-oriented programs from the specifications developed. [2,3,5,11]
- Develop teamwork and management skills to divide tasks and effectively develop software in teams of 3 or more people. [4,7,9]
- Produce well-documented code and program documentation for others. [3,5,7].
- Use CASE tools for object-oriented software engineering such as syntax-aware and programmable editors, debuggers, and makefiles. [2,3,5,11]

Contribution of Course to Meeting the Professional Component
Engineering Topics: 100%

Computer Usage:
Students use PC and/or Unix workstations with GNU C/C++ compilers and debuggers.
All of the assignments use computers as this is a programming course. The course also makes use of Internet services such as email and the web, for references. The course has a web site, which has downloadable software and documents, as well as reference links.

Design Credits and Features:
EE 491F has 1 design credit. All of the homework assignments and projects require program writing. Programming assignments are done individually while programming projects are done in groups of 3 or 4 students, with attention given to diversity within each group.

Instructor(s): T. Dobry.

Person(s) Preparing Syllabus and Date: T. Dobry, November 10, 2007

C.2 Justification

Electrical Engineering students typically take the introductory programming course, EE 160 Programming for Engineers, using the C language, in their freshman year. Those who choose the Computer Track (Computer Engineering) are then required to take EE 367, Computer Data Structures and Algorithms, as their second programming course, typically in their junior year. In the past, the two years between EE 160 and EE 367, as well as the expected programming level in EE 367 has made the transition to EE 367 difficult for many students. The proposed course, EE 205 Object Oriented Programming, is meant to improve the transition to EE 367 by giving students additional programming experience at the sophomore level as well as introduce students to the object-oriented paradigm used in most modern programming languages, such as C++ and Java. The course also introduces students to some standard data structures such as linked lists, stacks and queues, as well as software engineering principles for well documented and maintanable code early in the curriculum.

The syllabus for EE 205 has been developed and offered for the past three years as a special topics course, EE 491F, offered to sophomore students as well as senior level students taking EE 467, Object Oriented Software Engineering. In Fall 2007 the course was separated from EE 467 and offered to prospective Computer Engineering students planning to take EE 367 in Spring 2008. The introduction of EE 205 will reduce the need for remedial programming instruction in EE 367 and allow that course to concentrate on more complex data structures, algorithmsa and algorithm complexity than in the past, and allow EE 467 to concnetrate more fully on software engineering issues than on object oriented programming.

EE 205 will be a required course for students in the proposed Computer Engineering program. In addition, the three course sequence of EE 160, EE 205 and EE 367 will meet the prerequsites for courses in the ICS department that may be taken as electives in the proposed Computer Engineering program.

Appendix D. Industry Input

The Department has received the following input from industry

D.1. Industrial Advisory Board (IAB)

The Department had an IAB meeting on October 28, 2008 to evaluate our undergraduate program in electrical engineering and to review our proposed undergraduate computer engineering program. The Department had an Industrial Advisory Board (IAB) meeting on October 28, 2008 to evaluate the viability of our undergraduate electrical engineering program. The IAB is composed of industry representatives, where the visiting members were

- Kelly Matsumoto, Spirent Communications
- Kevin Miyashiro, Terasys Technologies LLC
- Ed Nakamoto, Spirent Communications
- Mark Sora, Referentia Systems Incorporated
- Nolan Tanaka, Northrop Grumman Corporation
- Larry Yamamoto, Pearl Harbor Navy

Northrop Grumman is a large mainland company, and Pearl Harbor Navy is federal government. But the rest of the representatives are from Hawaii companies or have a facility in Hawaii. They evaluated our computer engineering program proposal in addition to our electrical engineering program. Their comments were positive, and with suggestions to increase the number of the technical electives by considering eliminating some lower division requirements:

> "The IAB supports the program change of the department from 'Electrical Engineering' to 'Electrical and Computer Engineering' and the "Computer Track' to 'Computer Engineering.' The proposed curriculum is a good start but more should be looked in the future to replace non-engineering classes with engineering classes. Some areas to look at reducing are a math, chemistry, or physics class in favor of another programming class. Relook at the University of Texas' program as to why they do not have as much general classes. Require more technical elective classes from two. There were not enough electives on internet and the web. Make sure that there is a clear differentiation between Computer Engineering and the ICS degrees."

