AUTHORIZATION TO PLAN AN ACADEMIC PROGRAM AT MĀNOA

1. Locus (Unit, School/College)

2. Chair/Convener of Planning Committee

3. Program Category: ☑ New  ☐ Modified  ☑ Interdisciplinary

4. Department/Unit/Program

5. Level of Program or Major (Graduate, Undergraduate, etc.)

6. Degree or Certificate Proposed

7. Proposed Planning Period
   (If significant work has not been done during a one-year period, approval may be withdrawn)

8. Proposed Date of Implementation

9. Program Description (Objectives and Relationship to Mission)

10. Program Justification (Needs and Rationale)

11. Activities to be undertaken during the planning phase

12. Description of resources required and status or sources
    ✔ Faculty
    ✔ Library resources (including an evaluation of current resources and an estimate of the cost of additional resources required)
    ✔ Physical resources (space, equipment, etc.)
    ✔ Additional resources required (staff, graduate assistantships, etc.)
    ✔ Estimate of additional position counts and budget implementation for first five years of the program

13. Five-Year Business Plan. Please provide a five-year projected budget for the program that includes: 1) projected enrollment and estimated tuition revenue, 2) additional sources of revenue, and 3) costs associated with the resources noted above.

14. Does the current or proposed budget include funds or a request for funds for the proposed program? Please provide details.

15. Given a "flat budget" situation, how will the proposed program be funded?

16. Impact on current courses or programs.

17. If this program is multidisciplinary, provide evidence of commitment for support from the colleges, departments, programs, and/or individuals expected to participate.
18. Authorization to Plan Approved

**Department Chair(s)/Program Director(s):**

Galen Sasaki/Martha Crosby  
Print Name  Signature  Date  
5/14/07

**College/School Dean(s):**

Bruce Liebert  
Print Name  Signature  Date  
4/23/07

Charles Hayes  
Print Name  Signature  Date  
5/31/07

**Graduate Division Dean (graduate programs only):**
Comments and Recommendations:

Print Name  Signature  Date

**Vice Chancellor for Academic Affairs:**
Comments and Recommendations:

Print Name  Signature  Date

**Chancellor:**  □ Approved  □ Disapproved  □ Deferred
Comments and Recommendations:

Print Name  Signature  Date

C: Mānoa Faculty Senate  
Mānoa Budget Office

Revised June 2004
Department of Electrical Engineering
University of Hawai`i

REQUEST FOR THE AUTHORIZATION TO PLAN AN ACADEMIC PROGRAM AT MANOA

Computer Engineering Bachelor of Science Degree

Galen Sasaki, Chair- Department of Electrical Engineering
Martha E. Crosby, Chair – Department of Information and Computer Sciences

March 23, 2007

Summary: The Department of Electrical Engineering and Department of Information and Computer Sciences requests the Authorization to Plan an Academic Program at Manoa, and in particular a bachelor of science degree in computer engineering.

The program 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.

The program will support higher education in Hawai`i for high technology areas. It will train a highly skilled, flexible, world-class labor force of computer engineers for Hawai`i’s high technology companies.

The program will be a modification of the Department of Electrical Engineering’s existing undergraduate electrical engineering program. Once the program is established, the Department of Electrical Engineering will apply for accreditation with ABET, the national accreditation organization for engineering programs. The application has a good chance of success since the electrical engineering undergraduate program has been accredited for many years.
AUTHORIZATION TO PLAN AN ACADEMIC PROGRAM AT MANOA

Computer Engineering Bachelor of Science Degree

September 16, 2007

1. Locus (Unit, School/College)

College of Engineering and Department of Information and Computer Sciences

2. Chair/Convener of Planning Committee

Galen Sasaki and Martha E. Crosby

3. Program Category

New

4. Department/Unit/Program

Department of Electrical Engineering/ Computer Engineering Program
Department of Information and Computer Sciences

5. Level of Program or Major

Undergraduate

6. Degree or Certificate Proposed

Bachelor of Science

7. Proposed Planning Period

September 30, 2007 to December 31, 2007
8. Proposed Date of Implementation

August 1, 2008.

9. Program Description (Objectives and Relationship to Mission)

Computer engineering is an important profession in the high 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 high 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 and computer scientists for Hawai‘i’s high technology companies.
- The additional degree program can increase enrollment in the University of Hawai‘i.

The Department of Electrical Engineering and the Department of Information and Computer Sciences are proposing to offer a joint bachelor of science degree in computer engineering, and the program will be eventually accredited by ABET, the national accreditation organization for engineering programs. The program will be housed in the College of Engineering and will educate undergraduate students so they can design, analyze, and integrate hardware and software of computers. Hardware includes digital circuits, very large scale integration (VLSI) circuits, computer aided (CAD) circuit design, micro-processors, micro-controllers, high performance circuit design, and embedded systems. Software includes programming, data structures, algorithms, and elements of software engineering. The computer engineering program will have a different focus from computer science, which emphasizes software.

The implementation of the computer engineering program will be simple. To explain this, let us first discuss the current curriculum in the Department of Electrical Engineering and Department of Information and Computer Sciences. The Department of Electrical Engineering offers an ABET accredited, bachelor of science degree in electrical engineering. Appendix A1 has a description of the curriculum of the Department of Electrical Engineering (EE) and Appendix A2 has a description of the curriculum of the Department of Information and Computer Sciences (ICS) effective August 2007. EE electives are organized into three “Tracks” of specialization: Computers, Electro-Physics, and Systems. A student must specialize in a Track.

