AP COMPUTER SCIENCE AB

SYLLABUS MR. BACU

Course Overview

AP Computer Science AB is taught over a period of one year, extending the concepts studied in the previous two courses. The first previous course, Computer Science I, covers introductory Java programming, methods, decisions, loops, input and output, using files, and using classes. The second previous course, Computer Science II, covers designing and writing classes, arrays, searching, sorting, and an introduction to Big-Oh. The language of all 3 courses is Java.

The AP Computer Science AB course emphasizes object-oriented programming and class design. Student show proficiency in creating and implementing classes, including the use of inheritance by extending classes and implementing interfaces. The Java Library classes are studied and used throughout the course. Encapsulation, abstraction, inheritance, and polymorphism are all studied. Another emphasis is the organization of information through the implementation of data structures. One and two-dimensional arrays, array lists, linked lists, stacks, queues, trees, sets, maps, and hash tables are all implemented and used. Algorithm analysis using Big-Oh notation and recursion are also studied. Students learn to analyze many large projects of interacting classes, including the Grid World Case Study. All students become familiar with the interaction of hardware and software components and the ethical and social implications of computing systems.

The content and objectives of this course include all the course objectives for AP Computer Science AB which are listed in the AP Computer Science Course Description. The course enhances the students' problem solving ability and analytical skills, preparing them for the college computer science environment. All 6 topics in the course description are covered including object oriented program design, program implementation, program analysis, standard data structures, standard algorithms, and computing in context.

All AP Computer Science classes are taught in a modern computer lab. Lectures are very interactive; students take notes electronically, program the projects along with the teacher, print code and notes to add to a binder, and transfer programs to flash drives for work at home.

COMPUTER FACILITIES

Our lab contains 20 two year old PC's running Windows XP with CD-RW drives, a data projector, and laser printers. Students have accounts on a networked server and store all of their class files in their accounts. The lab is open both before and after school, and students may stop in to use the lab during their study halls.

All computers include the Sun JDK 1.6 and JCreator 4.5 installed on C: drive for quick processing. All students receive a CD with the software so that they may install it on their home computer.

TEXTBOOKS AND RESOURCE MATERIALS

- Horstmann, Cay. *Big Java 2nd Edition*, New York, NY: John Wiley and Sons, 2006

- Teukolsky, Roselynn. *Barron's AP Advanced Placement Exam Computer Science 2007 Levels A and AB 3rd Edition,* Hauppauge, NY: Barron's Educational Series, 2006.

- Litvin, Maria, and Roger Frank, Judy Hromcik, Gary Litvin, Dave Wittry. *Be Prepared for the A.P. Computer Science Exam in Java, 3rd Edition,* Andover, Mass.: Skylight Publishing, *2007.*

- The College Board *AP Grid World Case Study*. New York, NY: CEEB, 2006.

- AP Central Computer Science AB Quick Reference Guide for JDK 1.5

- Current magazine and Internet articles discussing ethical and social issues relating to computer use.

COURSE OUTLINE

Unit 1 (10 days) REVIEW OF TOPICS FROM COMPUTER SCIENCE I AND II

AP Course Description Topics Covered:

1. Object Oriented Program Design
2. Program Implementation
3. Program Analysis
4. Standard Data Structures
5. Standard Algorithms
6. Computing in Context

Activities:

Review Java language features: import statements, library classes, comments, indentation and braces, primitive data types, methods, declaring local variables, arithmetic operators, boolean expressions, relational and boolean operators, if and select case, loops, strings and their methods, applets and graphics

Classes, encapsulation, and abstraction
Arrays
Enhanced for loops
Linear and binary searches
Selection Sort
Documentation, specifications, pre and post conditions
Hardware and software components of a computer system and how they interact
Networks and their operation
Computer ethics, piracy, and copyright laws

Assignments:

Write Car and Point class
Multiple Choice Questions
Free Response Question on simulating a deck of cards
Design questions from earlier year AP exams

Readings:

Big Java: Pages 66 – 102, 104 – 150, 190 – 229, 232 – 277, 280 – 283, 303 – 311, 324 – 351, 576 – 606, 704 – 712, 725 – 730

Unit 2 (7 days) ALGORITHM ANALYSIS AND BIG-OH

AP Course Description Topics Covered:

3. Program Analysis

Activities:

Formula for summations
Review of logarithms
O(1), O(logN), O(N), O(N^2), O(N^3),O(NLogN), O(2^N)
Best, worst, and average cases
Space analysis
Analyzing code and determining Big-Oh running time
Comparing algorithms to solve problems efficiently
Numerical representations and limits

Assignments:

Multiple Choice and Free Response Questions from past years with an emphasis on Big-Oh analysis and comparisons