We should note that there is a clear differentiation between the computer engineering and ICS degrees. The computer engineering program has all of the required courses of the College of Engineering and the Department of Electrical Engineering whereas the ICS degree has the requirements of the College of Natural Sciences.

D.2. Industry Letters

We received three letters of support from Hawaii high tech companies:

- Tareq Hoque, President and Founder, Concentris Systems, 2800 Woodlawn Drive #238, Honolulu, HI 96822
- Tom Johnson, Director, Asia-Pacific Office, Camber Corporation, 900 Fort Street Mall, #1410, Honolulu, HI 96813
- Reid Shizumura, Engineering Site Manager, Honolulu Campus, Lockheed Martin IS & GS.

Concentris
systems
Indestructible Instant Networks

September 28, 2008

Galen H. Sasaki
Associate Professor
Department of Electrical Engineering
University of Hawaii
2540 Dole Street
Honolulu, HI 96822

Dear Galen:

I was pleased to learn that the Department of Electrical Engineering is proposing a new bachelor science degree in computer engineering. The continual melding of digital electronic hardware, software, and application-specific computational architectures have effectively eliminated the distinction of hardware, software, firmware, and system architecture. The mix of skills developed in a computer engineering program will likely produce very capable students who could benefit high technology companies such as Concentris.

As you are aware, I have run several successful high technology companies in Hawaii and the mainland. Over the years the companies I've ran have hire in excess of 50 graduates of the University of Hawaii. As a result I am always encouraged by efforts to improve the programs and courses at the University that will enhance the value of graduates in our organizations.

I whole heartedly support your efforts to advance this program for the benefit of your students and the technology community.

Sincerely,

Tareq Hoque,
President and Founder

2800 Woodlawn Dr, St. 238
Honolulu, HI 96822
www. concentris-systems.com
808.988.6100

Camber

October 27, 2008

Dear Professor Anthony Kuh,

We have reviewed the University of Hawaii's proposed Computer Engineering Bachelor of Science Degree Program and believe it will produce computer engineering graduates with the skills our Software Development and Integration Team desires in prospective software engineers. The program's core requirements provide the key courses required by our software engineers. We are very interested in the program's list of elective courses, particularly the following courses:

EE 344 Networking I
EE 449 Computer Communication Networks
EE 461 Computer Architecture
EE 467 Object Oriented Software Engineering
ICS 321 Data Storage & Retrieval
ICS 415 Introduction to Programming on the Web
ICS 421 Database Systems
ICS 422 Data Processing
ICS 423 Computer Security
ICS 424 Application Frameworks
ICS 466 Design for Mobile Devices

I strongly believe the new Computer Engineering Bachelor of Science Degree Program will produce software engineers with the basic foundation necessary in today's software development market. Our Software Development and Integration Team is growing rapidly and we will be looking locally for new developers to join our team. We will be very interested in interviewing graduates of this program for possible future software engineering positions.

Respectfully,

Tom Johnson
Camber Corporation, National Preparedness Division
Director, Asia-Pacific Office
900 Fort Street Mall, Suite 1410
Honolulu, HI 96813
(808) 237-3536
(808) 348-1885 (cell)
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Camber Corporation *"An Employee Owned Company"*

LOCKHEED MARTIN

July 29, 2008

Dr. Anthony Kuh
Professor and Chair, Department of Electrical Engineering
University of Hawaii at Manoa, College of Engineering
2540 Dole Street, Holmes Hall 483
Honolulu, HI 96822

Dear Tony,

I am writing in support of the College of Engineering's establishment of a computer engineering undergraduate program. This program will provide a great opportunity for students seeking a curriculum that integrates the fields of electrical engineering and computer science. I have found that graduates with a broad range of technical skills (e.g., signals, systems, computer design, computer programming, mathematics) are often the best prepared for entry-level engineering positions. A computer engineering program is well-suited to provide students with these types of skills. Creation of this program is an excellent idea and will further strengthen the College's reputation and recruiting ability.

Sincerely,

Reid Shizumura
Engineering Site Manager, Honolulu Campus
Lockheed Martin IS&GS

Appendix E. Student Input

The Department solicited EE undergraduate student input using a survey in October 2008. It was distributed in class by October 17, 2008. Students could review the survey and submit it on October 24, 2008. A copy of the survey is in Section E.1 and the results are summarized in Section E.2.

