Executive Summary

The department of computer science at the University of Hawaii – Hilo is a small and productive program that provides a high quality education to its undergraduate students. The program review provided an opportunity for the department to review its current standing, mission, and results. The following are major results from the period of self-study undertaken by the department as part of this process:

- The computer science department performs well by assessment measures such as MFAT and national competitions such as the ACM ICPC and Microsoft’s Imagine Cup.
- Students and alumni are pleased with the education provided by the computer science department. The department does a good job of preparing them for their future careers and studies.

While the department has largely been successful in fulfilling its core mission, the self-study and identified several challenges faced by the department. The following are:

- The department’s operating budget has significantly decreased from its 2010 levels (from approximately $30,000 to $8,600). The operating budget generally does not meet the day-to-day needs of the department, and updating the equipment in the labs is impossible under these funding levels. Lab updates tend to come from various administrative units on an irregular basis, but need to be on a more regular cycle in order to keep equipment current.
- The department will need time and resources (e.g. course releases) to develop curriculum to support proposed programs in Digital Media Art, Data Science and perhaps Health Informatics.
- The department needs to revise its courses for non-majors to use standardized materials and to meet more general education requirements.

The program reviewer (Dr. Kim Bruce) came away from this study “very impressed with the quality of education offered by the department, especially given the financial constraints”. The two major issues found by the reviewer were the budgetary problems mentioned above and the replacement of the vacant instructor position so that “the department can maintain the present high standards and effectiveness”.

In conclusion, the computer science department should be able to continue to maintain its quality and standing given appropriate resources from the university, effort from its faculty, and leadership from the administration.
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Error! Bookmark not defined.
Chapter 1: Background

This section of the document focuses on the overall mission of the computer science department, the objectives that support this mission. It also discusses how the department’s mission fits within the mission of the University of Hawaii – Hilo, the overall University of Hawaii system and the State of Hawaii. It also discusses how the department’s missions fit with national needs.

A. What is our Mission?

The mission of the Computer Science Department at the University of Hawaii – Hilo is twofold. As stated in the university catalog entry for the department\(^1\):

“The mission of the Computer Science Department is to:

- Educate computer science majors in a rigorous B.S. degree program so that graduates are prepared to enter high quality technical professional positions or go on to graduate programs.
- Provide a computer education that serves the needs of various student components of the University.”

In the following subsections, we explore how the department meets this mission statement through the goals for student learning in the subject and special features of the computer science program.

The department reaffirmed these missions during the January 16, 2017 meeting by an 8-0-0 vote.

i. Mission 1: Educate computer science majors in a rigorous B.S. degree program so graduates are prepared to enter high quality technical professional positions or go on to graduate programs.

The Bachelor of Science degree in computer science is designed to prepare students for success as computer science professionals. Students graduating from this degree program should be able to apply their knowledge to a specific design problem, including detailing the specifications, analyzing the problem and providing a design and implementation that functions as desired. The implementation should have satisfactory performance, meet desired cost criteria and be reliable and maintainable.

Furthermore, a broad background in the humanities and social sciences along with a course emphasizing professional ethics (cs495) provide students with a basis for understanding the societal implications of work performed within the field. In addition to preparing students for jobs in the technical industry, the program also helps to prepare students for graduate studies in computer science.

The learning outcomes for the program\(^2\) further support this goal, namely:

**Outcome 1:** Understand classical algorithmic processes and data structures and be able to perform simple analysis of algorithms

**Outcome 2:** Be proficient in one high-level programming language and have basic skill levels in a variety of programming languages

---

1. [https://hilo.hawaii.edu/catalog/computer-science](https://hilo.hawaii.edu/catalog/computer-science)
2. See program learning outcomes (Appendix 3 of this document).
Outcome 3: Understand the basics of logic design and computer organization and be aware of multiple architecture approaches and numerical limitations

Outcome 4: Be competent in techniques of discrete mathematics and understand the theoretical foundations of computing

Outcome 5: Understand the steps of the software development process and the activities/products appropriate to each

Outcome 6: Know the major issues in the design and implementation of major computing artifacts such as operating systems, programming languages, graphical user interfaces or systems programming, and databases, networks, or compilers

Outcome 7: Be able to adapt to changing development platforms and design/implementation tools

Outcome 8: Communicate effectively on technical matters in both oral and written forms, work well within a team, and understand the social/ethical issues of computing

ii. Mission 2: Provide a computer education that serves the needs of various student components of the University.

In addition to the offerings for students majoring in computer science, the department also offers a suite of “service courses” for non-computer science majors to help meet this second part of the mission. These courses are designed to enhance student ability to use computer technology. In particular, these courses help students to become competent in using up-to-date software (e.g. the latest edition of Microsoft Office) and to apply these software tools in a problem-solving environment (e.g. creating business presentations).

B. How does the department’s mission fit within UH-Hilo and the UH System?

The following subsections document how the mission statement for the computer science department supports the larger missions of the University of Hawaii – Hilo, the University of Hawaii system, the state of Hawaii, and the overall national picture.

i. UH-Hilo’s Mission

The University of Hawaii at Hilo’s current strategic plan (2011-2015) states the following as the primary mission of the university:

“The purpose of our university ’ohana/family is to challenge students to reach their highest level of academic achievement by inspiring learning, discovery and creativity inside and outside the classroom. Our kuleana/responsibility is to improve the quality of life of the people of Hawai’i, the Pacific region and the world.”

The computer science department’s mission supports the mission set forth in UH-Hilo’s strategic plan by offering a high quality undergraduate program that prepares students for careers that help to improve the quality of life for the people of Hawaii. The department’s low student to faculty ratio encourages hands on learning, discovery, and creativity through close faculty-student interaction.

3 The 2011-2015 strategic plan can be found at: https://hilo.hawaii.edu/strategicplan/2011-2015plan.php. The next version of the strategic plan is in progress at the time of this writing. https://hilo.hawaii.edu/strategicplan/
University of Hawaii Strategic Directions

The University of Hawaii System’s Strategic Directions for 2015-2021\(^4\) builds upon the Strategic Outcomes and Performance Measures from 2008-2015\(^5\). The computer science program at UH-Hilo helps to support the following goals for the system\(^6\):

**Hawaii Graduation Initiative (HGI) Goal:** Increase the educational capital of the state by increasing the participation and completion of students, particularly Native Hawaiians, low-income students and those from underserved regions and populations and preparing them for success in the workforce and their communities.

**Hawaii Innovation Initiative (HI2) Goal:** Create more high-quality jobs and diversify Hawai‘i’s economy by leading the development of a $1 billion innovation, research, education and training enterprise that addresses the challenges and opportunities faced by Hawai‘i and the world.

In particular, the department’s mission of preparing students for high quality technical professional positions align well with these initiatives. Students who prepare for graduate programs also generally assist with the second mission’s focus on research. Finally, by helping to prepare all majors in the use of computer technology, the department helps to increase the capacity of all individuals to take part in a diversified economy that is now more dependent upon computational and algorithmic thinking.

**State of Hawaii’s Mission**

The Hawaii State Department of Education’s mission states:

“We serve our community by developing the academic achievement, character and social-emotional well-being of our students to the fullest potential. We work with partners, families and communities to ensure that all students reach their aspirations, from early learning through college, career and citizenship.”

Likewise, Governor Ige’s Priorities for Hawaii lists education as a top priority and indicates an intent to:

“Empower our public schools and university, focus on 21st century skills and learning, and ensure schools provide a healthy and safe learning environment.”

The State’s Office of Enterprise Technology Services also identifies IT workforce development as a critical priority for efficient government within the state\(^9\).

Given the state’s focus on educating its citizens, building its technology capabilities and the jobs that available in these fields, the computer science department’s mission statement is well aligned with the State of Hawaii’s goals.

\(^4\) [http://blog.hawaii.edu/strategicdirections/files/2015/01/StrategicDirectionsFINAL-013015.pdf](http://blog.hawaii.edu/strategicdirections/files/2015/01/StrategicDirectionsFINAL-013015.pdf)
\(^5\) [http://hawaii.edu/offices/aa/performance_measures.html](http://hawaii.edu/offices/aa/performance_measures.html)
\(^6\) The other two goals relate to maintenance of buildings and financial viability for the UH system.
\(^7\) [http://www.hawaiipublicschools.org/ConnectWithUs/Organization/Mission/Pages/home.aspx](http://www.hawaiipublicschools.org/ConnectWithUs/Organization/Mission/Pages/home.aspx)
\(^8\) [http://governor.hawaii.gov/governor-david-iges-priorities-for-hawaii/](http://governor.hawaii.gov/governor-david-iges-priorities-for-hawaii/)
\(^9\) [https://my.sharplcloud.com/html/#/story/8b84ceb8-114a-484b-9f0f-75798e69a100/view/4da3c8b2-1856-4f6d-b463-f05438e382da](https://my.sharplcloud.com/html/#/story/8b84ceb8-114a-484b-9f0f-75798e69a100/view/4da3c8b2-1856-4f6d-b463-f05438e382da)
National Picture

According to the Bureau of Labor Statistics, “Employment of software developers is projected to grow 17 percent from 2014 to 2024, much faster than the average for all occupations. Employment of applications developers is projected to grow 19 percent, and employment of systems developers is projected to grow 13 percent. The main reason for the rapid growth in both applications developers and systems developers is a large increase in the demand for computer software.”

There are also strong job growth prospects for the areas of Computer System Analysts, Database Administrators, and Information Security Analysts.

Again, the computer science department’s mission statement with its focus on preparing students to enter high quality technical professional positions matches well against the continued need and job growth for technical positions at the national level.

Setting the Plan into Action

The computer science department’s Bachelor of Science program is a strong professional program designed to prepare students for the high-technology workforce. As stated in the preceding subsections, this is a key component of the workforce for both the State of Hawaii and the United States.

In addition, the service courses offered by the department emphasize skills such as critical thinking and the appropriate use of technology that help to develop fluency in information technology for all students regardless of their chosen field.

Furthermore, utilization of unique geographical resources as a natural laboratory receives quite a bit of emphasis at the University of Hawaii – Hilo. The department also does well in aligning its research interests with the unique aspects of Hawaii. In particular, the department has worked on projects involving mitigation of impacts caused by natural hazards present within the state as well as modeling aspects of the state’s biological diversity.

Finally, the physical isolation and fragile ecosystem of the Big Island necessitate developing industries that can be competitive with minimum reliance on the shipment of goods and that help to preserve the unique environment here. In these regards, software development and other technology related fields are appropriate industries. The computer science program can assist this development by providing the educated workforce that is required by these industries.

10 https://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm#tab-6
Chapter 2: Program Orientation and Performance

This section discusses the program efficiency indicators (e.g. SSH) and how the department has structured its curriculum to meet program goals from section 1 of this document.

Program Efficiency Indicators

Course Enrollment and Student Credit Hours

The number of computer science majors by semester is shown in Figure 1. The years from 2010 – 2016 constitute this program review and show a steady enrollment in the program on a yearly basis. The lower numbers from 2005-2006 and 2006-2007 represent the tail end of students who enrolled after the dot.com bust. For reference, the number in 2003 who had enrolled prior to this event was 12411. The department also has a small number of minors that averages around 5 per year.

![Graph: CS Majors by Year](image)

**Figure 1 – Number of Computer Science Majors**

Figure 2 shows the student semester hours taught by the department for the years 2003-2010. The years from 2010 – 2016 constitute this program review and show a steady amount of SSH taught by the department. The figures for fall 2010 are an anomaly since Dr. Sevki Erdogan was on sabbatical without a replacement.

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11 See program review from Computer Science Program Review for the University of Hawaii Hilo from December 2010.
Figure 2 – Number of SSH taught by the computer science faculty

A critical challenge for the department is to continue to generate SSH in light of changing general education requirements and a reduction in the number of instructors dedicated to the department (from 2 to 1 in 2013 and from 1 to 0 beginning in Fall 2017). In particular, these changes have caused the percentage of SSH generated by majors to go from 34.5% to 60.1% during the study period\textsuperscript{12}.