Readings:

Big Java: Pages 712 – 740

Exam:

6 Multiple Choice on Big-Oh and 2 Free Response (designing solution for a Gas Station class, analyzing stock and bond investments)

Unit 3 (14 days) ARRAYLIST<E> AND ITS USE

AP Course Description Topics Covered:

4. Standard Data Structures

Activities:

List methods add, size, get, set
Big-Oh of each method above
Method remove and its Big-Oh
Using Iterator<E> and its methods next, hasNext, and remove
Autoboxing
Practice multiple choice questions on above topics
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

Design a Bank class using ArrayList<Bank>
Design a class WordList and its methods
Design a Concentration Board

Readings:

Big Java: Pages 284 – 298, 842 – 861

Exams:

2 Free Response (2005 Student Grades, Number Set)
20 Multiple choice questions

Unit 4 (5 days) SORTING LISTS

AP Course Description Topics Covered:

5. Standard Algorithms

Activities:

Insertion sort
Bubble sort
Big-Oh analysis of each sort

Assignments:

Multiple choice questions on sorting and searching
Design a class Student, design a class StudentList, and sort the list

Readings:

Big Java: Pages 713 – 715, 731 – 740

Exams:

Computer Science A Practice Exam on material covered so far

Unit 5 (12 days) RECURSION

AP Course Description Topics Covered:

2. Program Implementation
5. Standard Algorithms

Activities:

Writing recursive methods
Tracing recursive methods
Ordinary and tail recursion
Quick sort
Merge sort both iterative and recursive

Big-Oh analysis of above sorts
Recursion in applets and graphics

Assignments:

Worksheet on 15 different recursive methods
Multiple choice questions from earlier year's exams involving recursion
Recursive binary search
Finding number of paths through a maze
Towers of Hanoi
Project on anagrams
Project on address books
I continue to assign recursive method projects during the rest of the course.

Readings:

Big Java: Pages 664 – 701, 715 – 725

Exams:

2 recursive methods exams
Computer Science A Practice Exam on material covered so far

Unit 6 (15 days) TWO DIMENSIONAL ARRAYS

AP Course Description Topics Covered:

4. Standard Data Structures

Activities:

Reading and printing
Writing methods using two dimensional arrays
Free response questions from previous years
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

1996 Free Response (SumCross and RemoveCross) changed into Java by me
1997 Free response (WordSearch) changed into Java by me
1998 Free Response (Black and White Pixels, recursive) changed into Java by me
2000 Free Response (Encryption) changed into Java by me
2001 Free Response (Window) changed into Java by me
Multiple choice questions
1999 Free Response (Quilt) changed into Java by me
Project "Kill the Blob"
Project "Simple Maze"
Project "Tougher Maze"
Project "Magic Square Class"

Readings:
Big Java: Pages 298 – 302

Exams:

5 Multiple Choice and 1 Free Response Question (SumBorder and BorderSum)
1 Free Response Question (2002 Free Response (Flight) changed into Java by me)

Unit 7 (7 days) INHERITANCE

AP Course Description Topics Covered:

1. Object Oriented Program Design

Activities:

Review of encapsulation and abstraction
Review of interfaces
Extending classes
Polymorphism
Early and late binding
Abstract classes

Assignments:

BankAccount classes
Square and Rectangle classes
Person and Student classes
Athlete, Runner, and Marathoner classes
Multiple choice questions
Design questions from previous years' exams

Readings:
Big Java: Pages 410 – 441, 468 – 514, 608 – 662

Exams:

Multiple Choice Questions on Inheritance
3 Free response Questions (Sales/Transaction Classes, Bird Class, Pet Interface)

Unit 8
(20 days over the course of the entire year) GRID WORLD CASE STUDY

AP Course Description Topics Covered:

1. Object Oriented Program Design
2. Program Implementation
3. Program Analysis

4. Standard Data Structures
5. Standard Algorithms
6. Computing in Context

Activities:

Running the Case Study in JCreator
Experimenting with the simulation
Identifying the classes
Bug variations
Grid World classes and interfaces: Location, Grid, Actor, Rock, Flower, Bug
Interactions of objects: class Critter and its extensions
Grid Data Structures: AbstractGrid, BoundedGrid, UnboundedGrid
Changing the grid to a different data structure
Compare and contrast all data structures used in GridWorld in terms of which is best to solve a problem

Assignments:

(from draft copy of GridWorld, will be changed to final copy when published)

Page 8 #1 – 4; Page 11 #1 – 7
Page 12 #1 – 5; Page 18 #1 – 5
Page 20 #1 – 4; Page 22 #1 – 5
Page 24 #1 – 11; Page 24 #1 – 4
Page 28 #1 – 6; Page 30 #1 – 6
Page 31 #1 – 7; Page 32 #1 – 6
Page 33 #1 – 4; Page 36 #1 – 5
Page 37 #1 – 8; Page 38 #1 – 5
Page 38 #1 – 3

Readings:

Grid World Case Study: Pages 1-38
Quick Reference Guide Appendices A-F

Exams:

Quiz Multiple Choice
Test Multiple Choice and Free Response
GridWorld multiple choice and free response questions will be included on other exams throughout the year.