The EE Computer Track (i.e., the electrical engineering undergraduate curriculum with the Computer Track specialization) is a computer engineering program except that the EE computer track has no requirement for a discrete math course. The discrete math requirement is essential for ABET accreditation and is available from the Department of Information and Computer Sciences.
Appendices B and C have comparisons between the EE Computer Track and the undergraduate computer engineering curricula at the University of Illinois at Urbana-Champaign and The University of Texas at Austin, respectively. The EE Computer Track is similar.

We propose a new bachelor of science degree in computer engineering by implementing the following change to the EE Computer Track curriculum:

- **Outside Major Track EE Technical Elective (3 hrs) is replaced with ICS 141 Discrete Math (3 hrs).**

We have requested and received approval from the Department of Information and Computer Science for our students to enroll in ICS 141 (see Appendix D).

A draft of the proposed computer engineering curriculum is presented in Appendix E.

The electrical engineering program is accredited by ABET, so the accreditation of the computer engineering program should be able to obtain accreditation.

10. Program Justification (Needs and Rationale)

Besides the justification given in Section 9, there are a number of local companies who are interested in employing our computer students. They include established companies such as Spirent-Adtech and Lockheed-Martin-Orincon, and start-up companies such as Sanjole. They are interested in engineers who have a background in both computer hardware and software. A program in computer engineering will support local high tech companies in their search for computer engineering talent.

11. Activities to Be Undertaken During the Planning Phase

We have a plan for implementation of the computer engineering program as described in Section 9. The planning phase will be used to:

- **Complete the description of the curriculum including, description of educational objectives and program outcomes.**
- **Design the process of how the curriculum will be maintained and improved.** We have a process used to maintain and upgrade the electrical engineering curriculum, which we will use as a starting point.
- **Ensure that the program will conform to ABET accreditation requirements (ABET is the national accreditation organization for engineering programs).** Our electrical engineering program has been accredited by ABET for many years. We believe providing mechanisms to ensure accreditation will be straightforward for our department.
12. Description of Resource Required and Status of Resources

As explained in Section 9, our plan to implement a computer engineering program is a single change to our current EE Computer Track curriculum. The change is to require students to take ICS 141, discrete math. Since the Department of Information and Computer Sciences has approved this, no additional resources are needed.

We expect that the new computer engineering degree will increase enrollment. The departments of EE and ICS can accommodate moderate increases. However, if the enrollment increases substantially more faculty, teaching assistants and resources will be needed.

The program can be improved with additional computer engineering faculty. They can teach upper division technical electives in their research specialty, and enhance the training of computer engineering graduates. But they are not required to initiate a computer engineering program.

12.a. Faculty

Faculty in the Department of Electrical Engineering. Faculty who are in the Computer Track (specialization option) are starred "***" and underlined. Note that there are six faculty members in the Computer Track.

- 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
- MARC FOSSORIER, , Ph.D., University of Hawai‘i, Error Control Codes, Communication Algorithms: Design and VLSI Implementation, Magnetic Recording, Statistics
- N. T. GAARDER, Ph.D., Stanford University, Communication and Information Theory
- *** ANNA HAC, Ph.D., Warsaw University of Technology, Poland, Telecommunications and Wireless Networks, Network Management
- 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-MADSSEN, 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

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

TODD REED, Ph.D. University of Minnesota, Signal, Image and Image Sequence Processing, Multidimensional Digital Signal Processing, and Computer Vision

GALEN SASAKI, Department Chair, Ph.D., Illinois at Urbana-Champaign, Communication Networks, Optimization Algorithms, Network Performance Evaluation

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

Faculty in the Department of Information and Computer Sciences. Faculty who can teach courses needed for the bachelor of science degree are "****" and underlined.

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., North Carolina-Chapel Hill, 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

WILL GERSCH, Ph.D., Columbia University, Mathematical Statistics, Machine Learning

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
12.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 publications in Hamilton Library are journals and books with TK and QA reference code located on the fourth and second floors of the library’s additional building. These publications are easily accessible for the faculty and students. The most useful library database is the search of available library resources that permit to locate required publication. In addition, the UH library subscribes to the IEEE (Institute of Electrical and Electronic Engineers) database. This subscription allows UH faculty and students to access many of the IEEE publications dated from 1998 to present. A high cost of accessing earlier publications in IEEE database did not allow the library for a full subscription for the years before 1998. The UH library does not subscribe to the IEEE
standards either, that would provide useful technical information and would be helpful in practical and application research. In summary, the present resources available in the UH library appear to be adequate for the Computer Engineering program.

12.c. Physical resources (space, equipment, etc.)

The resources of the Department of Electrical Engineering will be available to the computer engineering program. The resources are sufficient since it already supports the Computer Track option in the EE program, and the Computer Track is essentially our implementation of the computer engineering program.

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 F1.

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 314: Innovative Computation Lab
- 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 F2.

12.d. Additional resources required (staff, graduate assistantships, etc.)

No additional resources are required if the enrollment has a modest increase. If the enrollment increases substantially, more resources will be needed.