E.1 Undergraduate Survey

Computer Engineering Bachelor of Science Program
Student Survey

Instructions: **If you are an Electrical Engineering (EE) student, please complete and submit this survey**

To: **EE Office, Holmes Hall 483 (Fourth floor, Diamond Head side)**
Office hours 8:00 AM - noon and 1:00 - 4:30 PM. Closed 12noon - 1:00 PM

Deadline: **October 24, 2008 Friday, 4:30 PM**

For each question, circle one of the options:

A. What level you? (1) Freshman (2) Sophomore (3) Junior (4) Senior

B. What Track are you in? (1) Computer Track (2) EP Track (3) Systems Track (4) Undecided

C. Would you like to see a bachelor of science computer engineering program at the University of Hawaii at Manoa?

(1) Strongly Agree

(2) Moderately Agree

(3) Undecided

(4) Moderately Disagree

(5) Strongly Disagree

(6) Don't know enough to choose one of the above.

D. Provide any comments, if any, on the computer engineering program

E.2. Survey Results

There were 30 EE undergraduates that submitted a survey. Of these, 25 considered themselves knowledgeable about the issue. The 25 knowledgeable EE students, responded to the question

> **Would you like to see a bachelor of science computer engineering program at the University of Hawaii at Manoa?** (1) Strongly Agree, (2) Moderately Agree, (3) Undecided, (4) Moderately Disagree, (5) Strongly Disagree

The average score of the 25 students was 1.68. The number of these students who were in the Computer Track is 4. The rest of the students were in the Electro-Physics or Systems Tracks or undecided. The four computer students gave an average score of 1.75 to the question. So overall the students gave a favorable response somewhere between moderately and strongly agreeing.

Some of the students also filled in some comments. They were generally positive or expressed a desire for other programs.

Comments:

- About time
- Flexability between EE and ICS electives to much maybe. If ICS courses incorporate engineering principles/methods/ ??
- Whatever Tep wishes to implement should be supported as he's demonstrated well that his interests are academically aligned with the undergraduate student body's interests. Based on this, any mandate that tep is seeking has my full support.
- for T.E. add in a lab along with this course
- yes
- I think it's a great idea for a diverse education in computer engineering
- I don't want to expand the class sizes any more than it already is. We don't need more students and it only divides the luxury even more.
- There should be a power track
- What about a power track?
- computer engineering is a big part of EE and it wouldn't be that big of a jump to be added as another track
- Its good

Appendix F. Relationship Between Outcomes and Objectives

Table F.1 is a mapping of the undergraduate program outcomes to undergraduate program educational objectives (see Section I). In the table, each Outcome is given a value about how it affects an Objective: "2" = strongly, "1" = moderately, and "0" = low or no influence. At the bottom of the table is the sum of these values. All Objectives receive a reasonable amount of emphasis with Objectives 1, 2, 3, and 5 having high emphasis.

Table F.1. How Outcomes lead to achieving Objectives.

Outcomes	**Objectives**					
	1	**2**	**3**	**4**	**5**	**6**
1. Knowledge of probability and statistics, including examples relevant to Electrical Engineering (program criteria). Knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software. Knowledge of advanced mathematics, including differential equations (program criteria).	2	2	2	0	1	0
2. Demonstrated an ability to design and conduct experiments, as well as to interpret data.	2	2	2	0	1	0
3. Demonstrated an ability to design a system or component that meets a specified need.	2	2	2	0	1	0
4. Demonstrated an ability to function in a multi-disciplinary team.	2	2	2	1	2	1
5. Demonstrated an ability to identify, formulate and solve electrical engineering problems.	2	2	2	1	1	0
6. Understanding of professional and ethical responsibility.	2	2	2	1	2	2
7. Demonstrated an ability to communicate effectively (written and oral).	2	2	2	1	2	0
8. Demonstrated an understanding of the impact of engineering solutions in a global and societal context.	2	2	2	1	2	2
9. Recognition of the need for life-long learning.	2	2	2	2	0	0
10. Demonstrated a knowledge of contemporary issues.	2	2	2	1	2	1
11. Demonstrated an ability to use the techniques, skills, and modern tools necessary for engineering practice.	2	2	2	1	1	0
SUM OF SCORES	**22**	**22**	**22**	**9**	**15**	**6**

Appendix G. Relationship Between Courses and Outcomes

The following table shows good coverage of computer engineering courses to outcomes, especially the technical outcomes 1, 2, 3, 5, and 11 (see Section I for the list of Undergraduate Program Outcomes).