MIDTERM EXAM

40 Multiple Choice and 4 Free Response Questions on all material covered so far.
This exam is given over 2 days with extended class periods.

Unit 9 (15 days) LINKED LISTS

AP Course Description Topics Covered:

4. Standard Data Structures
5. Standard Algorithms

Activities:

How linked lists work
Advantages of using them
Writing our own singly linked list class
Big-Oh of linked list methods
Shallow vs. deep copies
Writing our own doubly, circular, and doubly circular linked list classes and their methods
List Iterator<E> and its methods add and set
Writing our own methods iterator and listIterator for our linked list class
The built in Java LinkedList<E> class and its methods
Comparison of ArrayList<E> and LinkedList<E>
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

Iterative and recursive methods for our own singly linked list class and its variations:
(addFirst, addLast, get, set, toString, getFirst, size, removeFirst, insertInOrder)
Review assignment on Grid World (class design)
Review assignment on two dimensional arrays (Bar Codes)
2003 Free Response (File Drawers)
Methods to add or remove from a doubly, circular, or doubly circular linked list
Write methods iterator, listIterator, next, hasNext, and remove for our classes

Readings:

Big Java: Pages 742 – 762

Exams:

Practice Exam 40 Multiple Choice Questions
2 Free Response Questions on Linked Lists

Unit 10 (6 days) STACKS AND QUEUES

AP Course Description Topics Covered:

4. Standard Data Structures
5. Standard Algorithms

Activities:

Implement Stack<E> as an array, ArrayList<E>, and LinkedList<E>
Infix, prefix, and postfix
Implement Queue<E> as an array, ArrayList<E>, and LinkedList<E>
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

Various class implementations of a stack
Project Palindrome
Project "Matching Parentheses"
Various class implementations of a queue
Practice multiple choice questions on lists, stacks, and queues
Project "Parking Garage"

Readings:

Big Java: Pages 762 – 773

Exams:

Free Response Question "Radix Sort"
Free Response Question on stacks and queues

Unit 11 (12 days) TREES

AP Course Description Topics Covered:

4. Standard Data Structures
5. Standard Algorithms

Activities:

Definitions and vocabulary
Writing a Binary Tree abstract class and a Binary Search Tree class
Using recursive methods
Big-Oh for tree methods
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

Tree methods search, preorder, inorder, postorder, and level by level traversals
Tree statistic methods height, width, perimeter, nodeCount, isfull, isComplete
Deleting a node
97 AP Free Response (Separate) changed into Java by me
Review project on Grid World
Multiple choice questions on all topics covered so far

Readings:
Big Java: Pages 796 – 815

Exams:
Multiple choice questions
Free Response Tree questions

Unit 12 (6 days) HASH TABLES

AP Course Description Topics Covered:
4. Standard Data Structures
5. Standard Algorithms
6.

Activities:
Designing our own HashTable class
The hashCode method
Big-Oh analysis of hashTables
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:
Project (Hash Table searching)

Readings:
Big Java: Pages 783 – 795

Exams:
Free Response Question using Linked Lists and Hash Tables

Unit 13 (4 days) SETS

AP Course Description Topics Covered:
4. Standard Data Structures
5. Standard Algorithms

Activities:
Set<E> methods
TreeSet<E> and HashSet<E>: advantages of each, Big-Oh of each

Assignments:
Project (Vocabulary list with no duplicates)
Project (TreeSet<E> with Operations)

Readings:
Big Java: Pages 776 – 781

Exams:
25 Multiple Choice Questions

Unit 14 (6 days) MAPS

AP Course Description Topics Covered:
4. Standard Data Structures
5. Standard Algorithms

Activities:
Map<E,K> methods
TreeMap<E,K> and HashMap<E,K>: advantages of each, Big-Oh of each
Using Iterator<E> with Sets and Maps
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:
Project (Dictionary Map)

Readings:
Big Java: Pages 781 – 783

Exams:
Grid World using Sets and Maps Free Response
Acorn Book 15 Multiple Choice

Unit 15 (8 days) PRIORITY QUEUES AND HEAPS

AP Course Description Topics Covered:
4. Standard Data Structures
5. Standard Algorithms