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

No additional resources are required if the enrollment has a modest increase. If the enrollment is higher the contributing departments may require more positions.
13. Five-Year Business Plan. Please Provide a Five-Year Projected Budget for the Program That Includes

13.a. Projected enrollment and estimated tuition revenue

We estimate that the number of computer engineering students will be 33.3% x 285 = 95 next academic year. The number 285 was our average EE undergraduate enrollment from Spring 2002 through Fall 2006. As shown in Figure 1, the EE enrollment during this period was relatively flat. The fraction of EE students that specialize in computers is about 33.3%. This is a conservative estimate. From Fall 1995 through Spring 2005, the fraction of EE bachelor of science students who graduated in the computer area was about 38%.

Figure 2 shows the estimated annual revenues over five years assuming a modest annual enrollment growth of 3%, and then assuming a stronger annual enrollment growth of 15%. For the years, 2007-08 and 2008-09, the actual tuition is used. Since the tuition for 2009-10, 2010-11, and 2011-12 are not available, we assumed a 5% increase.

![Figure 1. EE undergraduate enrollment.](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated Tuition</th>
<th>Estimated Enrollment 3% Growth</th>
<th>Revenue for 3% Enrollment Growth</th>
<th>Estimated Enrollment 15% Growth</th>
<th>Revenue for 15% Enrollment Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-08</td>
<td>$5,136</td>
<td>92</td>
<td>$472,512</td>
<td>92</td>
<td>$472,512</td>
</tr>
<tr>
<td>2008-09</td>
<td>$5,952</td>
<td>95</td>
<td>$564,011</td>
<td>106</td>
<td>$629,721</td>
</tr>
<tr>
<td>2009-10</td>
<td>$6,249</td>
<td>98</td>
<td>$609,978</td>
<td>122</td>
<td>$760,388</td>
</tr>
<tr>
<td>2010-11</td>
<td>$6,562</td>
<td>101</td>
<td>$659,691</td>
<td>140</td>
<td>$918,169</td>
</tr>
<tr>
<td>2010-12</td>
<td>$6,890</td>
<td>104</td>
<td>$713,456</td>
<td>161</td>
<td>$1,108,689</td>
</tr>
</tbody>
</table>
13.b. Additional sources of revenue

As explained earlier, if the enrollment has a modest increase then there will be no additional costs. But having a computer engineering degree program will enhance our department's stature as one having expertise in computer technology. This will help recruit quality computer faculty in the future who have the capability to establish successful research programs. Such programs will bring in additional research grants, and grants and donations for computer equipment and software. Some of these resources can be used in the undergraduate curriculum especially the upper division and project courses.

By having a computer engineering program, more companies may be interested in supporting the program in the form of scholarships, internships, and undergraduate research project grants.

13.c. Costs associated with the resources noted above

As explained earlier, there are no additional costs if the enrollment has a modest increase. If the enrollment is higher then, of course, the department will require more faculty, teaching assistants, and resources.
14. Does the Current or Proposed Budget Include Funds or a Request for Funds for the Proposed Program?

As explained earlier, no additional funds are required if the enrollment has a modest increase. If the enrollment is higher then, of course, the department will require more faculty, teaching assistants, and resources.

15. Given a “Flat Budget” Situation, How Will the Proposed Program be Funded?

No additional resources are required if the enrollment has a modest increase.

16. Impact on Current Courses or Program

We expect there will be an increase in overall enrollment in the Department of Electrical and Computer Engineering due to the availability of the new computer engineering degree. Course enrollments for BSCE courses are expected to increase.

17. If This Program is Multidisciplinary, Provide Evidence of Commitment for Support From the Colleges, Departments Programs, and/or Individuals Expected to Participate

This is a multidisciplinary program between the EE and ICS departments. After completing EE 160, EE 367 and EE 467, the students will have the prerequisites for any of the appropriate upper division ICS 300 and 400 level courses. Also, the BSCE curriculum requires the students to take a discrete mathematics (ICS 141) course from the ICS department. The department of ICS has agreed to have ICS 141 and other 300 and 400 ICS courses fulfill the computer engineering Bachelor of Science degree requirements (see Appendix D).
Appendix A1. EE Curriculum

The following is the EE curriculum.

Design Experience Statement

A key aspect of electrical 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 Electrical Engineering curriculum assigns design credits to each course (see design credits). 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 adviser 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 Projects course and two credits of EE 396, Junior Projects course. The project courses help students in getting design experience outside the classroom as they learn engineering concepts in the classroom. The project courses prepare the students for EE 496, the capstone design project. 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.

Bachelor’s Degree

The BS degree program requires a minimum of 122 credit hours. (Note that the University requires 124 credit hours for a bachelor’s degree.) The departmental requirements consist of 51 credit hours of basic courses and 20 credit hours of technical electives.