In particular, CS100 (Principles of Computer Science) and CS101 (Digital Tools for the Information World) have declined in the number of sections due to students coming to university with greater perceived knowledge of computers and their applications. CS200 (Web Technology) and CS135 (Animation Programming) have had steady enrollment due to their general education designations of language arts and Hawaiian Pan-Pacific categories respectively. There has also been an uptick in the number of students taking CS150 (Introduction to Computer Science) since majors such as Physics & Astronomy and Engineering have begun to recognize computational thinking as a critical skill.

A new registration system (GPS\textsuperscript{13}) that suggests electives based on alphabetical order\textsuperscript{14} is not anticipated to assist the department in improving this number, although we are not in as dire a shape as Spanish or Women’s Studies due to the high placement of C in the lexicographic ordering of the English alphabet.

Faculty Distribution and Staffing Levels

The program review from 2002 pointed to the “faculty body count” being insufficient for the student credit load. During the period covered by the 2010 review, the department managed to stabilize its faculty ranks with the hiring of three new assistant professors. The tenure track positions have now been stable since 2009.

In the current period, staffing of the instructor positions have been less stable. With the departure of David Bishop in 2013, the administration decided not to transfer the position to the chemistry department. At the end of 2017, Barbara Meguro will retire, and there are no plans to replace her at this time. With the loss of these two positions, the department has had rely far more on sessional lecturers

\textsuperscript{12} See Appendix I
\textsuperscript{13} https://hilo.hawaii.edu/gps/
\textsuperscript{14} You can’t make this stuff up. Furthermore, they have also suggested basing elective choice on pass rate, which constitutes a race to the bottom.
to fill its non-majors courses. The 2017 retirement will be particularly difficult since there should be a full time faculty member who is responsible for overseeing the courses for non-majors.

With the loss of the two instructor positions, the department needs to hire a variety of lecturers to fill the sections that the instructors would ordinarily cover. Lecturer staffing is a continuous challenge since these positions are temporary and transient in nature. The university does not guarantee lecturers continuous employment, so it is difficult for lecturers to be loyal to the university should a full time position arise elsewhere. As a result, the chair needs to continuously recruit qualified individuals to the pool of lecturers and assure that all classes are covered while having to provide the bad news when classes are not available to lecturers.

Curricular Organization to Meet Program Goals

Goal 1: Educate Computer Science Students in a Rigorous B.S. Program

Students in the computer science program take 43 semester hours of required computer science courses plus 12 hours of computer science electives. (See the counseling materials in Appendix 2, for specific degree requirements.)

The required courses provide breadth across many different areas of computer science, such as algorithms, computer organization and architecture, data structures, theoretical foundations, programming languages, operating systems, and software engineering.

Elective courses such as graphical user interfaces, systems programming, database design, networks/data communication, compiler theory, graphics, data visualization, security and artificial intelligence, round out the students' computer science education.

In addition, students are required to take one year of physics, one year of calculus, a linear algebra class, and fulfill all other graduation requirements. Many computer science courses are heavily project-oriented, and integrate oral and written communication skills.

The materials in Appendix 3 tie specific learning objectives to individual core courses in our curriculum. This appendix has a Matrix of Program Outcomes and Courses as well as an assessment plan. There are also goals for ABET accreditation, which the department may undertake should resources become available.

Goal 2: Provide Computer Science Education that Serves the Various Needs of the University Community

The department has developed service courses in support of this goal. These courses are heavily laboratory-oriented, giving students considerable hands-on experience, which is consistent with the goal of emphasizing proficiency in the use of software as a problem-solving tool. These courses also emphasize critical thinking in the use of technology to solve a problem rather than rote picking-and-clicking to run an application.

The goal is to allow students in these courses to gain fluency in information technology, which ...entails a process of lifelong learning in which individuals continually apply what they know to adapt to change and acquire more knowledge to be more effective at applying information technology to their work and personal lives.
While the department still has other courses for non-majors in the catalog, these courses are currently offered and maintained by the department.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS100</td>
<td>Principles of Computer Science</td>
<td>A survey of the field of computer science, intended as a general education course.</td>
</tr>
<tr>
<td>CS101</td>
<td>Digital Tools for the Information World</td>
<td>Hands-on computer class with emphasis on producing professional-level documents, spreadsheets, presentations, databases and web pages for problem solving.</td>
</tr>
<tr>
<td>CS130</td>
<td>Beginning Graphics and Game Programming</td>
<td>Introduction to two-dimensional graphics and game programming: graphic elements, layers and simple animation; principles of game design and implementation.</td>
</tr>
<tr>
<td>CS132</td>
<td>Intro to Health Informatics</td>
<td>This introductory course will cover a broad range of topics relating to the area of health informatics and health care technology with a focus on standard and current software tools.</td>
</tr>
<tr>
<td>CS135</td>
<td>Animation Programming</td>
<td>An introduction to computer programming using animations developed with the Alice Programming Language. Has HPP certification for general education.</td>
</tr>
<tr>
<td>CS138</td>
<td>Introduction to Computing with Robots</td>
<td>An introduction to computer programming using robot kits and a high level programming language.</td>
</tr>
<tr>
<td>CS200-CS201</td>
<td>Web Technology I &amp; II</td>
<td>Introductory courses that focus on Web page authoring, client-side and server-side scripting.</td>
</tr>
<tr>
<td>CS300</td>
<td>Web Site Management</td>
<td>Advanced topics in web site administration. Issues covered include site management; security and content.</td>
</tr>
</tbody>
</table>

Table 1 – Frequently Offered Non Major Courses

Curricular changes in response to current scholarship, developments in the field, employment opportunities or service to community

The field of computer science is constantly evolving and requires changes as new knowledge, new teaching practices, and new technologies emerge. New textbooks, platforms, and technologies arrive every year. Furthermore, the relatively young age of the field often means changes in major theoretical principles as compared with older fields of study. Due to these constant changes, the computer science faculty exerts major individual efforts to keep classes current and up to date.

On a broader level, the B.S. program offered by the department meets nearly all of the knowledge areas from the ACM/IEEE Computer Science Curriculum 2013 standards.15

The table in Appendix 5 shows the core topics in this curriculum and the core topics covered by the courses in the department. In examining the curriculum coverage, the department could benefit from some more coverage of operating systems and networking technology. In addition, faculty member responsible for the security course is currently revising this course to include more hands-on activities

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that will hopefully make it more attractive for students to take as an elective. The department has also implemented a visualization course (CS475) that will be taught with marine science and art departments to support computational science. The department is currently hiring a new assistant professor in support of a cross disciplinary program in data science that will also help to support this area.
Chapter 3 – Student Learning

This section of the report deals with student educational outcomes and provides evidence in the forms of assessment measures and feedback from key stakeholders. In addition to these key measures, this section discusses innovative teaching practices within the department as well as other factors in student learning.

Assessment Measures of the CS Degree Program

MFAT Test Scores

The ETS® Major Field Achievement Test (MFAT) provides the best evidence for the educational outcomes of the computer science department students. The MFAT is a test developed and administered by the Educational Testing Service (ETS). According to ETS, the MFAT test is “a comprehensive undergraduate outcomes assessments designed to measure the critical knowledge and understanding obtained by students in a major field of study.”

The computer science department has administered this test to our junior and senior students every year since 1988. With the exception of 1994, the results of this assessment have been above the national norm as evidence by Figure 3 below.

Figure 3 – Major Field Achievement Test Results by Year

This activity of ongoing assessment promotes a culture of educational effectiveness and student success within the department. The computer science department is pleased with its students and their long-term performance on this important assessment measure.

The results from 2011-2016 show that UH-Hilo placed above the 50th percentile each year. The stabilizing trend toward the mean is likely due to the department having a more consistent number of upper division students for the past six years. While graduation numbers have held steady at a rate of 9 per year over the past two program review periods, the standard deviation for the number of graduates has decreased from 5 to 2.5 meaning that a more consistent number of students are taking the test each year.

The department is also teaching its junior and senior (upper division) courses on an annual basis. However, students are limited in the number they can take, so juniors taking the test tend not to perform as well as senior students.

Programming Team Activities
A final area of assessment for our students is their performance in national contests. Currently, UH-Hilo students participate in three–four major contests throughout the academic year. These contests involve various skills that the students learn in the computer science curriculum such as programming, problem solving, networking, security, and software engineering. In addition, these contests allow UH-Hilo to compare itself against the best institutions in the world.

IBM Master the Mainframe
The first of these is the IBM Master the Mainframe contest, which challenges students to learn the skills necessary to program large mainframe systems that still handle the bulk of accounting and inventory management tasks in Industry. UH-Hilo students have been successful in this contest with four students reaching the 3rd and final round since 2006 (Joshua Loving, Tinteru Jack, Kyle Cannoles, and John Evans). UH-Hilo students have also been successful in having the school represented as one of the top 50 sites worldwide in several of the past 12 years.

![Figure 4 – Master the Mainframe T-Shirts from 2010 and 2014](image)

ACM ICPC
The second contest is the Association for Computing Machinery (ACM) Intercollegiate Programming Contest (ICPC). UH-Hilo has taken part in this contest since 2004. The results for each year are shown in Table 2.

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17 Sorry IBM, Hilo is not in Ohio (2010 Shirt).
<table>
<thead>
<tr>
<th>Year</th>
<th>Problems Solved</th>
<th>Overall Standings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Team A – 2 Team B - 1</td>
<td>1st in Hawaii Site Competition</td>
</tr>
<tr>
<td>2005</td>
<td>Team A – 0 Team B - 0</td>
<td>Tied 2nd in Hawaii Site Competition</td>
</tr>
<tr>
<td>2006</td>
<td>Team A – 3 Team B - 3</td>
<td>2nd &amp; 3rd Place in Hawaii Site Competition</td>
</tr>
<tr>
<td>2007</td>
<td>Team A – 3 Team B - 2</td>
<td>1st Place &amp; 2nd Place Hawaii Site Competition</td>
</tr>
<tr>
<td>2008</td>
<td>Team A – 5 Team B – 2 Team C - 1</td>
<td>1st Place &amp; 3rd Place Hawaii Site Competition</td>
</tr>
<tr>
<td>2009</td>
<td>Team A – 5 Team B – 4 Team C - 1</td>
<td>1st Place &amp; 3rd Place Hawaii Site Competition</td>
</tr>
<tr>
<td>2010</td>
<td>Team A – 4 Team B – 1 Team B - 1</td>
<td>1st Place &amp; 3rd Place Hawaii Site Competition (17th in Pacific Northwest Region)</td>
</tr>
<tr>
<td>2011</td>
<td>Did Not Compete</td>
<td>N/A</td>
</tr>
<tr>
<td>2012</td>
<td>Team A – 3 Team B - 3</td>
<td>3rd &amp; 6th Place Hawaii Site</td>
</tr>
<tr>
<td>2013</td>
<td>Team A – 4 Team B – 3 Team C - 2</td>
<td>3rd &amp; 7th Place Hawaii Site</td>
</tr>
<tr>
<td>2014</td>
<td>Team A – 1 Team B - 0</td>
<td>2nd &amp; 3rd Place Hawaii Site Division I</td>
</tr>
<tr>
<td>2015</td>
<td>Team A – 3 Team B – 3</td>
<td>3rd Place Hawaii Site Division I 5th Place Hawaii Site Division II</td>
</tr>
<tr>
<td>2016</td>
<td>Team A – 2 Team B - 3</td>
<td>2nd Place Hawaii Site Division I 1st Place Hawaii Site Division II</td>
</tr>
</tbody>
</table>

Table 2 – UH-Hilo Performance in the ACM ICPC by year.

