General Education Foundations Course Articulation
From a UH Campus to UH M~noa: PROPOSAL FORM, INFO. & COMPUTER SCIENCE

Course Information

Course: ICS 241 Submitting Campus: Kapi'olani Community College

Title & Catalog Description:
Recursive algorithms, program correctness, structured programming, graph theory, trees and their applications, probability theory, Boolean algebra, introduction to formal languages and automata theory.

PREQ: ICS 111, ICS 141

UHM Equivalent Course (check one): [Only equivalent courses may be submitted for Fast Track review.]

ICS 141 Discrete Mathematics for Computer Science I, Symbolic Reasoning
X ICS 241 Discrete Mathematics for Computer Science II, Symbolic Reasoning

Symbolic Reasoning (FS) Hallmarks & Application Questions

Answer the following questions and submit the answers along with this form and at least one course syllabus.

1. Students will be exposed to the beauty, power, clarity and precision of formal systems. How will the course meet this hallmark?

2. Instructors will help students understand the concept of proof as a chain of inferences. How will instructors help students understand this concept?

3. Instructors will teach students how to apply formal rules or algorithms. How will instructors meet this hallmark?

4. Students will be required to use appropriate symbolic techniques in the context of problem solving, and in the presentation and critical evaluation of evidence. What symbolic techniques will be required and in what contexts? How will presentations and evaluations of evidence be incorporated into the course?

5. The course will not focus solely on computational skills. What reasoning skills will be taught in the course?

6. Instructors will build a bridge from theory to practice and show students how to traverse this bridge. How will instructors help students make connections between theory and practice?

Required Signatures

Requested by ____________________________ Business Education__________
Alfred Seita ____________________________________
Chair/Director Department/Unit

_________________________ _________________________
Signature Date

Approved by ____________________________
Chief Academic Officer Campus

_________________________ _________________________
Signature Date

Submit to vpaa-gened@hawaii.edu by 4:00 p.m., February 5, 2003.
Foundations Hallmarks and Application Questions: SYMBOLIC REASONING

1. Students will be exposed to the beauty, power, clarity and precision of formal systems.
   How will the course meet this hallmark?

   The breadth of material include some of the major topics in mathematics. They include recursive algorithms, program correctness, structured programs, graph theory, trees and their applications, probability theorem, and Boolean algebra. The material covers modeling computation by covering formal language recognition and the relationship of Turing Machines to computer programming. ICS faculty will introduce applications of these topics to everyday problems. These application examples are carefully selected to expose the beauty, power, clarity and precision of formal computational systems. In addition, the homework exercises are specifically selected to show students the power and precision of these computational systems.

2. Instructors will help students understand the concept of a proof as a chain of inferences.
   How will instructors help students understand this concept?

   There are two sections of the course where we explicitly focus on the notion of a proof. While covering the concept of program correctness we use the notion of rules inference, conditional statements, and loop invariants to establish the correctness of simple programs. While covering formal languages and automata theory we explicitly prove many of the properties of these systems from first principles. In probability theory we introduce the Kolmogorov axioms and demonstrate the critical computational consequences of these axioms.

3. Instructors will teach students how to apply formal rules of algorithms.
   How will instructors meet this hallmark?

   The notion of formal rules and algorithms is fundamental to all topics in this course. The notion of algorithms is emphasized while discussing recursive algorithms. Formal rules are used to discuss the notion of formal languages as first presented by linguist Noam Chomsky. Other concepts of algorithms are covered when discussing probability theory, graph theory, and Boolean algebra.

4. Students will be required to use appropriate symbolic techniques in the context of problem solving, and in the presentation and critical evaluation of evidence.
   What symbolic techniques will be required and in what contexts? How will presentations and evaluations of evidence be incorporated into the course?

   Symbolic techniques are fundamental to all topics in this course. Student are required to use symbolic representations for the concepts of programs, graphs, trees, languages, and automata. They will use these representations in homework and exam exercises. In the Modeling of Computation students are introduced to the concept of finite state automata and are asked to design automata that give change in a vending machine as well as to recognize formal languages.

5. The course will not focus solely on computational skill.
   What reasoning skills will be taught in the course?

   In the area of program correctness we focus on the notion of logically proving that a program meets its stated objectives. Students are exposed to the notions of indirect proof, proof by contradiction, proof by cases, counterexample, mathematical induction, iteration, etc.. They also learn the well-ordering property and the principle of mathematical induction.


Prerequisites: ICS 111 and ICS 141

Course Description:
This course covers recursive algorithms, program correctness, structured programs, graph theory, trees and their applications, probability theory, Boolean algebra, and an introduction to formal languages and automata theory. Selected algorithms/programs will hopefully be observed and compared on the computer.