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

College Requirements

Course work in each curriculum consists of a set of required courses common to all engineering majors and additional courses to satisfy departmental requirements. The courses required of all engineering students, which also satisfies the General Education Core requirements of UH Manoa, consist of the following 51 credits:

Written Communication

- ENG 100 Composition I (3) (FW) or approved FW course

Arts, Humanities and Literature

- SP 251 Principles of Effective Public Speaking (3) (DA)
- One elective (3) (DH or DL)
Social Sciences

- ECON 120 Introduction to Economics (3), ECON 130 Principles of Economics (3), or ECON 131 Principles of Economics (3) (DS)
- One elective (3) (DS)

Global and Multicultural Perspectives

- Two approved FG electives (6)

Symbolic

- MATH 241 Calculus I (4) (FS)
- MATH 242 Calculus II (3)
- MATH 242L Calculus Computer Lab (1)
- MATH 243 Calculus III (3)
- MATH 244 Calculus IV (3)

Natural Sciences

- CHEM 161/161L, and 162 General Chemistry/Lab (3/1/3) (DP/DY)
- PHYS 170/170L General Physics I/Lab (4/1) (DP/DY)
- PHYS 272/272L General Physics II/Lab (3/1) (DP/DY)

In addition, a student must complete the Focus Graduation Requirements, 1H, 1E, 1O and 5W courses. The Hawaiian or Second Language is not required for the engineering degree.

BS Degree Requirements

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

Departmental Requirements

Students must complete a total of 67 credit hours including the following:

- EE 160 Programming for Engineers (4)
- EE 211 Basic Circuit Analysis I (4)
- EE 213 Basic Circuit Analysis II (4)
- EE 260 Introduction to Digital Design (4)
- EE 315 Signal and System Analysis (3)
- EE 323 Microelectronic Circuits I/Lab (3/1)
- EE 324 Physical Electronics (3)
- EE 342 EE Probability and Statistics (3)
- EE 371 Engineering Electromagnetics I (3)
- PHYS 274 General Physics III (3)
- Engineering Breadth* (3)
- MATH 307 Linear Algebra and Differential Equations (3)
• Projects (6)
• Technical electives (24)

* 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.

Projects

There is a requirement of EE 296, EE 396, and EE 496, which is the capstone design experience. A minimum of, respectively, 1, 2, and 3 credits are required of each.

Technical Electives

There is a requirement of a minimum of 24 credits of technical electives. A minimum of 17 credits is in one of the major tracks (computers, electro-physics, systems), which includes all courses in Group I and the remaining courses from Group II. A minimum of 3 credits is outside the major track that must be at the 300 level or higher.

Computers Track:

• Group I: EE 361/361L, 366, 367/367L
• Group II: EE 344, 449, 461, 467, 468, 469

Electro-Physics Track:

• Group I: EE 326/326L, 327, 372/372L
• Group II: EE 328/328L, 422/422L, 423, 425, 426, 427, 473, 474, 475, 477

Systems Track:

• Group I: EE 341/341L, 351/351L, 415
• Group II: EE 344, 442, 446, 449, 452, 453

A student, along with a faculty member, may propose an alternate track. This alternate track must be (1) equivalent in rigor and breadth to the existing tracks, (2) endorsed by another faculty member, and (3) approved by the Department’s Undergraduate Curriculum Committee.
Appendix A2. ICS Curriculum

The following ICS courses can be used to fulfill requirements for the BSCE degree.

Required Courses for the Computer Engineering Bachelor of Science Degree
- ICS 141 Discrete Mathematics for Computer Science I

Equivalent Series of Courses offered by department of Electrical Engineering
- ICS 111 Introduction to Computer Science I
- ICS 211 Introduction to Computer Science II
- ICS 212 Program Structure

Electives in ICS
- ICS 241 Discrete Mathematics for Computer Science II
- ICS 311 Algorithms
- ICS 312 Machine-Level and Systems Programming
- ICS 313 Programming Language Theory
- ICS 321 Data Storage and Retrieval
- ICS 331 Logic Design and Microprocessors
- ICS 412 Operating Systems
- ICS 413 Software Engineering I
- ICS 414 Software Engineering II
- ICS 415 Introduction to Programming for the Web
- ICS 421 Database Systems
- ICS 422 Data Processing
- ICS 423 Computer Security
- ICS 424 Application Frameworks
- ICS 431 Computer Architecture
- ICS 432 Concurrent and High-Performance Programming
- ICS 441 Theory of Computation
- ICS 442 Analytical Models and Methods
- ICS 451 Data Networks
- 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 471 Probability, Statistics, and Queuing
- ICS 481 Introduction to Computer Graphics
Appendix B. Comparison of UH EE Computer Track and University of Texas at Austin Computer Engineering

June 6, 2005

This is a comparison between the University of Hawai‘i’s Electrical Engineering Computer Track undergraduate curriculum and the computer engineering undergraduate curriculum at The University of Texas at Austin (http://www.ece.utexas.edu/undergrad/ce04-06.html). The UH EE Computer Track curriculum considered here is effective August 2005. The UH EE Computer Track is 122 credit hours and the University of Texas Computer Engineering is 123 credit hours.

The comparison below is divided into four categories: basic sciences and mathematics; advanced mathematics; computer engineering core; and technical electives. In each table, the equivalent or nearly equivalent courses are in the same row. For the basic sciences and mathematics, the UH curriculum has more credit hours, chemistry, and physics. For advanced mathematics, the UH curriculum is short a discrete math course. In our opinion, this is the only course deficiency to convert the UH curriculum into a computer engineering bachelor of science curriculum that could be ABET accredited. For computer engineering core, the curricula have the same coverage except the University Texas covers microprocessors, while UH covers computer architecture and VLSI circuit design.