Figure 5 – ACM ICPC Trophies in CH-11

The contest scores from the program review period (2010-2016) reflect the consistency of the other metrics with students solving 2.35 problems as a mean average with 3 being the median and mode. The Hawaii site contest has become harder in recent years due to cutbacks in funding that prevent UH-Hilo
from entering the same number of teams as the Oahu schools. It should also be noted that HPU has a dedicated class devoted to the contest and does not have the same fundraising burden as UH-Hilo\textsuperscript{18}.

\textit{Microsoft Imagine Cup}

The Microsoft Imagine Cup is an annual competition that has students put together software engineering projects to “help solve the world’s toughest problems”. The contest is far more business oriented than the ACM ICPC or Master the Mainframe. Students need to produce a working software product, pitch video, and a business plan. Finalists go on to compete in a co-located contest that is structured similar to a business competition. Students present elevator pitches, give formal business presentations, and take part in booth demonstrations for a host of judges.

UH-Hilo has done exceedingly well in the years that it has entered the contest with the team of Ryder Donahue, Wallace Hammada, Kayton Summers, and Mike Purvis capturing the US National Championship in 2013. The team went to Russia where they were in a tight competition for 3\textsuperscript{rd} place in the world citizenship category.

\textbf{Figure 6 – Team Poliahu at their Booth in St. Petersburg, Russia (Wallace Hamada, Mike Purvis, Ryder Donahu, Kayton Summers)}

In 2015, Theodore DeRego, Lucas DeRegro, and Brian Hall won the Pitch video contest for their video game entry ReForge. In 2016, the team of Pauleen Pante, Bryson Fung, Anthony Vizzone, and Reuben Tate garnered an entry into the 2016 US National Finals with their application for restoring ecosystems using native and non-invasive plants.

\textsuperscript{18} UH-Hilo needs to undertake Interisland Travel, pay for lodging and ground transportation at a cost of approximately $2000 per year raised by students in the program.
<table>
<thead>
<tr>
<th>Year</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>US National Champions for Help Me Help Application Honorary Mention World Finals (St. Petersburg, Russia)</td>
</tr>
<tr>
<td>2015</td>
<td>1st Place US Pitch Video Contest Games Category (ReForge)</td>
</tr>
<tr>
<td>2016</td>
<td>US National Finals – World Citizenship Category (Restoring Ecosystems Services Tool)</td>
</tr>
</tbody>
</table>

The majority of the students (9 out of 11) involved in these contests have gone on to high paying jobs in the tech industry.

Other Contests

The department takes part in other contests on a more ad-hoc basis. The NYU-Polytechnic Capture the Flag (CTF) contest is a worldwide contest that focuses on developing security skills. In 2009, the UH-Hilo computer science department placed 8th worldwide and was invited to New York City to participate in the World Finals. In 2010, UH-Hilo placed 10th worldwide amongst undergraduate teams, but was unable to obtain funding to participate in the World finals. The department also participate in 2012 and 2016.

Google Code Jam is an international programming contest hosted by Google. In 2015, Reuben Tate placed in the Top 1% of all entrants. Theodore DeRego had also had an excellent performance that helped him land a job at Google.

Finally, Mike Purvis created the winning entry in the 2013 Pearson Coding Contest garnering UH-Hilo a 2nd National Championship for that year.

CRA CERP Results (Data Buddies)

The 2016 Computer Research Association Center for Evaluating the Pipeline (CRA CERP) Data Buddies report shows minimal differences between UH-Hilo Students and their national co-hort. Important differences are the number of students who have attended community college (48% UHH vs. 14% average) and those who receive financial support from their families (22% UHH vs 72% national average).

The reports show that students view themselves positively, feel a sense of community and receive good support from both the department and from their peers. Students would recommend taking computing courses at UH-Hilo to their friends (4.43 mean average on a 5 point Likert Scale) and are glad they chose to study computing (4.63 on a 5 point Likert Scale).

Feedback from Stakeholders

The University of Hawaii-Hilo is located in a predominately rural environment with limited high tech employment opportunities. As a result, most of UH-Hilo computer science graduates find employment or attend graduate school elsewhere in the state or on either side of the Pacific. Because of this geographical scattering, there is no single employer or graduate school that draws our students more than any other. Hence, it is impossible to identify any key stakeholder as a primary employer of our graduates.

Recent UH-Hilo computer science graduates have been employed by Microsoft, Google, Hawaii DoE, Taos Consulting, U.S. Department of Defense, HFS Federal Credit Union, Mercury Defense Systems, iFit, Amazon Web Services, Canada France Hawaii Telescope, Gemini Observatory, Rackspace, Philips
Research, the University of Hawaii at Hilo, and the U.S. Air National Guard amongst other locations. UH-Hilo computer science graduates have gone on to attend graduate school at Boston University, Georgia Tech University, University of Illinois at Urbana-Champaign, Masters University, Carnegie Mellon, the University of Hawaii-Manoa, Colorado State University, the University of Arizona, North Carolina State and the University of Washington amongst others.

Alumni Survey Results

The department conducted an alumni survey, which was completed by 50 former students, which represents a return rate of 74.6% from the 67 surveys that were sent out by the department. Almost all of them are working in the CS field with job titles such as Database Engineer, Engineering Director, enterprise Architect, Operations Research Systems Analyst, IT Specialist, or Computational Bioinformatics Scientist. The plurality are employed as System Engineer /Software Engineer. There are also several who are currently engaged in graduate studies or in the educational field.

In addition to demographic data, the survey also had the alumni rate several key aspects of the program using a 5-point Likert Scale. The results of this survey are shown below in Table3. As can be seen from this table, alumni were pleased with the overall education they received at UH-Hilo with a rating average of 4.55 on a 5-point scale with the mode average being excellent. Alumni were positively poised about all aspects of the program.
<table>
<thead>
<tr>
<th>Question</th>
<th>Poor</th>
<th>Below Average</th>
<th>Average Above Average</th>
<th>Excellent</th>
<th>N/A</th>
<th>Total</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you rate your overall CS education at UHH?</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>2.13% (1)</td>
<td>40.43% (19)</td>
<td>57.45% (27)</td>
<td>0.0% (0)</td>
<td>47</td>
</tr>
<tr>
<td>How well prepared were you for your initial position or grad school?</td>
<td>2.13% (1)</td>
<td>2.13% (1)</td>
<td>17.02% (8)</td>
<td>29.79% (14)</td>
<td>31.91% (15)</td>
<td>17.02% (8)</td>
<td>47</td>
</tr>
<tr>
<td>How well did the UHH CS curriculum develop your oral comm skills?</td>
<td>0.0% (0)</td>
<td>2.13% (1)</td>
<td>31.91% (15)</td>
<td>51.06% (24)</td>
<td>10.64% (5)</td>
<td>4.26% (2)</td>
<td>47</td>
</tr>
<tr>
<td>How well did the UHH CS curriculum develop your written comm skills?</td>
<td>0.0% (0)</td>
<td>6.38% (3)</td>
<td>25.53% (12)</td>
<td>42.55% (20)</td>
<td>23.40% (11)</td>
<td>2.13% (1)</td>
<td>47</td>
</tr>
<tr>
<td>How well did the UHH CS curriculum help you improve your problem solving skills (analysis &amp; critical thinking)?</td>
<td>0.0% (0)</td>
<td>2.13% (1)</td>
<td>2.13% (1)</td>
<td>40.43% (19)</td>
<td>55.32% (26)</td>
<td>0.0% (0)</td>
<td>47</td>
</tr>
<tr>
<td>How would you rate the overall CS department teaching quality during your matriculation?</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>8.51% (4)</td>
<td>36.17% (17)</td>
<td>55.32% (26)</td>
<td>0.0% (0)</td>
<td>47</td>
</tr>
<tr>
<td>Significance?</td>
<td>Not at all</td>
<td>Slightly</td>
<td>Somewhat</td>
<td>Moderately</td>
<td>Highly</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>How significant was the software engineering course sequence in preparing you for your career?</td>
<td>2.13% (1)</td>
<td>4.26% (2)</td>
<td>19.19% (9)</td>
<td>27.66% (13)</td>
<td>38.30% (18)</td>
<td>8.51% (4)</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 3 – Alumni Survey Results.

In the qualitative portion of the survey, alumni were pleased with the interactions they had with fellow students and the faculty in the UH-Hilo computer science department. Many alumni felt that having a degree from the UH-Hilo computer science department gave them an advantage in the job market. Alumni also offered exceedingly positive feedback regarding the factors of the UH-Hilo computer science program that gave them an advantage in the job market:
“Well reputable CS program with a lot of talent coming out; gained a great deal of technical knowledge about several programming languages and what makes each different, so I can pick up on new languages faster.”

“1. Work-study program allowed me to put into practice what I was learning in class 2. Software Engineering course delivered a working prototype that was put in use by the school, also provided practical experience 3. Professional prep course in Senior Year that helped with resume, interviewing skills helped.”

“The Imagine Cup was probably the biggest advantage I had going into the job market. Seeing 'Microsoft' on anyone's resume is a plus.”

“1. Breadth of knowledge. I feel adaptable enough to pick up any language needed as well as having a foundation to read most CS related academic papers. 2. Application of theory. Even though most of my work is more practical or development related, I feel like both an understanding of academic background as well as practical application of it honed my thinking about development.”

In addition to the positive feedback, the alumni offered several suggestions on improving the program. Common themes include having some more courses that focused on developing Unix skills, networking skills, and mobile development, and presenting code version control technology such as git.

**Student Survey Results**

In preparation for this program review, the department distributed formal surveys to undergraduate students between the fall 2016 and spring 2017 semesters. Though we distributed the survey to 83 current students, we only received feedback from 22 students for a low response rate of 26.5%. Feedback from 63 undergraduate students indicated a high degree of satisfaction with the program as evidenced by the results shown in Table 4. On a five point scale, students rated their education in the department as 4.56 (the mode was ‘Excellent’) and the quality of teaching within the department as 4.28 with an above average mode. They rated their overall education at UH-Hilo as 3.83, again with a mode category of above average.

<table>
<thead>
<tr>
<th>Question</th>
<th>Poor</th>
<th>Below</th>
<th>Average</th>
<th>Above</th>
<th>Excellent</th>
<th>N/A</th>
<th>Total</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Education at UH-Hilo</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>3.33% (6)</td>
<td>50.00% (9)</td>
<td>16.67% (3)</td>
<td>0.0% (0)</td>
<td>18</td>
<td>3.83</td>
</tr>
<tr>
<td>Overall Education in the CS Department</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>11.11% (2)</td>
<td>22.22% (4)</td>
<td>66.67% (12)</td>
<td>0.0% (0)</td>
<td>18</td>
<td>4.56</td>
</tr>
<tr>
<td>Overall Quality of Teaching in the CS Department</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>16.67% (3)</td>
<td>38.89% (7)</td>
<td>44.44% (8)</td>
<td>0.0% (0)</td>
<td>18</td>
<td>4.28</td>
</tr>
</tbody>
</table>

*Table 4 – Student Survey Results.*

Nearly all the student responses identified that studying within the program gave them improved problem solving skills:
“Every CS class covers various topics, problems, theories, methods, etc. that prepared me to tackle a variety of situations in real-life, CS and non-CS related.”

“CS courses are improving my analytical and critical thinking skills through case studies, assignments, and discussions that require the exercise and stretching of my problem-solving abilities.”

“CS by nature has us all problem solve things in different ways. We compare the most effective and efficient ways to solve problems. CS is based on this type of thinking so it has greatly improved my problem solving skills.”

“CS courses introduce me to new problems to solve and new ways to think about those problems. I’ve always been adept at problem solving, but these courses just keep honing that edge. I think more problem solving classes, like an algorithms courses dedicated to that sort of stuff, would be a wonderful addition to the program.”

Innovative Teaching Practices
The following subsections discuss innovative teaching practices in the computer science department.