		OUTCOMES										
	Credits	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
MATHEMATICS												
Math 241 Calculus	4	3	0	0	0	0	0	0	0	0	0	0
Math 242 Calculus II	4	3	0	0	0	0	0	0	0	0	0	0
Math 243 Calculus III	3	3	0	0	0	0	0	0	0	0	0	0
Math 307 Linear Algebra & Diff Equations	3	3	0	0	0	0	0	0	0	0	0	0
ICS 141 Discrete Math for Computer Science I	3	3	0	0	0	0	0	0	0	0	0	0
EE 342 EE Prob & Stat	3	3	2	2	0	2	0	0	1	2	1	2
BASIC SCIENCES												
Chem 161 General Chem I	3	3	0	0	0	0	0	0	0	0	0	0
Chem 161L General Chem I Lab	1	3	3	0	2	0	0	0	0	0	0	0
Chem 162 General Chem II	3	3	0	0	0	0	0	0	0	0	0	0
Phys 170 General Physics I	3	3	0	0	0	0	0	0	0	0	0	0
Phys 170L General Physics I Lab	1	3	3	0	2	0	0	0	0	0	0	0
Phys 172 General Physics II	3	3	0	0	0	0	0	0	0	0	0	0
Phys 172L General Physics II Lab	1	3	3	0	2	0	0	0	0	0	0	0
Phys 274 General Physics III	3	3	0	0	0	0	0	0	0	0	0	0
ENGINEERING REQUIRED												
EE 160 Programming for Engrs	4	0	1	2	2	1	0	1	0	1	0	2
EE 211 Basic Circuit Analysis I	4	2	2	2	0	1	0	1	1	1	1	2
EE 213 Basic Circuit Analysis II	4	3	2	2	1	2	0	1	0	1	0	1
EE 260 Intro to Digital Design	4	1	1	2	2	1	0	1	0	1	0	3
EE 296 Soph Projects	1	0	0	2	2	1	0	2	0	1	0	2
EE 315 Signals & Systems Analysis	3	3	0	2	0	2	0	0	1	2	1	1
EE 323 Microelectronic Circuits I	3	2	1	3	0	3	0	0	1	2	1	3
EE 323 Microelectronic Circuits I Lab	1	2	3	2	1	2	1	2	0	1	0	3
EE 324 Physical Electronics	3	3	0	0	0	1	0	0	0	1	0	1
EE 361 Digital Systems & Computer Design	3	2	0	3	0	3	0	0	0	2	0	3
EE 361L Digital Sys & Comp Design Lab	1	2	1	3	1	3	1	3	0	2	0	3
EE 366 CMOS VLSI Design	4	2	0	3	0	3	0	3	0	0	0	3
EE 367 Computer Data Structures & Algorithms	3	1	3	3	1	2	1	2	2	0	1	2
EE 367L Comp Data Struct & Algorithms Lab	1	1	3	3	1	2	1	2	2	0	1	2
EE 371 Engineering Electromagnetics I	3	2	0	2	0	3	0	0	1	1	1	2
EE 396 Junior Projects	2	1	1	3	1	3	0	3	0	1	1	3
EE 495 Ethics in Electrical Engineering	1	0	0	0	0	0	3	1	2	1	0	0
EE 496 Senior Capsstone Design Project	3	1	3	3	2	3	1	3	1	3	1	3
Engineering Breadth		0	0	0	0	0	0	0	0	0	0	0
GENERAL EDUCATION												
ENG 100 Composition I	3	0	0	0	0	0	0	3	0	0	0	0
SP 251 Principles of Eff Pub Speaking I	3	0	0	0	0	0	0	3	0	0	0	0
Writing Intensive (W)-- 5 courses		0	0	0	0	0	0	3	0	0	0	0
Oral Communication (O)-- 1 course		0	0	0	0	0	0	3	0	0	0	0
Hawaiian, Asian, and Pac Issues (H) -- 1 course		0	0	0	0	0	0	0	1	0	0	0
Global & Multicultural Perspectives	6	0	0	0	0	0	0	0	1	0	1	0
Social Science	3	0	0	0	0	0	0	0	1	0	0	0
Economics ECON 120, 130, or 131	3	0	0	0	0	0	0	0	1	0	1	0

Key: (= 0, no emphasis) (=1, some emphasis) (=2, moderate emphasis) (=3, significant emphasis)