**Basic Sciences and Mathematics REQUIRED COURSES**

<table>
<thead>
<tr>
<th>U of Texas</th>
<th>20 hours</th>
<th>UH</th>
<th>36 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 408C (4 hrs)</td>
<td>Differential and Integral Calculus</td>
<td>Math 241, Math 242 and L (8 hrs)</td>
<td>Calculus I, II and IIL</td>
</tr>
<tr>
<td>M 408D (4 hrs)</td>
<td>Sequences, Series, and Multivariable Calculus</td>
<td>Math 243 &amp; 244 (6 hrs)</td>
<td>Calculus III and IV</td>
</tr>
<tr>
<td>M 427K (4 hrs)</td>
<td>Advanced Calculus for Applications I (ordinary and partial differential equations)</td>
<td>Math 307 (3 hrs)</td>
<td>Linear algebra and differential equations</td>
</tr>
<tr>
<td>PHY 303K and 103M, the lab, (4 hrs)</td>
<td>Univ. Physics, Mechanics</td>
<td>Phys 170 and L (5 hrs)</td>
<td>General Physics I</td>
</tr>
<tr>
<td>PHY 303L and 103N, the lab, (4 hrs)</td>
<td>Univ. Physics, Elec. &amp; Magnetism</td>
<td>Phys 272 and L (4 hrs)</td>
<td>General Physics II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phys 274 (3 hrs)</td>
<td>General Physics III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chem. 161 and L, and Chem. 162 (7 hrs)</td>
<td>General Chemistry</td>
</tr>
</tbody>
</table>

**Advanced Mathematics REQUIRED COURSES**

<table>
<thead>
<tr>
<th>U of Texas</th>
<th>6 hrs</th>
<th>UH</th>
<th>3 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 325K (3 hrs)</td>
<td>Discrete Math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 351K (3 hrs)</td>
<td>Probability, Statistics, and Random Processes</td>
<td>EE 342 (3 hrs)</td>
<td>EE Probability and Statistics</td>
</tr>
</tbody>
</table>
Computer Engineering Core. REQUIRED COURSES.
Courses stress the fundamental computer engineering concepts and basic laboratory techniques which comprise the common intellectual understanding of all computer engineering. The main difference is U Texas has more emphasis on microprocessors (EE 319K and 345L) and U Hawai‘i EE Computer Track has more emphasis on VLSI computer circuit design (EE 366) and introduction to computer architecture (EE 361 and 361L).

<table>
<thead>
<tr>
<th>U of Texas</th>
<th>42 hours</th>
<th>UH</th>
<th>44 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 302 (3 hrs)</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>EE 211 (4 hrs)</td>
<td>Basic Circuit Analysis I</td>
</tr>
<tr>
<td>EE 306 (3 hrs)</td>
<td>Introduction to Computing</td>
<td></td>
<td>This material is covered in EE 160 and EE 260</td>
</tr>
<tr>
<td>EE 312 (3 hrs)</td>
<td>Introduction to Programming</td>
<td>EE 160 (4 hrs)</td>
<td>Programming for Engineers</td>
</tr>
<tr>
<td>EE 411 (4 hrs)</td>
<td>Circuit Theory</td>
<td>EE 213 (4 hrs)</td>
<td>Basic Circuit Analysis II</td>
</tr>
<tr>
<td>EE 325 (3 hrs)</td>
<td>Electromagnetic Engineering</td>
<td>EE 371 (3 hrs)</td>
<td>Engineering Electromagnetics I</td>
</tr>
<tr>
<td>EE 313 (3 hrs)</td>
<td>Linear Systems and Signals</td>
<td>EE 315 (3 hrs)</td>
<td>Signal and System Analysis</td>
</tr>
<tr>
<td>EE 316 (3 hrs)</td>
<td>Digital Logic Design</td>
<td>EE 260 (4 hrs)</td>
<td>Introduction to Digital Design</td>
</tr>
<tr>
<td>EE 319K (3 hrs)</td>
<td>Microprocessor Programming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 345L (3 hrs)</td>
<td>Microprocessor Interfacing Laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 339 (3 hrs)</td>
<td>Solid State Electronic Devices</td>
<td>EE 361 and L (4 hrs)</td>
<td>Digital Systems and Computer Design</td>
</tr>
<tr>
<td>EE 339 (3 hrs)</td>
<td>Solid State Electronic Devices</td>
<td>EE 324 (3 hrs)</td>
<td>Physical Electronics</td>
</tr>
<tr>
<td>EE 322C (3 hrs)</td>
<td>Data Structures and Software Principles</td>
<td>EE 367 and L (4 hrs)</td>
<td>Computer Data Structures and Algorithms</td>
</tr>
<tr>
<td>EE 438 (4 hrs)</td>
<td>Electronic Circuits I</td>
<td>EE 323 and L (4 hrs)</td>
<td>Microelectronics Circuits I and Lab</td>
</tr>
<tr>
<td>EE 464K (4 hrs)</td>
<td>Senior Capstone Design</td>
<td>EE 495 (3 hrs)</td>
<td>Senior Capstone Design</td>
</tr>
</tbody>
</table>
Technical Electives

<table>
<thead>
<tr>
<th>U of Texas</th>
<th>24 hrs</th>
<th>UH</th>
<th>19 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Technical Area Elective (18 hrs)</td>
<td>4 Technical Electives (13 hrs) = 2 Computer Track TEs + EE Elective + 1 Lab + Technical Elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved Technical Elective (3 hrs)</td>
<td>This is an upper division hard science or math course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved Elective (3 hrs)</td>
<td>Free elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE 296 and 396 (3 hrs)</td>
<td>Sophomore and junior projects courses</td>
<td></td>
</tr>
</tbody>
</table>

| | | Engr breadth (e.g., CEE 270 or ME 311) (3 hrs) | Technical courses to broaden engineering knowledge. It can be CEE 270, ME 311, or a science course from an approved list. |

Credit Hour Analysis

The credit hour analysis does not include general university and college requirements such as humanities, economics, social sciences, etc.