Courses for CS Majors
Individual courses within the department have their own approach based on the instructor and the pedagogical features of the course. However, some global characteristics apply to CS courses as a whole, namely:

- Projects involving group and teamwork, particularly in upper division courses such as software engineering, architecture, and data mining.
- Flipped classroom with a lab focus in Numerical Analysis.
- Hands on class activities and assignments as opposed to a pure didactic lecture based approach.
- Use of modern tools within the constraints of our budget (Visual Studio.NET, Microsoft Project, Unity, R Studio, Pyton etc.)
- Heavy use of course management and content delivery systems such as Laulima\(^\text{19}\) and NoteBowl.
- Use of alumni and industry guest lecturers in the professional development course (CS495)
- Studio-based learning approaches such as Oregon Crits and Open Labs

Service Courses
In order to assist students in mastering the technologies that they encounter in these courses, the department has developed a wide variety of learning aids such as specialized laboratory manuals, carefully structured laboratory exercises, and tutorial files.

CS101 uses a role-playing model based around assigned roles in simulated shopping mall (MiniMall). Students take on different roles such as personnel management, marketing, and store manager. Students need to select and filter information appropriate to their role and to communicate this information as it relates to the operation of the mall. Students need to critically analyze the situations they encounter as part of this role-play and select the appropriate tool (e.g. Excel, Access) to apply to

\(^{19}\) Laulima is UH-Hilo’s implementation of the Sakai course management system (http://laulima.hawaii.edu).
the situation. This approach also provides a limited real world experience, which differs significantly from the standard textbook approach of teaching a skill through structured limited examples.

CS135 (Animation Programming) and CS138 (Robotics) both use studio-based approaches that allow students to use lab time to collaborate on projects and demonstrate those projects during class time for critique by other students and guests.

Other Factors in Student Learning

In addition to the three main sections above, the following factors contribute to student learning in the computer science department:

- Small class sizes. Computer science classes are typically capped at 22 students due to the size limitations of the labs.
- Faculty are highly available and are frequently on campus late into the evening. The computer science department’s late evening activity and weekend work is frequently recorded in campus security reports should the administration wish to verify this fact.
- The department has a strong advising program as evidenced by the materials presented Appendix 2 of this document.
- The students in the department have a strong sense of community.

Concerning the last point, upper division students and students working on research have their own lab space. Students receive their own keys to this space and can come and go as they please. Students take responsibility for the physical security and housekeeping of this area while the computer science department maintains the computer infrastructure.

Students in the upper division typically take classes with each other and spend long hours in the lab, which develops a strong sense of community. This camaraderie is also underscored in the 2016 CRA CERP Data Buddies results concerning students feeling a strong sense of community in the department (mean 4.10 out of 5.00).

The upper division lab was featured in a campus newspaper article as one of the best study hangouts on campus. The CH-13 lab also has its own Facebook group. Due to this camaraderie, students really do care about one another and take pride in being part of one of the most rigorous programs on campus.

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Chapter 4 - Current Resources

Faculty and Staff

The computer science department currently has 2 full professors, 3 associate professors, 1 instructor, 1 full time lecturer, and 4 part time lecturer. The department is currently searching for a full time assistant professor to assist with the development of an institutional data science program funded by EPSCoR.

In addition to the instructional staff, the department has 60% of an information technology (IT) specialist. This person is responsible for system administration, networking, installation, and maintenance of the department’s computer hardware and software infrastructure. The IT specialist also researches software and other products in response to instructional and research needs and manages the purchasing and budget maintenance for the department.

The department usually has a student assistant grader who assists with grading the labs various courses. From time to time, departmental research efforts such as EPSCoR and other grants may employ students to act as research assistants.

The Natural Sciences Division Office occasionally provides very minimal clerical support to the department, primarily in the form of processing personnel paperwork, formalizing schedules, and ordering textbooks. However, the department drafts most of its own clerical paperwork and sends it to support staff for formalization.

The department now has a far more stable basis from which to work. With this stable base, the department should be able to accomplish long-term goals such as ABET accreditation.

Funding

The computer science department receives an annual UHH General Fund budget assigned by the Natural Sciences Division (B Budget). The B Budget supports all operational costs such as:

- Office Supplies
- Software Subscriptions
- Course Note Duplication
- Spare Parts
- Software Licenses
- Hardware and Hardware Repair Costs
- Minor Facility Renovations

In some years, the B budget has supported small amounts of faculty research (e.g. conference fees, specialized software) and a small amount of student travel for special events (research conferences and contests).

Due to budget constraints, the B-budget has decreased from $22,000 in 2010 to $8,600 in 2015 and 2016. This level of B-Budget only allows the department to purchase essential supplies (paper, toner, office supplies, MFAT Forms, minimal interisland travel, and replacement parts). The department can no longer afford other expenses such as the aforementioned professional development fund, software licenses and replacement of lab computers.

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21 For reference, the budget in 2005 was $27,920 (see table on following page).
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>$41,300</td>
<td>31,709.00</td>
<td>76.78%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>$19,400</td>
<td>9,274.00</td>
<td>47.80%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>$27,920</td>
<td>8,219.00</td>
<td>29.44%</td>
</tr>
<tr>
<td>Geology</td>
<td>$17,300</td>
<td>10,897.00</td>
<td>62.99%</td>
</tr>
<tr>
<td>Marine Science</td>
<td>$24,300</td>
<td>20,371.00</td>
<td>83.83%</td>
</tr>
<tr>
<td>Math</td>
<td>$11,200</td>
<td>7,690.00</td>
<td>68.66%</td>
</tr>
<tr>
<td>Natural Science</td>
<td>$1,000</td>
<td>200.00</td>
<td>20.00%</td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursing</td>
<td>$12,100</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>Physics/Astronomy</td>
<td>$17,200</td>
<td>10,997.00</td>
<td>63.94%</td>
</tr>
</tbody>
</table>

Table 5— Historic B-Budgets

The current budget crisis was further exasperated by the discontinuation of the department’s RCUH fund, which was funded by the sale of course packs. The department used these course packs in lieu of standard textbooks for some of its non-majors courses (e.g. CS101, CS200). The course packs represented a substantial savings over traditional textbooks ($35 vs. $150) and generated approximately $5000 - $7000 per year.

Beginning in 2015, the CAS Dean’s Office mandated the discontinuation of the departments selling the course packs and required that the graphics department produce course packs for sale through the bookstore. The cost of the course packs rose to $100 as a result and students did not purchase them.

The department had used the RCUH funds to purchase computers and software (e.g. MS Office Licenses) used by these courses. As a result of discontinuing this funding mechanism, the department now has no way to replace its computers or upgrade its software. The purchase of new computer equipment and software for entire computer labs needs to occur every 4-5 years at the very least.

Given budgets that are now 27.7% of their 2000 levels, upgrading of the computer labs occurs in an ad hoc and unplanned manner. The department now relies on either the Natural Sciences Division, the CAS Dean’s Office, the VCAA’s Office or the Office of Technology and Distance Learning to upgrade computers and software when funding permits at the end of the fiscal year. Unfortunately, this policy means that there is no regular replacement of lab equipment and students often need to learn on outdated technology, particularly at the end of the hardware life cycle.

The past two program reviews and external reviews have raised this issue. However, nothing has been done to rectify the situation.

Space, Facilities, and Equipment
The department currently has several facilities dedicated to instruction and research: College Hall 7, College Hall 11, College Hall 12, College Hall 13, PB4-101, and PB22-Room 01. All classrooms are
equipped with projectors and audio-visual systems. During the current cycle (2014-2017), the
department has been successful in modernizing its facilities as part of the 21st Century classrooms
initiative that is part of the University of Hawaii strategic plan.

College Hall 11
CH-11 is the primary lab based classroom that the department uses for teaching nearly all of the lower
division lab-based classes. This classroom has 22 workstations, including an ADA compliant workstation.
The computers in this classroom run Windows 10 along with the latest versions of Microsoft Office and
Visual Studio. This department and auxiliary services reconfigured the room in 2016 to remove the
power poles that obstructed the view of the white board and projector and to have all seats face the
front of the classroom as shown in Figure 7.

CH-11 also serves as a lower division lab with the overall room being partitioned into two sections
(classroom and lab). The lab portion of CH-11 allows for approximately 12 lower division students to
work at a time. This lab is kept open in the evenings and often on weekends by the faculty and staff of
the department.

PB4-101
CH-11 is a secondary lab based classroom that the department uses for classes that are running
concurrently in PB-11 and for upper division laboratory courses. PB4-101 also serves as the primary lab
for the department’s visualization efforts in support of the UH Systems Academy for Creative Media. In
addition to the standard projection equipment, the classroom has three eighty-inch 3-D television
monitors to aid in visualization research.
College Hall 7
In addition to these two classroom labs, the department uses College Hall 7 as its primary classroom for traditional lecture based courses. In 2016, the department used funding from its Foundation (Private Donor) Accounts to purchase new furniture to enable easier collaborations between students and to support mobile devices. The cost for this retrofit was $9520.66.

Robotics Lab
The department has a robotics and security lab currently located in PB-22-Room 01. This lab is equipped with 15 computer stations, an instructor station, and Vex robotics equipment. The Vice Chancellor of Administrative Affairs originally granted the space for this lab for a limited period. Administrative Affairs is currently planning to use this facility to temporarily house performing arts during a renovation of their facility, so the department may need to find another location for these activities.
CH12N Graduate Lab

In the prior program review, College Hall 12(N) served as storage space, a faculty meeting room, and lab space for EPSCoR research students. The department repurposed the space in 2016 using $1200 of Research Return Funds to provide a space for alumni who are interested in completing the online graduate degree program from UH-Manoa. The lab has four workspaces for students and video conferencing equipment. Currently, one alumnus uses the lab for a course from UH-Manoa’s medical school. The first cohort of two graduate students will begin studies in Fall 2017.

Figure 10 – College Hall 12 (Graduate Lab)

CH12S Administrative Area

College Hall 12S serves primarily as the server, printing and repair area for the department. This room also has partitions that hold the department’s old supercomputer (a 256 node IBM Netfinity cluster) and a network room.

Faculty Offices

The department has 10 offices for faculty and staff. Each office is equipped with a networked workstation. However, several of these offices are partitions of existing space (e.g. the offices in CH-13A, lecturer offices, and the IT specialist office). Finally, the department has a closet storage space (CH-4E) which holds files required by state law (e.g. search committee records).

Library Resources & Technical Support

The University library provides a bare minimum in terms of research materials. While the library provides electronic access to the JSTOR and EBSCO database, the library does not have access to major databases for our field such as the ACM Digital Library and IEEE Explore. Individuals in the department either purchase their own subscription to these databases or access these databases through other institutions. Lack of access to research materials creates a major obstacle to conducting high quality research.

The information technology specialist typically provides technical support through the use of vendor websites and help lines.

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22 [http://www.ics.hawaii.edu/academics/online-learning/m-s-program-online/](http://www.ics.hawaii.edu/academics/online-learning/m-s-program-online/)
23 [http://guides.library.uhh.hawaii.edu/home](http://guides.library.uhh.hawaii.edu/home)
Chapter 5 – Broad Statement of Long Term Goals

Given the limited resources of the past three years described in Chapter 4, the department has done limited long term goal planning. Major long-term goals for the department are to assist the university with the establishment of a data science program and to continue providing an outstanding education to our undergraduate students. Some members of the department would like to pursue ABET accreditation, but the resources (course releases and budget) cannot be supplied by the administration at this time.

Other department goals are continued student learning assessment, continual curriculum development, and continued faculty development.

Student Learning Assessment
The department plans to continue its tradition of asking junior and senior students to take the Major Field Achievement Test and will continue to analyze the results since this is the most important assessment tool for the department. The department also plans to continue using the CRA CERP Data Buddies Project to gauge student attitudes within the department. Finally, the department plans to continue encouraging our students to take part in contests such as the ACM ICPC and Microsoft’s Imagine Cup.

Curriculum Development
The department would like to make modest revisions to its curriculum in order to support efforts such as the proposed data science program and the proposed health informatics track for students in the health sciences. Depending on the demand for these programs, there could be substantial work involved in creating them.