Course Competencies:
Upon successful completion of ICS 241, the student should be able to:

1. Use recursive algorithms.
2. Understand concept of program correctness.
3. Use graphs, paths, cycles and trees.
4. Solve problems in elementary probability.
5. Use Boolean algebra to realize logic circuits.
6. Understand basic concepts of formal languages and automata theory.

Course Format:
Lectures, discussions, demonstrations, and homework will be used to present the course material. Questions and problems relating to each topic will be discussed in class as time permits. There may be some work with the computer to run programs that demonstrate some of the concepts discussed in class. This work must be done outside of class.
# ICS 241 Schedule

Presented here is a tentative schedule that is subject to change upon the discretion of the instructor.

<table>
<thead>
<tr>
<th>Week</th>
<th>Subjects</th>
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</thead>
</table>
| 1    | Introductions: Student and Instructor  
ICS Course Syllabus, Schedule, and Homework Set Policy  
The Fundamentals: Algorithms, the Integers, and Matrices  
2.4 Integers and Division |
| 2    | Mathematical Reasoning  
3.4 Recursive Definitions and Structural Induction |
| 3    | Mathematical Reasoning  
3.5 Recursive Algorithms  
3.6 Program Correctness |
| 4    | Counting  
4.5 Generalized Permutations and Combinations |
| 5    | Counting  
4.6 Generating Permutations and Combinations  
5.2 Probability Theory |
| 6    | Advanced Counting Techniques  
6.3 Divide-and-Conquer Algorithms and Recurrence Relations  
6.4 Generating Functions  
6.5 Inclusion-Exclusion |
| 7    | Advanced Counting Techniques  
6.6 Applications of Inclusion-Exclusions |
| 8    | Graphs  
8.3 Representing Graphs and Graph Isomorphism  
8.4 Connectivity |
| 9    | Graphs  
8.5 Euler and Hamilton Paths  
8.6 Shortest Path Problems |
| 10   | Graphs  
8.7 Planar Graphs  
8.8 Graph Coloring |
| 11   | Trees  
9.3 Tree Traversal |
| 12   | Trees  
9.4 Spanning Trees  
9.5 Minimum Spanning Trees |
| 13   | Boolean Algebra  
10.1 Boolean Functions  
10.2 Representing Boolean Functions  
10.3 Logic Gates  
10.4 Minimization of Circuits |
| 14   | Modeling Computations  
11.1 Languages and Grammar  
11.2 Finite-State Machines with Output |
| 15   | Modeling Computations  
11.3 Finite-State Machines with No Output  
11.4 Language Recognition |
| 16   | Modeling Computations  
11.5 Turing Machines |
ICS 241 Discrete Mathematics for Computer Science II

1. COURSE DESCRIPTION: 9/17/01

ICS 241 Discrete Mathematics for Computer Science II (3)
3 hours lecture per week
Prerequisite: ICS 111 and ICS 141.

This course covers recursive algorithms, program correctness, structured programs, graph theory, trees and their applications, probability theory, Boolean algebra, introduction to formal languages and automata theory.

2. COURSE OBJECTIVES/COMPETENCIES:

Upon successful completion of ICS 241, the student should be able to:

... Use recursive algorithms.

... Understand concept of program correctness.

... Use graphs, paths, cycles and trees.

... Solve problems in elementary probability.

... Use boolean algebra to realize logic circuits.

... Understand basic concepts of formal languages and automata theory.

3. GENERAL EDUCATION AND RELATIONSHIP TO OTHER COURSES:

ICS 241 is a required course in the Pre-Information and Computer Science Advising Program curriculum. It is a required course for UH Manoa's Bachelor of Science and Bachelor of Arts curricula in ICS. This course along with ICS 141 provides the formal mathematical foundations for the development and implementation of algorithms to solve problems in computer science. The first pre-requisite, ICS 111, provides experience in a computer language from which students can apply (write programs) the theory learned in ICS 241. The second pre-requisite, ICS 141, is required since ICS 241 is a continuation of ICS 141.
This course supports the following college competency areas:

... Computation and communication abilities

... Problem-solving and decision-making abilities

... Career choices and life-long learning

... Study in a selected program

This course also satisfies the following Associate in Art degree competencies:

... Employ those skills in communication, mathematics and historical content essential to further college work.

... Demonstrate, by completion of elective and/or required courses the educational background necessary for more specific professional and personal goals.

... Make a decision if desired about further course of study in a four-year college, with a capacity to declare a major and select courses directed toward that major, based upon a realistic assessment of personal needs and aspirations.