<table>
<thead>
<tr>
<th></th>
<th>University of Texas Comp E</th>
<th>U. Hawai'i EE Comp Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Science and Math and Advanced Math</td>
<td>26</td>
<td>39</td>
</tr>
<tr>
<td>Computer Engineering Core</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>102</td>
</tr>
</tbody>
</table>
Appendix C. Comparison of UH EE Computer Track and University of Illinois at Urbana-Champaign Computer Engineering

June 6, 2005

This is a comparison between the University of Hawai‘i’s Electrical Engineering Computer Track undergraduate curriculum and the University of Illinois at Urbana-Champaign’s computer engineering undergraduate curriculum (http://www.ece.uiuc.edu/ugrad/newce.html). The UH curriculum considered here is effective August 2005. The UH curriculum is 122 credit hours and the University of Illinois Computer Engineering is 128 credit hours.

The comparison is divided into four categories: basic sciences and mathematics; advanced mathematics; computer engineering core; and technical electives. Each comparison is in the form of a table, where the equivalent or nearly equivalent courses are in the same row. For the basic sciences and mathematics, the University of Illinois has an additional thermal physics course. For advanced mathematics, the UH curriculum is short a discrete math course. In our opinion, this is the only course deficiency to convert the UH curriculum into a computer engineering bachelor of science curriculum that could be ABET accredited. For computer engineering core, the curricula have the same coverage except the University of Illinois covers microprocessors, while UH covers VLSI circuit design.

Basic Sciences and Mathematics Required Courses

<table>
<thead>
<tr>
<th>U of Illinois</th>
<th>30 hours</th>
<th>UH</th>
<th>36 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 220 (5 hrs)</td>
<td>Calculus I</td>
<td>Math 241 (4 hrs)</td>
<td>Calculus I</td>
</tr>
<tr>
<td>Math 230 (3 hrs)</td>
<td>Calculus II</td>
<td>Math 242 and L (4 hrs)</td>
<td>Calculus II</td>
</tr>
<tr>
<td>Math 242 (3 hrs)</td>
<td>Calculus of Several Variables</td>
<td>Math 243 &amp; 244 (6 hrs)</td>
<td>Calculus III and IV</td>
</tr>
<tr>
<td>Math 385 (3 hrs)</td>
<td>Intro Differential Equations</td>
<td>Math 307 (3 hrs)</td>
<td>Linear algebra and differential equations</td>
</tr>
<tr>
<td>Physics 211 (4 hrs)</td>
<td>Univ. Physics, Mechanics</td>
<td>Phys 170 and L (5 hrs)</td>
<td>General Physics I</td>
</tr>
<tr>
<td>Physics 212 (4 hrs)</td>
<td>Univ. Physics, Elec. &amp; Magnetism</td>
<td>Phys 272 and L (4 hrs)</td>
<td>General Physics II</td>
</tr>
<tr>
<td>Physics 213 (2 hrs)</td>
<td>Univ. Physics, Thermal Physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics 214 (2 hrs)</td>
<td>Univ. Physics, Quantum Phys</td>
<td>Phys 274 (3 hrs)</td>
<td>General Physics III</td>
</tr>
<tr>
<td>Chem. 102/103 (4hrs)</td>
<td>General Chemistry and Lab</td>
<td>Chem. 161 and L, and Chem. 162 (7 hrs)</td>
<td>General Chemistry</td>
</tr>
</tbody>
</table>
### Advanced Mathematics REQUIRED COURSES

<table>
<thead>
<tr>
<th></th>
<th>9 hrs</th>
<th>UH</th>
<th>3 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U of Illinois</strong></td>
<td>Math 213 (3 hrs)</td>
<td>Intro. Discrete Math</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Math 415 (3 hrs)</td>
<td>Linear Algebra</td>
<td>Math 307</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Also counted in basic math. So the credit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hours are not counted here.</td>
</tr>
<tr>
<td><strong>ECE 413 (3 hrs)</strong></td>
<td>Probability with</td>
<td>EE 342 (3 hrs)</td>
<td>EE Probability and Statistics</td>
</tr>
<tr>
<td></td>
<td>Engineering Applications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Computer Engineering Core. REQUIRED COURSES
Courses stressing the fundamental computer engineering concepts and basic laboratory techniques which comprise the common intellectual understanding of all computer engineering. The main difference is that U. Illinois has more emphasis on microprocessors (ECE 385 and ECE 390) and UH EE Computer Track has more emphasis on VLSI computer circuit design (EE 366). Though the U. Illinois has more emphasis on microprocessors, the UH curriculum covers the essential topics in microprocessors in EE 361 including the topics of instruction set architecture, microprocessor organization, machine programming, assembly language, and I/O. Also, the EE 361L laboratory has assignments covering micro-controllers, an important class of microprocessors.