ABET Accreditation
Some faculty members in the department would like to pursue ABET accreditation in order to establish the department as the only ABET accredited program in the state. As mentioned above, limited resources in terms of budget and course releases make this goal more of a long-range vision.

Pre-Engineering Program
The department will continue to support the pre-engineering program that allows students to take their first two years of engineering courses at UH-Hilo before transferring to a full engineering program such as UH-Manoa.

Alliances
The department of computer science has established an active alliance with the University of Hawaii-Manoa to allow students from Hilo to study in the online master’s program at UH-Manoa while residing in Hilo.

Faculty Development
The department would like to provide support such as travel to conferences, release time for research and material support for research. This will be especially critical for our anticipated new assistant professor. Hopefully, resources from the EPSCoR grant will be able to assist with this as there is no money in the B-Budget.
Realistic Annual Budgets
The operating budget (B-Budget) is insufficient for maintaining day-to-day operations and does not allow for wholesale updates to the labs. The department would like to have B-Budgets return to the levels prior to 2010 when the last program review took place.

While the department has sometimes been fortunate to receive special funding at the end of the year from various administrative offices to support lab upgrades, this funding is irregular and always comes as a last minute handout. Computer science is often omitted from planning for general computing upgrades due to the closed nature of our labs, which are open only to students in computer science courses. As mentioned in the two previous program reviews, this overlooks the fact that service courses to the entire UH-Hilo student body constitute 40% of our curriculum. Having a revolving fund designated for computing upgrades would allow the machines and software used by these courses to be updated on a more regular basis. The cycle for such a fund should not be longer than four years.

The department’s current office space, lab space, and classroom space is adequate, although the department may need space for the robotics lab or an alternative plan to support the class.
Chapter 6 – Chair’s Evaluation

Evaluation of performance of department in terms of mission/goals

The computer science department at the University of Hawaii – Hilo has been successful in meeting its primary goal of maintaining a strong and up to date Bachelor of Science degree program in computer science. Graduates from our program are successful in the job market and in graduate school. The department has continued to develop and to improve distinctive service courses for various audiences at UH-Hilo.

Summary of Evidence

Computer science students score consistently well on the Major Field Achievement Test and perform well in national contests against much larger schools. While student demand for service courses is not as strong as it was in the last program review, the percentage of FTE from general education courses is still 47.1% of the FTE.

Past and Potential Problems

In the last program review, the external reviewer indicated a problem with no documentation of the procedures for the APT support position. This problem manifested itself shortly after the review when the current APT left his position for a job on Oahu. The department worked hard to document the procedures. The department has been able to transition between support personnel in a seamless manner since documenting the procedures.

The department has also addressed the turnover of full time staff and has had consistent staffing in the full time ranks. Furthermore, lecturer turnover is no higher than would be ordinarily expected for such positions.

The department will also need to look at a further diversification of its service courses due to declining enrollment. The department will need to revise these courses to have more standard course materials (e.g. textbooks) since the department can no longer allocate faculty time to produce custom course materials.

Concerning budgets, the department needs to find sources of funding to support its instructional needs given budgets that are approximately 25%-35% of what they were prior to 2010.

Finally, the department will need to adapt to any proposed reorganization of the university. Several different reorganization plans are being considered by the administration.

Plans to Address Potential Problems

The department plans to meet in the spring 2017 to select texts for both CS200 and CS101. The department will create standardized syllabi that correspond to these courses so that they can be handed off to lecturers hired to teach these courses.

The department will attempt to work with the current administration and future administrative units to improve its budgets.
Additional Resources Needed
Since the administration has removed the ability for departments to take care of their own maintenance, it is imperative to have administrative commitment to assure regular computer hardware and software upgrades to our labs. The department will also need space to house any robotics classes even if the space is temporary.

Responses to External Reviewer’s Report and Recommendations
The external reviewer produced an exceedingly positive report on the state of the department. The department chair obviously supports the recommendations for fixing the budget difficulties and for replacing the instructor position.

Concerning curriculum changes, the department will explore the possibility of providing students with new options that in lieu of the physics requirements (e.g. the new data science courses). The department will also review the choice of programming language for the lower division courses, although a change in language will require significant redesign of several courses. It is unlikely that the department would be interested in creating a new BA program since this would reduce the rigor of the program and would be impractical given the reticence of University of Hawaii Board of Regents to approve new programs.
## Appendix C: Quantitative Data

### University of Hawai‘i at Hilo

#### B.S in Computer Science

<table>
<thead>
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<td>iii. Percent of FTE of Majors within College</td>
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<td>54.2%</td>
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<td>12</td>
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<td>5</td>
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<td>i. Percent of FTE of Writing Intensive (WI) Courses</td>
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<td>20.9%</td>
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<td>11.2%</td>
<td>16.3%</td>
<td>15.4%</td>
<td>9.3%</td>
<td>13.8%</td>
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<td>ii. SSH by WI Courses</td>
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<td>297</td>
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<td>453</td>
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<tr>
<td>ii. FTE by WI Courses</td>
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<td>20</td>
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<td>80.2%</td>
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<td>74.2%</td>
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<td>61.5%</td>
<td>60.4%</td>
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<td>50</td>
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### 3. Course Delivery (by Fall Semesters)

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<th>Course Delivery</th>
<th>Brick and Mortar</th>
<th>Distance Learning</th>
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<td>5 6 18 16 17 17 17 13 19 17 15 15 0</td>
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<td>0 0 0 0 0 0 0 0 0 0 0</td>
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<td>4 4 4 4 4 4 4 8 7 6 0</td>
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### 4. Graduation and Placement (by Fiscal Year)

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<th>Value</th>
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<tr>
<td>Number of graduates/degrees earned</td>
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<tr>
<td>Percent of Majors Graduating</td>
<td>14.6% 6.8% 2.2% 14.0% 7.3% 8.6% 10.1% 7.9% 13.8% 7.1% 7.7%</td>
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<td>Number of Native Hawaiian graduates</td>
<td>0 1 0 1 0 2 2 4 1 0 0</td>
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<tr>
<td>Number of Certificates awarded</td>
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## 5. Cost of Delivery (by Fiscal Year)

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<td>i. A-Budget</td>
<td>$723,596</td>
</tr>
<tr>
<td>ii. A-Budget</td>
<td>$757,410</td>
</tr>
<tr>
<td>iii. A-Budget</td>
<td>$751,746</td>
</tr>
<tr>
<td>iv. A-Budget</td>
<td>$855,864</td>
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<tr>
<td>v. A-Budget</td>
<td>$747,804</td>
</tr>
<tr>
<td>vi. A-Budget</td>
<td>$740,727</td>
</tr>
<tr>
<td>vii. A-Budget</td>
<td>$569,145</td>
</tr>
<tr>
<td>viii. A-Budget</td>
<td>$823,308</td>
</tr>
<tr>
<td>ix. A-Budget</td>
<td>$831,788</td>
</tr>
<tr>
<td>x. A-Budget</td>
<td>$824,445</td>
</tr>
<tr>
<td>xi. A-Budget</td>
<td>$0</td>
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</table>

|                | B-Budget               |
| i. B-Budget    | $723,596               |
| ii. B-Budget   | $757,410               |
| iii. B-Budget  | $751,746               |
| iv. B-Budget   | $855,864               |
| v. B-Budget    | $747,804               |
| vi. B-Budget   | $740,727               |
| vii. B-Budget  | $569,145               |
| viii. B-Budget | $823,308               |
| ix. B-Budget   | $831,788               |
| x. B-Budget    | $824,445               |
| xi. B-Budget   | $0                     |

| i. SSH by Fiscal Year | $287.94 |
| ii. Cost per SSH     | $275.42 |
| iii. Cost per SSH    | $320.30 |
| iv. Cost per SSH     | $353.08 |
| v. Cost per SSH      | $323.30 |
| vi. Cost per SSH     | $396.75 |
| vii. Cost per SSH    | $262.04 |
| viii. Cost per SSH   | $340.77 |
| ix. Cost per SSH     | $378.43 |
| x. Cost per SSH      | $404.93 |
| xi. Cost per SSH     | $0.00   |

### Notes:

1. Number of Majors = Number of 1st Declared Majors of the selected program. These figures do not count 2nd, 3rd, or 4th declared major.
2. Number of Minors = Number of 1st Declared Minors of the selected program. These figures do not count 2nd, 3rd, or 4th declared minor.
4. GE Course listing from C. Travis approved gen ed and courses approved to meet integrative requirements nov 2013.
5. Excludes classes numbered 99 (individual instruction).
6. Average Class Size Calculation = Number of Registrations/Number of Classes.
7. FTE Student-Faculty Rate Calculation = Full-Time Equivalent (FTE)/Total FTE Tenure/Tenure-Track Faculty & Adjunct Faculty.
8. Number of graduates/degrees earned = Number of graduates or degrees earned/Number of Majors.
9. Percent of Majors Graduating Calculation = Number of graduates or degrees earned/Number of Majors.
10. Budget Allocation provided by R. Ivanova on 2014-05-20. Budget Allocations is not available by Program Level for the College of Arts and Sciences. Presented here is an approximation of the salaries paid for the Fiscal Year. This total does not include fringe benefits paid and/or overload costs and/or faculty paybacks.
11. Cost per SSH Calculation = Budgetary Allocation/SSH Generated.
12. Figures may not sum due to rounding. "FTE" and "Check FTE" will not match up due to "FTE" coming from IRO_SOCAD and "Check FTE" came for IRO_REGS.
13. Other Faculty defined as (in HR Datamart) Employee Type Code: N (Non-Compensated), GA (Graduate Assistant), and Unknown.
14. Sources: C. Travis approved gen ed and courses approved to meet integrative requirements nov 2013, HR Datamart "Faculty-Lecturer Listing 2005-2013", IRO_BASE (Census), IRO_DEGREE (EOS), IRO_REGS (Census), IRO_SOCAD (Census), IRO_SOCALL (Census).
Appendix 2 – Advising Materials

Four Year Plan

This is the 4-year plan for 2017-2018 as approved by the department 8-0-0 at the February 23, 2017 staff meeting.

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<td><strong>Fall</strong></td>
<td><strong>Fall</strong></td>
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<tr>
<td>MATH 225</td>
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<td>CS 469 (GE OCC, WI)</td>
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<td>GE SOC SCI AREA I</td>
<td>GE HUM AREA II</td>
<td>400 level CS course</td>
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<td>CS 266</td>
<td>GE HPP</td>
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<tr>
<td>CS 141</td>
<td>WI, pref. from ENG Dept*</td>
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<td><strong>Spring</strong></td>
<td><strong>Spring</strong></td>
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<tr>
<td>MATH 225</td>
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<td>CS 450</td>
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<td>CS 241</td>
<td>GE HUM AREA I</td>
<td>CS 410</td>
<td>CS 461 (WI)</td>
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<td>CS 151</td>
<td>CS 340 or 350</td>
<td>CS 420</td>
<td>CS 462</td>
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<th>32</th>
<th>44</th>
<th>61</th>
<th>96</th>
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Notes:
- A minimum of a 2.0 cumulative GPA is required.
- A grade of "C" or better in each CS course required for the degree and in MATH 311.
- 45 upper division (300-400 level) semester hours are required.
- * One WI course, preferably from ENG department, such as ENG 209, 225, or 287. CS315 is currently designated as writing intensive.