Critical thinking, an analytical and creative process, is essential to every content area and discipline. It is an integral part of information retrieval and technology, oral communication, quantitative reasoning, and written communication. Upon completion of an A.A. degree, the student should be able to:

... Apply problem-solving techniques and skills, including the rules of logic and logical sequence.

... Communicate clearly and concisely the methods and results of logical reasoning.

Information retrieval and technology are integral parts of every content area and discipline. Upon completion of an A.A. degree, the student should be able to:

... Recognize, identify, and define an information need.

Quantitative reasoning can have applications in all content areas and disciplines. Upon completion of an A.A. degree, the student should be able to:

... Apply numeric, graphic, and symbolic skills and other forms of quantitative reasoning accurately and appropriately.
4. COURSE CONTENT:

8% Recursive algorithms, program correctness, and structured programs.
22% Probability: discrete probability, probability theory, random variables and expectations.
14% Solving recurrence relations, divide and conquer relations, and generating functions to solved recurrence relations.
14% Graphs theory: representing graphs and graph isomorphism, connectivity, Euler and Hamiltonian paths, shortest path problems, planar graphs, graph coloring.
14% Trees and their application: applications of trees, tree traversal, trees and sorting, spanning trees, minimal spanning tress, and decision trees.
14% Boolean algebra: boolean functions, representing boolean functions, logic gates, and minimization of circuits.
14% Introduction to formal languages and automata theory: languages and grammar, finite-state machines with output, finite-state machines with no output, language recognition.

5. POSSIBLE TEXTS:


In addition to the text, students are expected to purchase several high density 3 1/2 inch floppy disks.

6. REFERENCE MATERIALS:

A number of textbooks dealing with discrete mathematics are available at U.H. Manoa's Hamilton Library. A limited but sufficient number of textbooks are also available at KCC's Library.

7. AUXILIARY MATERIALS AND CONTENT:

Use is made of an instructor presentation computer with LCD projector to demonstrate mathematical concepts and program activities too complex for a purely verbal description. Overhead transparencies, slides, films, and other media may also be used to supplement the lecture method of presentation.
Several class sessions may be scheduled in the Business Education instructional labs for demonstrations and "hands on" activities to step the students through an activity which is highly specific to the machine and software.

8. METHODS OF INSTRUCTION:

The lecture method will be used primarily. Students will be assigned homework to help them understand the material. Exams and quizzes will be given appropriately throughout the semester.

Classroom activities in this course will include:

Lectures - Instructor presents concepts/material to the student.

Discussions - Instructor answers questions, explains and clarifies previously covered material, and encourages student participation.

Demonstrations - Instructor will use appropriate computer-aided instruction to demonstrate mathematical concepts during lecture.

Homework - Instructor provides outside assignments to demonstrate and reinforce material covered in the lectures. Students are to accomplish homework outside of class time.

Review - Instructor emphasizes important points of previously covered material and recommends study methods and materials.

9. METHOD OF EVALUATION:

The following represents the anticipated weight of the various graded activities of the course:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Examinations</td>
<td>60%</td>
</tr>
<tr>
<td>Homework</td>
<td>30%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>10%</td>
</tr>
</tbody>
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The letter grade awarded as the final measure of student achievement in the course will be based upon the following percentages:

- A 90 - 100%
- B 80 - 89%
- C 70 - 79%
- D 60 - 69%
- F 0 - 59%

10. JUSTIFICATION:

A. This course was previously offered at KCC and at U.H. Manoa, but was discontinued when it was thought that ICS 141 could provide the necessary Discrete Mathematics for Computer Scientists. The current ICS 141 is not fulfilling the needs of the students; therefore, the ICS Department at U.H. Manoa has decided to offer ICS 241 Discrete
Mathematics Computer Science II to provide a more comprehensive coverage of Discrete Mathematics for their computer science majors. The inclusion of this curriculum is required to ensure that KCC once again can offer all lower level undergraduate ICS courses to students in KCC’s Pre-ICS Advising Program.

B. ICS 241 is not an experimental course.

C. ICS 241 will not increase nor decrease the number of required hours needed for a certificate or degree.

11. RESOURCE REQUIREMENTS:

A. This course proposal will not require any change in staff, equipment, facilities, or other resources. This course will be supported by general funds by adjusting the offerings of all other ICS courses.

B. This course will not impact on other departments. The IT/ICS programs will manage the classroom and office resources internally.

C. Course enrollment is estimated to be 24 students. It is expected that one section per year will satisfy the initial demand.

12. ARTICULATION:

A. This course is currently offered with three credit hours at UH Manoa (ICS 241) and UH Hilo (CS 215).

B. This course is appropriate for articulation with the ICS Department at UH Manoa and the CS Department at UH Hilo.