UH EE Computer Track has additional courses that are upper division requirements for EEs: EE 315 (Signals and Systems), EE 323 and Lab (Microelectronics circuits I and Lab), EE 496 (Senior Capstone Design). Note that the total credit hours for UH EE Computer Track (minus the EE 315, EE 323 and L, and EE 496) is 34 hours, which is the same credit hours as the U. Illinois.

<table>
<thead>
<tr>
<th>U of Illinois</th>
<th>34 hours</th>
<th>UH</th>
<th>44 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 110 (4 hrs)</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>EE 211 (4 hrs)</td>
<td>Basic Circuit Analysis I</td>
</tr>
<tr>
<td>ECE 190 (4 hrs) or ICS 125 (4 hrs)</td>
<td>Intro to Computer Systems or Introduction to Computer Science</td>
<td>EE 160 (4 hrs)</td>
<td>Programming for Engineers</td>
</tr>
<tr>
<td>ECE 210 (4 hrs)</td>
<td>Analog signal processing</td>
<td>EE 213 (4 hrs)</td>
<td>Basic Circuit Analysis II</td>
</tr>
<tr>
<td>ECE 329 (3hrs)</td>
<td>Introduction to Electromagnetic Fields</td>
<td>EE 371 (3 hrs)</td>
<td>Engineering Electromagnetics I</td>
</tr>
<tr>
<td>ECE 385 (2 hrs)</td>
<td>Digital Systems Lab</td>
<td>EE 260 (4 hrs)</td>
<td>Introduction to Digital Design</td>
</tr>
<tr>
<td>ECE 290 (3 hrs)</td>
<td>Introduction to Computer Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECE 390 (3 hrs)</td>
<td>Computer Engineering II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECE 411 (4 hrs)</td>
<td>Computer Organization and Design</td>
<td>EE 361 and L (4 hrs)</td>
<td>Digital Systems and Computer Design</td>
</tr>
<tr>
<td>ECE 440 (3 hrs)</td>
<td>Solid State Electronic Devices</td>
<td>EE 324 (3 hrs)</td>
<td>Physical Electronics</td>
</tr>
<tr>
<td>CS 224 (4 hrs)</td>
<td>Data Structures and Software Principles</td>
<td>EE 367 and L (4 hrs)</td>
<td>Computer Data Structures and Algorithms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE 366 (4 hrs)</td>
<td>CMOS VLSI Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE 315 (3 hrs)</td>
<td>Signal and System Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE 323 and L (4 hrs)</td>
<td>Microelectronics Circuits I and Lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE 496 (3 hrs)</td>
<td>Senior Capstone Design</td>
</tr>
</tbody>
</table>
## Technical Electives

<table>
<thead>
<tr>
<th><strong>U of Illinois</strong></th>
<th>21 hrs</th>
<th><strong>UH</strong></th>
<th>19 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved basic science course (3 hrs)</td>
<td></td>
<td>4 EE Technical Electives (13 hrs) = 2 Computer Track TEs + EE Elective + Lab + Technical Elective</td>
<td>Upper division EE technical electives</td>
</tr>
<tr>
<td>Any non-required ECE or CS course (18 hrs)</td>
<td></td>
<td>Engr. breadth (e.g., CEE 270 or ME 311) (3 hrs)</td>
<td>Technical courses to broaden engineering knowledge. It can be CEE 270, ME 311, or a science course from an approved list.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE 296 and 396 (3 hrs)</td>
<td>Sophomore and junior project courses</td>
</tr>
</tbody>
</table>

## Credit Hour Analysis

The credit hour analysis does not include general university and college requirements such as humanities, economics, and social sciences, etc.

<table>
<thead>
<tr>
<th></th>
<th>University of Illinois Comp E</th>
<th>U. Hawai‘i EE Comp Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Science and Math and Advanced Math</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>Computer Engineering Core</td>
<td>34</td>
<td>44</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>102</td>
</tr>
</tbody>
</table>
Appendix D. Approval for BSCE Students to take ICS Course from the Department of Information and Computer Sciences
Letter from Martha E. Crosby dated March 23, 2007:

University of Hawaii at Manoa
Department of Information and Computer Sciences
1680 East West Center Road, POST 317
Honolulu, Hawaii 96822
phone: (808) 956-3500 • fax: (808) 956-3548
Dr. Martha E. Crosby
e-mail: crosby@hawaii.edu

March 23, 2007

Dr. Galen H. Sasaki, Chair
Department of Electrical Engineering
Holmes Hall Room 436
2540 Dole Street
Honolulu, HI 96848-1711

Dear Dr. Sasaki:

The Department of Information and Computer Sciences (ICS) would like to collaborate with the Department of Electrical Engineering (EE) to offer a Bachelor of Science Degree in Computer Engineering (BSCE). The ICS faculty agrees that the BSCE degree should be offered through the College of Engineering. As you know, ICS voted unanimously to let BSCE students enroll in our discrete mathematics courses (ICS 141 and ICS 241) in May of 2005. For the current proposal, the ICS faculty voted unanimously to allow BSCE students to take any ICS upper division courses (suitable to the BSCE curriculum) as their technical electives. The ICS faculty realizes that BSCE students will have different introductory programming needs than ICS students; however, we want to ensure that BSCE students will have enough programming experience to adequately prepare for the ICS upper division courses. Thus, we request that the BSCE students take enough lower division EE courses to cover the information taught in the introductory ICS programming classes (ICS 111, ICS 211 and ICS 212).