Rev. 02/2017
## Bachelor of Science in Computer Science Requirements 2016-2017
(121 semester hours)

### General Education Requirements

<table>
<thead>
<tr>
<th>Basic, Area, &amp; Integrative</th>
<th>Course</th>
<th>Course Name</th>
<th>Sem</th>
<th>Grade</th>
<th>Credits</th>
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<tr>
<td><strong>GF. Composition – 3 hrs</strong></td>
<td>ENG 100</td>
<td>Expository Writing</td>
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<tr>
<td><strong>GL. Language Arts – 3 hrs</strong></td>
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</table>

*CS 200 is one possibility*

| **GQ. Quant. Reasoning – 6 hrs**            | Satisfied by MATH 205 and MATH 206 | -    |       |         |
| **GW. World Cultures – 6 hrs**             |                                          | 3    |       |         |
| **GH. Humanities – 6 hrs**                 |                                          | 3    |       |         |
| **GS. Social Sciences – 6 hrs**            |                                          | 3    |       |         |
| **GN. Natural Science – 7 hrs**            | Lecture Course: Satisfied by CS 150     | -    |       |         |
|                                             | Lecture + Lab: Satisfied by PHYS 170 & PHYS 170L | -    |       |         |
| **Writing Intensive: 3 courses**           | Satisfied by CS 460, CS 461, and 1 more course (see below) | -    |       |         |
| **Hawaii Pan-Pacific – 3 hrs**             | *CS 135 is one possibility*              | 3    |       |         |
| **Global and Community Citizenship**       | Satisfied by CS 460                      | -    |       |         |

**Total** 27
## Computer Science Requirements in Other Disciplines

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Name</th>
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</tr>
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<tbody>
<tr>
<td>ENG 287/209/225</td>
<td>Rhetoric / Writing Bus / Writing Sci</td>
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<td>PHYS 170</td>
<td>Gen Physics I</td>
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<td>MATH 205</td>
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<td>MATH 206</td>
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<td>Linear Algebra (min. C)</td>
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### General Elective(s)

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<td><strong>Total</strong></td>
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</table>

### General Education Notes:

1. No course may be counted for more than one General Education CORE requirement. Students are cautioned that, in a few instances, a single course has been certified for more than one of the General Education Basic or Area Requirements. However, students completing such a course may only receive credit toward a single such requirement. They will be offered their choice of which requirement is satisfied and will be expected to fulfill the other requirement(s) with other courses.

2. Courses which meet both major requirements and General Education Core or Integrative requirements may be simultaneously counted for both.

3. Courses which are certified for a General Education Core requirement and an Integrative requirement may be counted for both.
Computer Science Requirements: CS Courses

No Grades Below C Accepted

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Name</th>
<th>Sem</th>
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<td>CS 141</td>
<td>Discrete Math for CS I</td>
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<td>CS 150</td>
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<td>CS 321</td>
<td>Data Structures</td>
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<tr>
<td>CS 407</td>
<td>Intro to Numerical Analysis</td>
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<tr>
<td>CS 410</td>
<td>Elements of Cmptr Architect.</td>
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<td>Database Internals</td>
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<td>CS 430</td>
<td>Operating Systems</td>
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<td>CS 450</td>
<td>Org. of Program. Languages</td>
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<td>CS 460</td>
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<td>CS 461</td>
<td>Software Engineering II (WI)</td>
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<td>Theory of Computing</td>
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**Required CS Electives**

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<td>Systems Programming</td>
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<td>CS 421</td>
<td>Database Systems Design (3)</td>
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<td>CS 431</td>
<td>Networks &amp; Data Comm (3)</td>
<td>3</td>
</tr>
<tr>
<td>CS 440</td>
<td>Artificial Intelligence (3)</td>
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<tr>
<td>CS 451</td>
<td>Compiler Theory (3)</td>
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<tr>
<td>CS 4__</td>
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</table>

**Total** 55
Minimum of a 2.0 cumulative GPA

Grade of "C" or better in each CS course required for the degree and in Math 311

45 upper division (300–400-level) semester hours are required

A total of three writing intensive courses are required for the major. Students are encouraged to take a writing intensive course from the English department.

Minimum of 120 total semester credits

Students should always check course prerequisites and the frequency with which courses are offered.

To ensure progress toward degree completion, students are strongly encouraged to meet with an advisor each semester before registering and to use the helpful planning aids provided by the Department at cse.uhh.hawaii.edu/.

Reminder: To earn a Bachelor of Science degree in Computer Science, students must fulfill the requirements for the major and meet all of the University’s other baccalaureate degree requirements. (Please see the chapter on Baccalaureate Degree Requirements in the Catalog.)

- 30 credits must be completed at UHH (UH Hilo requirement for all degrees)
- 25% of the CS Program requirements must be completed at UH Hilo
  "College of Arts & Sciences ... students must earn a minimum of 25% of the credits required for their major, minor, and/or certificate at UH Hilo." The CS major requires 55 CS credits plus Math 311. Therefore, 15 credits toward the major must be earned at UH Hilo.
COMPUTER SCIENCE
Course Flowchart
2016-17

MATH 140X

CS 150

MATH 205

CS 206

PHYS 170 & L

CS 151

MATH 206

CS 141

PHYS 171 & L

MATH 311

CS 241

CS 407

CS 321

WE: Prefer ENG 287, 200 or 225

CS 410

CS 340*

CS 430

CS 350*

CS 421*

CS 420

CS 341*

CS 411*

CS 460

CS 450

CS 470

CS 422*

CS 461

CS 495

CS 435*

CS 421*

CS 440*

CS 482*

CS 485*

* CS electives
Appendix 3 – Learning Outcomes and Core CS Objectives

Matrix of Program Outcomes and Courses

Degree or Program Name: Computer Science (BS)

Program / Department Chair: Dr. H. Keith Edwards hedwards@hawaii.edu

Revision Date: February 19, 2017

**Outcome 1:** Understand classical algorithmic processes and data structures and be able to perform simple analysis of algorithms

**Outcome 2:** Be proficient in one high-level programming language and have basic skill levels in a variety of programming languages

**Outcome 3:** Understand the basics of logic design and computer organization and be aware of multiple architecture approaches and numerical limitations

**Outcome 4:** Be competent in techniques of discrete mathematics and understand the theoretical foundations of computing

**Outcome 5:** Understand the steps of the software development process and the activities/products appropriate to each

**Outcome 6:** Know the major issues in the design and implementation of major computing artifacts such as operating systems, programming languages, graphical user interfaces or systems programming, and databases, networks, or compilers

**Outcome 7:** Be able to adapt to changing development platforms and design/implementation tools

**Outcome 8:** Communicate effectively on technical matters in both oral and written forms, work well within a team, and understand the social/ethical issues of computing

<table>
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<tr>
<th>Courses for Majors</th>
<th>Require</th>
<th>Outcome 1</th>
<th>Outcome 2</th>
<th>Outcome 3</th>
<th>Outcome 4</th>
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</table>

I = Introduced, D = Developed & Practiced with Feedback, M = Demonstrated at the Mastery Level appropriate for graduation in this program, P = Prerequisite to Success in Later Courses
## Assessment Plan for Program Outcomes

**Degree or Program Name:** Computer Science  
**Program / Department Chair:** Dr. H. Keith Edwards  
**Revision Date:** February 19, 2017

<table>
<thead>
<tr>
<th>Program Outcome (same outcomes as Deliverable #1)</th>
<th>Assessment Plan</th>
<th>Status / Progress / Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understand classical algorithmic processes and data structures and be able to perform simple analysis of algorithms</td>
<td>Successful completion of projects and exams in CS 321. Above national average in MFAT sub-area <strong>Discrete Structures and Algorithms</strong></td>
<td></td>
</tr>
<tr>
<td>2. Be proficient in one high-level programming language and have basic skill levels in a variety of programming languages</td>
<td>Successful completion of projects and exams in CS 321 and CS upper division courses (except CS 470 and 495). Above national average in MFAT sub-area <strong>Programming Fundamentals</strong></td>
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</tr>
<tr>
<td>3. Understand the basics of logic design and computer organization and be aware of multiple architecture approaches and numerical limitations</td>
<td>Successful completion of projects and exams in CS 266, CS 410, and CS 407. Above national average in MFAT sub-area <strong>Systems (Architecture, Operating Systems, Networking, Database)</strong></td>
<td></td>
</tr>
<tr>
<td>4. Be competent in techniques of discrete mathematics and understand the theoretical foundations of computing</td>
<td>Successful completion of assignments and exams in CS 141, 142, and 470. Above national average in MFAT sub-area <strong>Discrete Structures and Algorithms</strong></td>
<td></td>
</tr>
<tr>
<td>5. Understand the steps of the software development process and the activities/products appropriate to each</td>
<td>Contribute to production of a successful software engineering project in CS 460-461</td>
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</tr>
<tr>
<td>6. Know the major issues in the design and implementation of major computing artifacts such as operating systems, programming languages, graphical user interfaces or systems programming, and databases, networks, or compilers</td>
<td>Successful completion of projects and exams in CS 430, 450, 340 or 350, and 421, 431, or 451. Above national average in MFAT sub-area <strong>Systems (Architecture, Operating Systems, Networking, Database)</strong></td>
<td></td>
</tr>
<tr>
<td>7. Be able to adapt to changing development platforms and design/implementation tools</td>
<td>Successful completion of CS upper division courses (except CS 470 and 495).</td>
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<tr>
<td>8. Communicate effectively on technical matters in both oral and written forms, work well within a team, and understand the social/ethical issues of computing</td>
<td>Write and present meaningful reports in CS 141, 321, 450 and 460-461. Make meaningful contributions to group work in CS 141, CS 321, and CS 460-461. Successful completion of assignments in CS 495</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** All these assessment mechanisms are in place. The MFAT has been given for 20 years at UH-Hilo.
Appendix 4 – Student Outcomes Assessment

Required Courses

CS150 – Introduction to Computer Science I

Must Know:

- Basic control structures - decision and looping
- Concepts of parameter passing by value and by reference
- Architecture of a computer program
- Construction and use of simple classes

Should Know:

- The scope of the computer science field; a breadth-first level knowledge of algorithms, computer organization, system software, programming languages, and theory

Must Be Able To:

- Design, implement, debug, and test simple object-oriented programs in a modern high-level language using an IDE

CS151 - Introduction to Computer Science II

Must Know:

- Class definition and implementation including container and derived classes
- Linear structures - array, string, list, stack and queue
- Sorting and searching with linear structures
- Pointers and dynamic variables
- Implementation of a linked list
- Data abstraction - function and class templates
- Recursive thinking

Should Know:

- How to create a basic graphical user interface.

Must Be Able To:

- Create classes and objects to solve problems
- Select the appropriate linear structures to solve a variety of problems
- Explain the advantages and disadvantages of different implementations of linear structures, i.e., static arrays, dynamic arrays, or linked lists
- Write programs in an object-oriented language such as C++
CS141/241 – Discrete Mathematics I & II

Must Know:

- Propositional and predicate logic
- Proof techniques: A) Direct proof  B) Proof by contraposition  C) Proof by contradiction
- Elementary combinatorics
- Relation and function properties

Should Know:

- Graph terminology
- Elementary group theory
- Operation of finite-state machines
- Concept of order of magnitude

Must Be Able To:

- Solve problems using strong and weak induction
- Solve linear recurrence relations
- Perform set manipulations
- Perform Boolean algebra manipulations and minimizations

CS266 - Computer Organization and Assembly Language

Must Know:

- The computer system: A) Buses  B) Internal Memory C) Input/Output  D) Interrupts
- The central processing unit and the control unit
- Computer arithmetic
- Various addressing modes of a computer
- The complex instruction set computer and reduced instruction set computer
  - A) Superscalar processors
  - B) Pipelining

Should Know:

- The evolution and performance of computers
- Microprogramming

Must Be Able To:

- Program in assembly language
CS321 – Data Structures and Algorithms

Must Know:

- Techniques of algorithm analysis, including A) Recurrence relations B) Decision trees
- Tree structures (Binary search trees and AVL Trees)
- Search algorithms and their efficiencies
- Sort algorithms and their efficiencies
- Hashing
- Graph algorithms
  - Minimal path
  - Spanning tree

Should Know:

- Priority queues
- Huffman codes
- Idea of NP/NP complete

Must Be Able To:

- Implement classical algorithms
- Set up testbeds for empirical efficiency results

CS407 – Numerical Analysis

Must Know:

- Floating Point Representation (IEEE 754)
- Gaussian Elimination
- Techniques for Solving Non-Linear Equations
  - Bisection Method
  - Newton’s Method
  - Secant Method
- Polynomial Interpolation
- Numerical Differentiation and Integration
- Techniques for Spline Construction
- Solving Initial Value Problems

Should Know:

- Least Squares Method
- Monte Carlo Methods and Simulation
- Linear Programming

Must Be Able To:

- Implement classical from the field
- Analyze the results for errors
CS410 – Architecture

Must Know:

- Combinational logic
  - Two-level design
  - Decoders and encoders
  - Multiplexers
  - ROM
  - Programmable logic arrays and array logic

- Fundamental sequential devices (latches and Flip-Flops)

Should Know:

- Sequential logic circuits
  - Counters
  - Modulo-N counters
  - Shift registers as counters

- Microprocessor operations
  - Input/Output
  - Interrupts

- Parallel processing, Parallel random access machine (PRAM) model, and Parallel Algorithms

Must Be Able To:

- Simulate logical circuits.
- Analyze and synthesize synchronous sequential circuits
  - Mealy model
  - Moore model

CS420 – Introduction to Database Management Systems

- The significant differences between:
  A) stream files / no structure
  B) sequential files / \(<\text{crf}\) at end of each record
  C) relative files / array on the disk - possibly a control record
  D) indexed files / key position, length is metadata
  E) database as file access / full metadata

- The major relational database concepts
  A) table, tuple, attribute (file, record, field)
  B) metadata tables
  C) integrity (data, entity, referential)

- The basics of SQL
  A) embedded SQL (in C, C++, Java)
  B) as a tool in a database environment such as Access

- XML as a data transport and storage mechanism
- Major database indexing algorithms including B and B+ trees

Must Be Able To:

- Use embedded SQL as a file access method from within a host procedural language
- Use interactive SQL to develop simple queries to a relational database
- Implement XML-based data storage and retrieval algorithms
CS430 – Operating Systems

Must Know:

- Computer system architecture
- Basic features of an operating system
- Process scheduling
- Resource allocation
- Deadlock
- Concurrent programming
- File management
- Distributed systems

Must Be Able To:

- Explain the differences among various process scheduling methods
- Recognize whether mutual exclusion is possible among competing processes
- Explain the differences between processes and threads
- Recognize the necessary conditions that lead to a deadlock
- Simulate context switching and process scheduling such as round robin or shortest job first
- Recognize the problems and opportunities associated with distributed systems.

CS450 – Programming Languages

Must Know:

- The major features of languages representing the major programming paradigms
  A) procedural languages (e.g., C, Ada, Algol, ...)
  B) functional languages (Scheme, Lisp, ...)
  C) logic programming languages (PROLOG, ...)
  D) object-oriented languages (C++, Ada 95, Java, Smalltalk, ...)

- The major syntactic / semantic constructions used in modern programming languages
  A) block structure, scope, overloading / dynamic allocation
  B) primitive types, variables
  C) data, control, and procedural abstraction
  D) classes, objects / message passing, dynamic binding
  E) generics / templates
  F) recursion

Must Be Able To:

- Construct and execute programs in languages representing the major paradigms
CS460/461 – Software Engineering I and II

Must Know:

- The software development life cycle and its various models
- Requirements definition and analysis
- Software systems definition
- Software design process
- Software implementation process
- Quality assurance
- Validation and verification
  - Testing
  - Program Inspections and Reviews
- Configuration management
- Software Project management
- Software documentation

Must Be Able To:

- Explain and define the various aspects of the software development process
- Participate in the development of a team project by assuming one or more responsibilities in the development team
- Present both orally and in written form the development effort
- Help complete the team project on time and within budget

CS470 – Theory of Computing

Must Know:

- The Chomsky language hierarchy
- The hierarchy of computational models (Finite-state machines, Pushdown automata, Linear bounded automata Turing machines)
- The relation of language classes and machines as recognizers/acceptors
- The role of nondeterminism
- Church-Turing Thesis
- Undecidability

Should Know:

- Normal forms for context-free grammars
- Closure properties for language classes

Must Be Able To:

- Use productions to generate words in a language
- Demonstrate machine recognition of a language
- Use the Pumping Lemma for regular and context-free languages

CS495 – Professional Seminar

Must Know:

- Obligations of a CS Professional (Continued education, Ethical standards)
- Professional Societies and Codes of Ethics
- Analysis of social implications of systems and the systems development process

Should Know:

- Elements of career planning
## Appendix 5 – Current ACM/IEEE Curriculum and UHH Courses

The following is the overview of knowledge that should be obtained as part of the ACM/IEEE computing guidelines for 2013.

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>CS 2013 Tier 1 + Tier 2 Hours</th>
<th>Courses in Our Curriculum</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AL – Algorithms and Complexity</strong></td>
<td>28</td>
<td>CS141, CS150, CS151, CS241, CS321, CS440, CS470</td>
<td>Algorithms are at the heart of what we do. CS321 is the data structures and algorithms course.</td>
</tr>
<tr>
<td><strong>AR – Architecture and Organization</strong></td>
<td>16</td>
<td>CS266, CS410</td>
<td></td>
</tr>
<tr>
<td><strong>CN - Computational Science</strong></td>
<td>1</td>
<td>CS475</td>
<td>We have a new course for 2017 that focuses on computer visualization and modeling.</td>
</tr>
<tr>
<td><strong>DS – Discrete Structures</strong></td>
<td>41</td>
<td>CS141, CS241, CS321, CS470</td>
<td>CS141 and CS241 are entirely focused on these concepts.</td>
</tr>
<tr>
<td><strong>HCI – Human Computer Interaction</strong></td>
<td>8</td>
<td>CS340, CS440</td>
<td>CS340 is the topic course while CS440 covers topics such as the Turing Test, Uncanny Valley.</td>
</tr>
<tr>
<td><strong>IAS – Information Assurance and Security</strong></td>
<td>9</td>
<td>CS435, CS460, CS461</td>
<td>CS435 is the topic course while software engineering touches on these topics.</td>
</tr>
<tr>
<td><strong>IM – Information Management</strong></td>
<td>10</td>
<td>CS420, CS421, CS422, CS460, CS461</td>
<td>CS420, CS421, and CS422 are the database certificate sequence.</td>
</tr>
<tr>
<td><strong>IS – Intelligent Systems</strong></td>
<td>10</td>
<td>CS422, CS440</td>
<td>Artificial Intelligence and Data Mining cover these topics.</td>
</tr>
<tr>
<td><strong>NC – Networking and Communication</strong></td>
<td>10</td>
<td>CS431</td>
<td>Networking is a stand alone course.</td>
</tr>
<tr>
<td><strong>OS – Operating Systems</strong></td>
<td>15</td>
<td>CS430</td>
<td>Operating Systems is a stand alone course.</td>
</tr>
<tr>
<td><strong>PBD – Platform Based Development</strong></td>
<td>0</td>
<td>CS340</td>
<td>The GUI class covers mobile development as a module.</td>
</tr>
<tr>
<td><strong>PD – Parallel and Distributed Computing</strong></td>
<td>15</td>
<td>CS350, CS410, CS430, CS450</td>
<td>These courses each touch on the topic of parallel computing.</td>
</tr>
<tr>
<td><strong>PL – Programming Languages</strong></td>
<td>28</td>
<td>CS150, CS151, CS321, CS450, CS451</td>
<td>Programming languages (450) and Compilers (451) are the core.</td>
</tr>
<tr>
<td><strong>SDF – Software Development Fundamentals</strong></td>
<td>43</td>
<td>CS150, CS151, CS321, CS460, CS461</td>
<td>All these courses cover fundamentals in different ways.</td>
</tr>
<tr>
<td><strong>SE – Software Engineering</strong></td>
<td>28</td>
<td>CS420, CS460, CS461, CS495</td>
<td>CS460 and CS461 are the core of the software engineering sequence.</td>
</tr>
<tr>
<td><strong>SF – System Fundamentals</strong></td>
<td>27</td>
<td>CS350, CS430</td>
<td>CS350 is systems programming.</td>
</tr>
<tr>
<td><strong>SP – Social Issues and Professional Practice</strong></td>
<td>16</td>
<td>CS435, CS460, CS461, CS495</td>
<td>CS495 is a repeatable seminar on the topic.</td>
</tr>
</tbody>
</table>
The following tables show where each sub-topic from the 2008 knowledge areas are covered and the approximate number of hours each topic receives.

<table>
<thead>
<tr>
<th>DS. Discrete Structures (43 core hours)</th>
<th>OS. Operating Systems (18 core hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• DS/FunctionsRelationsAndSets (6)</td>
<td>• OS/OverviewOfOperatingSystems (2)</td>
</tr>
<tr>
<td>• DS/BasicLogic (10)</td>
<td>• OS/OperatingSystemPrinciples (2)</td>
</tr>
<tr>
<td>• DS/ProofTechniques (12)</td>
<td>• OS/Concurrency (6)</td>
</tr>
<tr>
<td>• DS/BasicsOfCounting (5)</td>
<td>• OS/SchedulingandDispatch (3)</td>
</tr>
<tr>
<td>• DS/GraphsAndTrees (4)</td>
<td>• OS/MemoryManagement (3)</td>
</tr>
<tr>
<td>• DS/DiscreteProbability (6)</td>
<td>• OS/DeviceManagement</td>
</tr>
<tr>
<td></td>
<td>• OS/SecurityAndProtection (2)</td>
</tr>
<tr>
<td></td>
<td>• OS/FileSystems</td>
</tr>
<tr>
<td></td>
<td>• OS/RealTimeAndEmbeddedSystems</td>
</tr>
<tr>
<td></td>
<td>• OS/FaultTolerance</td>
</tr>
<tr>
<td></td>
<td>• OS/SystemPerformanceEvaluation</td>
</tr>
<tr>
<td></td>
<td>• OS/Scripting</td>
</tr>
<tr>
<td></td>
<td>• OS/DigitalForensics</td>
</tr>
<tr>
<td></td>
<td>• OS/SecurityModels</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PF. Programming Fundamentals (47 core hours)</th>
<th>NC. Net-Centric Computing (15 core hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PF/FundamentalConstructs (9)</td>
<td>• NC/Introduction (2)</td>
</tr>
<tr>
<td>• PF/AlgorithmicProblemSolving (6)</td>
<td>• NC/NetworkCommunication (7)</td>
</tr>
<tr>
<td>• PF/DataStructures (10)</td>
<td>• NC/NetworkSecurity (6)</td>
</tr>
<tr>
<td>• PF/Recursion (4)</td>
<td>• NC/WebOrganization</td>
</tr>
<tr>
<td>• PF/EventDrivenProgramming (4)</td>
<td>• NC/NetworkedApplications</td>
</tr>
<tr>
<td>• PF/ObjectOriented (8)</td>
<td>• NC/NetworkManagement</td>
</tr>
<tr>
<td>• PF/FoundationsInSecurity (4) (435)</td>
<td>• NC/Compression</td>
</tr>
<tr>
<td>• PF/SecureProgramming (2) (435)</td>
<td>• NC/MultimediaTechnologies</td>
</tr>
<tr>
<td></td>
<td>• NC/MobileComputing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AI. Algorithms and Complexity (31 core hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• AI/BasicAnalysis (4)</td>
</tr>
<tr>
<td>• AI/AlgorithmicStrategies (5)</td>
</tr>
<tr>
<td>• AI/FundamentalAlgorithms (12)</td>
</tr>
<tr>
<td>• AI/DistributedAlgorithms (3)</td>
</tr>
<tr>
<td>• AI/BasicComputability (6) (241,321)</td>
</tr>
<tr>
<td>• AI/PervasusNP (241,321)</td>
</tr>
<tr>
<td>• AI/AlclamaTheory (241,470)</td>
</tr>
<tr>
<td>• AI/AdvancedAnalysis (321)</td>
</tr>
<tr>
<td>• AI/CryptographicAlgorithms (241,435)</td>
</tr>
<tr>
<td>• AI/GeometricAlgorithms (321)</td>
</tr>
<tr>
<td>• AI/ParallelAlgorithms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AR. Architecture and Organization (36 core hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• AR/DigitalLogic (7)</td>
</tr>
<tr>
<td>• AR/ComputerArchitecture (5)</td>
</tr>
<tr>
<td>• AR/InterfacingAnd/OSStrategies (3)</td>
</tr>
<tr>
<td>• AR/MemoryArchitecture (5)</td>
</tr>
<tr>
<td>• AR/FunctionalOrganization (6) (266,410)</td>
</tr>
<tr>
<td>• AR/Multiprocessing (6)</td>
</tr>
<tr>
<td>• AR/PerformanceEnhancements (410)</td>
</tr>
<tr>
<td>• AR/DistributedArchitectures (410)</td>
</tr>
<tr>
<td>• AR/Devices (410)</td>
</tr>
<tr>
<td>• AR/DirectionsInComputing (410)</td>
</tr>
<tr>
<td>• AR/VirtualMachines (1)</td>
</tr>
<tr>
<td>• AR/BasicLanguageTranslation (2) (450)</td>
</tr>
<tr>
<td>• PL/DeclarationAndTypes (3) (450)</td>
</tr>
<tr>
<td>• PL/AbstractionMechanisms (3) (450)</td>
</tr>
<tr>
<td>• PL/ObjectOrientedProgramming (10) (450)</td>
</tr>
<tr>
<td>• PL/FunctionalProgramming (450)</td>
</tr>
<tr>
<td>• PL/LanguageTranslationSystems (450,451)</td>
</tr>
<tr>
<td>• PL/TypesSystems (450,451)</td>
</tr>
<tr>
<td>• PL/ProgrammingLanguageSemantics (450,451)</td>
</tr>
<tr>
<td>• PL/ProgrammingLanguageDesign (450,451)</td>
</tr>
</tbody>
</table>
HC. Human-Computer Interaction (8 core hours)
- HC/Foundations (6) (340)
- HC/BuildingGUIInterfaces (2) (340)
- HC/UserCenteredSoftwareEvaluation (340)
- HC/UserCenteredSoftwareDev (340)
- HC/Design (340)
- HC/Programming (340)
- HC/MultimediaAndMultimodal (340)
- HC/CollaborationAndCommunication (340)
- HC/InteractionDesignNewEnviron (340)
- HC/HumanFactorsAndSecurity (435)