Sincerely,

[Signature]

Martha E. Crosby
Professor and Chair

23
Appendix E. Proposed Computer Engineering Curriculum

The curriculum is modified from the Computer Track EE Curriculum described in Appendix A, except that ICS 141 replaces 3 credit hours of EE Technical Electives.

Design Experience Statement

A key aspect of electrical 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 Electrical Engineering curriculum assigns design credits to each course (see design credits). 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 adviser 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 Projects course and two credits of EE 396, Junior Projects course. The project courses help students in getting design experience outside the classroom as they learn engineering concepts in the classroom. The project courses prepare the students for EE 496, the capstone design project. 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.

Bachelor’s Degree

The BS degree program requires a minimum of 122 credit hours. (Note that the University requires 124 credit hours for a bachelor’s degree.) The departmental requirements consist of 51 credit hours of basic courses and 20 credit hours of technical electives.

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

College Requirements

See Appendix A for the College requirements.

Departmental Requirements

Students must complete a total of 71 credit hours including the following:

- EE 160 Programming for Engineers (4)
- EE 211 Basic Circuit Analysis I (4)
- EE 213 Basic Circuit Analysis II (4)
- EE 260 Introduction to Digital Design (4)
- EE 315 Signal and System Analysis (3)
- EE 323 Microelectronic Circuits I/Lab (3/1)
- EE 324 Physical Electronics (3)
- EE 342 EE Probability and Statistics (3)
- EE 361 Digital Systems and Computer Design (3/1)
- EE 366 CMOS VLSI Design (4)
- EE 367 Computer Data Structures and Algorithms (3/1)
- EE 371 Engineering Electromagnetics I (3)
- PHYS 274 General Physics III (3)
- Engineering Breadth* (3)
- ICS 141 Discrete Mathematics for Computer Science I (3)
- MATH 307 Linear Algebra and Differential Equations (3)
- Projects (6)
- Technical electives* (9)

* 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.

** Technical electives are from EE 344, 449, 461, 467, 468, 469, 491 (E,F,G).

**Projects**

There is a requirement of EE 296, EE 396, and EE 496, which is the capstone design experience. A minimum of, respectively, 1, 2, and 3 credits are required of each.
Appendix F1. 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

Lab bench equipment

Classroom
EE Intermediate Circuits Laboratory: Holmes Hall 358

Courses
- 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

Lab bench equipment

Classroom
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
Lab bench equipment  Classroom
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 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

- **4 each** Pentium 4 Processor 3.0GHz, 512MB PC1200 SDRAM
  - LCD Flat Panel Display
  - MS Windows2000
  - Matlab, OfficeXP, PowerLAN X-Windows, Adobe Acrobat, MS Visual Studio .Net, Agilent ADS, OrCAD PSpice, Routetrisim, 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
and many more...

Lab monitor desk in foreground and SUN workstations in top center

Lab computers
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

Equipment on a lab bench

View of the lab room
Photonics and Optics Laboratory: 

Courses
- EE 372L Engineering Electromagnetics Lab (1 3-hr Lab) This undergraduate laboratory is the supporting laboratory for EE 372 Engineering Electromagnetics II: Photonics and Optics, having 10 experiments, introducing students to the most recent optical technologies currently used in communications, sensors research, and the photonics industry. Pre-requisites: 371 and PHYS 274 (or concurrent); or consent. Co-requisite: 372.

Equipment
- Capacity of 18 students (6 benches, with 2-3 students per bench)
- Lab bench equipment
  - HeNe laser with laser driver and mount
  - 1” lens kit
  - Polarizers and wave plates
  - Prisms
  - Mirrors
  - Testing tank
  - Optical mounts: posts and post holders, lens holders, kinematic mirror mounts, base plates, rotation stages, micrometer translation stages, fiber chucks and holders, mounting hardware
- Other equipment
  - Lock-in amplifier
  - 100m of multi-mode optical fiber
  - Spectrum analyzers with software
  - AO modulator and driver
  - Optical collimator
  - UV filter
  - Laser diodes
Physical Electronics Laboratory (PEL):
Holmes Hall 448, 449, 458

Courses

- EE 328L Physical Electronics Lab. Hands-on laboratory where students make various electronic devices using IC technology. Devices are also tested and analyzed. Laboratory course for EE 328.

Equipment

- Capacity of 12 students
- Equipment
  - Wet Chemistry Fumehoods (3)
  - Thermal Evaporators (2)
  - Thermal Furnaces (10 tubes)
  - Photolithography Equipment
    - Photoresist Spinner
    - Mask Aligners (2)
    - Hard Bake and Soft Bake ovens (1 ea.)
  - Inspection Microscopes (3)
  - Sputtering Systems (2)
  - Semiconductor Parameter Analyzer
  - Probe Stations (2)
  - Signal generators
  - PCs (6)
Appendix F2. 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
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.
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 calculation 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 source code, 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.
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 Enterprise Edition
- Windows Vista Business
Research

- Innovative Computation Laboratory does research in dynamic programming optimization tools, Petri net simulation software and reconfigurable computer architecture.
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.
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
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 432: 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).
- **MPII**
  - MPICH v1.2.5.
- **FORTRAN**
  - Intel Fortran Compiler 8.1.