GV. Graphics and Visual Computing (3 core hours)
- GV/FundamentalTechniques (2) (482)
- GV/GraphicSystems (1) (482)
- GV/GraphicCommunication (482)
- GV/GeometricModeling (482)
- GV/BasicRendering (482)
- GV/AdvancedRendering (482)
- GV/AdvancedTechniques (482)
- GV/ComputerAnimation (135)
- GV/Visualization (422)
- GV/VirtualReality (422)
- GV/ComputerVision (422)
- GV/ComputationalGeometry (422)
- GV/GameEngineProgramming (422)

IS. Intelligent Systems (10 core hours)
- IS/FundamentalsIssues (1) (440)
- IS/BasicSearchStrategies (5) (440)
- IS/EnvironmentsBasedReasoning (4) (440)
- IS/AdvancedSearch (440)
- IS/AdvancedReasoning (440)
- IS/Accord (440)
- IS/NaturalLanguageProcessing (440)
- IS/MachineLearning (440)
- IS/PlanningAndReasoning (440)
- IS/Robotics (440)
- IS/Perception (440)

CN. Computational Science (no core hours)
- CN/ModelingAndSimulation (460)
- CN/ComputationsResearch (460)
- CN/ParallelComputation (460)

IM. Information Management (11 core hours)
- IM/InformationModels (4) (420)
- IM/DatabaseSystems (3) (420,421)
- IM/DataModeling (4) (420,421)
- IM/RelationalDatabases (420,421)
- IM/QueryLanguages (420,421)
- IM/RelationalDatabaseDesign (420,421)
- IM/TransactionProcessing (420,421)
- IM/DistributedDatabases (420,421)
- IM/ParallelDatabaseDesign (420,421)
- IM/DataMining (422)
- IM/InformationStorageAndRetrieval (420,421)
- IM/MedicalData (420,421)
- IM/MedicalSystems (420,421)
- IM/DigitalLibraries (420,421)

SP. Social and Professional Issues (16 core hours)
- SP/HistoryOfComputing (2) (150)
- SP/SocialContext (3) (495)
- SP/AnalyticalTools (2) (495)
- SP/ProfessionalEthics (3) (495)
- SP/Risks (2) (495)
- SP/SecurityOperations (345,495)
- SP/IntellectualProperty (3) (495)
- SP/PrivacyAndCivilLiberties (2) (495)
- SP/ComputerCrime (435,495)
- SP/EconomicsOfComputing (435,495)
- SP/PhilosophicalFrameworks (435,495)

SE. Software Engineering (31 core hours)
- SE/SoftwareDesign (8) (460,461)
- SE/UsingAPIs (5) (460,461)
- SE/ToolsAndEnvironments (3) (460,461)
- SE/SoftwareProcesses (2) (460,461)
- SE/RequirementsSpecifications (4) (460,461)
- SE/VerificationAndValidation (3) (460,461)
- SE/Evolution (3) (460,461)
- SE/ProjectManagement (3) (460,461)
- SE/ComponentBasedProgramming (460,461)
- SE/FormalMethods (461)
- SE/SoftwareReliability (460,461)
- SE/SpecializedSystems (460,461)
- SE/RiskAssessment (460,461)
- SE/RobustAndSecurity (460,461)
- EnhancedProgramming (460,461)
Appendix 6 – Certificate Programs

Certificate in Database Management
The Certificate in Database Management is intended to give students a thorough technical foundation in the theory, design, implementation and application of databases.

Required courses:

- MATH 205 Calculus I (4)
- CS 141 Discrete Mathematics for Computer Science I (3)
- CS 150 Introduction to Computer Science I (3)
- CS 151 Introduction to Computer Science II (3)
- CS 321 Data Structures (3)
- CS 420 Introduction to Database Management Systems (3)
- CS 421 Database Management System Design (3)
- CS 422 Advanced Database Topics (3)

Students must obtain a grade of “C” or better in each required course in order to be awarded the certificate.

Certificate in Computer Application Development Specialization (CADS)
The Certificate in Computer Application Development Specialization allows students to learn applied technical skills that are directly applicable in the 21st century workplace.

Required: 21 semester hours from the following courses with a minimum of one course each from Groups B, C, and D

Group A: CS 100 or CS 101 (not both), CS 130, CS 135, CS 137, CS 138, CS 140, CS 200

Group B: CS 150, CS 151, CS 201

Group C: CS 205, CS 300

Group D: CS 394

Students must obtain a grade of “C” or better in each required course in order to be awarded the certificate.
Proposed Digital Visualization and Communication Certificate

The 18 credit certificate in Digital Visualization and Communication allows students to learn applied technical skills that are directly applicable to a career in Digital Media Development.

Choose one of:

- CS 130 Beg Graphics, Game Programming (3)
- CS 135 Animation Programming (3)
- CS 200 Web Technology I (3)

Choose one of:

- ART 112 Introduction to Digital Media (3)
- CS 150 Intro To Computer Science I (3)

Choose one of:

- ART 121 FP Studio: Beg Drawing (3)
- ART 123 FP Studio: 2-D Design (3)

Choose one of:

- ART 207 Photography I (3)
- ART 394 Special Topics: Drawing and Sculpting in VR (3)
- ART 301 Digital Video and Installation (3)
- CS 340 Graphical User Interface (3)

Choose one of:

- ENG 285 Intro to News Writing & Report (3)
- ENG 286 Intro to Creative Writing (3)
- ENG 314 Journalism (3)
- ENG 318 Playwriting (3)

Complete Art300/CS475/MARE 498 (3)
Appendix 7 – Student Survey Design

1. What is your student ID number?

2. Current Major at UH-Hilo
   - Computer Science
   - Other (please specify)

3. Future Major at UH-Hilo
   - Computer Science
   - Other (please specify)

4. Past Major at UH-Hilo
   - Computer Science
   - Other (please specify)

5. Class Year
   - Freshman
   - Sophomore
   - Junior
   - Senior
   - Post Baccalaureate

6. Anticipated Year of Graduation

7. Which classes are you taking now?
   - CS 135
   - CS 200/201
   - CS 141/241
   - CS 150/151
   - CS 321
   - CS 4XX (any upper division course)

8. What led to your decision to major in computer science?

9. Were you a transfer student to UH-Hilo?
   - Yes
   - No

10. Did you start at UH-Hilo (either as a freshman or transfer student) as a computer science major?
    - Yes
    - No

11. Are you a working student?
• Yes
• No
• If yes, describe your work and approximate number of hours per week.

12. Are you a double major?
• Yes
• No
• If yes, list your other major(s)

13. What CS topic or course do you consider most valuable to you as a computer science major & why?

14. What CS topics or courses would you like to see available in the future?

15. How are CS courses improving your written communication skills?

16. How are CS courses improving your oral communication skills?

17. How are CS courses improving your problem-solving skills (analysis & critical thinking)?

18. What are your future career plans?

19. Overall Education at UH-Hilo
• Poor  Below Average  Average  Above Average  Excellent  N/A

20. Overall Education in the Computer Science Department
• Poor  Below Average  Average  Above Average  Excellent  N/A

21. Overall Quality of Teaching in the Computer Science Department
• Poor  Below Average  Average  Above Average  Excellent  N/A

22. Do you have any comments on these ratings?
Appendix 8 – Alumni Survey Design

The computer science department at the University of Hawaii – Hilo is undergoing a program review. Your candid answers to this brief survey will be extremely helpful in assessing our degree program and in planning for future changes. Current department information can be found at:

http://cse.uhh.hawaii.edu

1. Please create a user id of six character (used to sort answers)
2. Personal Information (will not be included in the report and may be omitted if you wish to remain anonymous)
   a. Name
   b. Company
   c. Address
   d. Address 2
   e. City/Town
   f. State
   g. Zip
   h. Country
   i. Email Address
   j. Phone Number (type)
   k. Phone Number
   l. Facebook Page
   m. Twitter Account
3. Year of Graduation
4. Did you pursue advanced education after graduating from UH-Hilo?
   a. Graduate School Attended
   b. Current Status (Degree Earned or In Progress)
5. Present Occupation
6. Present Employer
7. Main Duties (select one)
   a. Developer
   b. Management
   c. Technical
   d. Student
   e. Other
8. Please provide a rating of the following items (5 Point Likert with N/A as an option)
   a. Overall education you received in computer science at UH-Hilo
   b. How well prepared you were for your initial position or graduate school
   c. How significant the software engineering course was in preparing you for your career
   d. How well the CS degree helped you develop oral communication skills
   e. How well your CS degree helped you to develop written communication skills
   f. How well your CS degree helped you to improve your problem solving skills (analysis and critical thinking)
   g. Overall quality of teaching in the computer science department
   h. Free form comments
9. What computer science courses or topics at UH-Hilo were most valuable in contributing to your success

10. Please describe the technical skills you use most in your current occupation

11. If you feel that your UH-Hilo computer science education gave you an advantage in the job market, please list 2-4 contributing factors with the most important listed first. (These factors need not be technical).

12. If you could replace one required CS course in the UH-Hilo curriculum with a different CS course, what course would you eliminate and what course would you replace it with? Were there any activities or programs you participated in while a student at UH-Hilo that were particularly helpful in preparing you for the workforce or your career?

13. What courses or topics do you feel should be added to the existing CS curriculum at UH-Hilo that could help prepare students for careers in computer science.

14. Please describe what you see yourself doing in five years.

Add

- Willing to recruit students to your organization? (Yes/No)
- Give 495 talks? (Yes/No)
- Help UH-Hilo CS in other ways? (Open Ended)