Activities:
Definitions and vocabulary
Big-Oh
Designing and writing heap methods
Heap sort
Compare and contrast all data structures studied so far in terms of which is best to solve a problem

Assignments:

Write heap methods reheapUp and reheapDown
Code and test heap sort
Liver transplant project using priority queues
Min Heap Free Response question

Readings:

Big Java: Pages 815 – 839

Exams:

Multiple Choice questions on all covered topics
City/State Map

Unit 16 (8 days throughout the year) COMPUTERS AND SOCIETY

AP Course Description Topics Covered:

7. Computing in Context

Activities:

Students will review processors, computer systems, and memory storage. They will investigate the use of different operating systems and compliers. They will continue to explore the interaction of hardware and software. The idea of intellectual property and copyright laws will be emphasized.

Students will also explore the effect of the computer on society. They will read and analyze articles from the media concerning careers, ethics, computer crimes, hardware and software, privacy, copyright laws and legal issues, and the responsible use of the computer.

Assignments:

Article summations
Oral presentations
Career investigations
Panel discussions

Readings:

Articles from the media and web sites

Exams:

Essays added to other exams

Unit 17 (10 days) EXAM REVIEW

AP Course Description Topics Covered:

1. Object Oriented Program Design
2. Program Implementation
3. Program Analysis
4. Standard Data Structures
5. Standard Algorithms
6. Computing in Context

Activities:

Distribute copies of 2004 Multiple Choice and Free Response and 2005 and 2006 Free Response.
Go through 1 section of each type of question daily

Assignments:

2004 #1 (Library)
2004 #2 (Voter Ballots)
2004 #4 (Tree Priority Queue)
2005 #2 (Postal Codes)
2005 #3 (Tree Statistics)
2005 #4 (Email)
2004 40 Multiple Choice Questions
2006 #1 (Thesaurus)
2006 #2 (Product)
2006 #3 (WaitingList)
2007 Selected Free Response Questions
2 Free Response questions on Grid World

Readings:

Teacher handouts

Exams:

All students must take the AP Computer Science AB Exam.

Unit 18 (21 days)

This unit follows the A.P. exam and will cover various topics based on student needs and interests.

FINAL EXAM

40 Multiple Choice questions on all material covered during the course. This exam is given during an extended class period.

Correlation to AP Topic Outline – Computer Science AB

I. Object-Oriented Program Design The overall goal for designing a piece of software (a computer program) is to correctly solve the given problem. At the same time, this goal should encompass specifying and designing a program that is understandable, can be adapted to changing circumstances, and has the potential to be reused in whole or in part. The design process needs to be based on a thorough understanding of the problem to be solved.	
A. Program design	
1. Specify the purpose and goals for a problem.	Unit 1
2. Apply data abstraction and encapsulation.	Unit 1
3. Decompose a problem into classes; define relationships and responsibilities of those classes.	Unit 1
4. Understand and implement a given class hierarchy.	Unit 1
5. Identify reusable components from existing code using classes and class libraries.	Unit 1
B. Class design	
1. Design and implement a set of interacting classes.	Unit 1
2. Design an interface.	Unit 1
3. Choose appropriate advanced data structures and algorithms.	Unit 1
4. Apply functional decomposition.	All Units
5. Extend a given class using inheritance.	Unit 7
II. Program Implementation The overall goals of program implementation parallel those of program design. Classes that fill common needs should be built so that they can be reused easily in other programs. Object-oriented design is an important part of program implementation.	
A. Implementation techniques	
1. Methodology	
a. Object-oriented development	Unit 1
b. Top-down development	Unit 1
c. Encapsulation and information hiding	Unit 1
d. Procedural abstraction	Unit 1
B. Programming constructs	
1. Primitive types vs. objects	Unit 1
2. Declaration	
a. Constant declarations	Unit 1
b. Variable declarations	Unit 1
c. Class declarations	Unit 1
d. Interface declarations	Unit 1
e. Method declarations	Unit 1
f. Parameter declarations	Unit 1
3. Console output (System.out.print/println)	Unit 1
4. Control	
a. Methods	Unit 1
b. Sequential	Unit 1
c. Conditional	Unit 1
d. Iteration	Unit 1
e. Recursion	Unit 5
C. Java library classes (included in the AB-level Java Subset)	All Units

III. Program Analysis The analysis of programs includes examining and testing programs to determine whether they correctly meet their specifications. It also includes the analysis of programs or algorithms in order to understand their time and space requirements when applied to different data sets.	
A. Testing	
1. Test classes and libraries in isolation.	All Units
2. Identify boundary cases and generate appropriate test data.	All Units
3. Perform integration testing.	All Units
B. Debugging	
1. Categorize errors: compile-time, run-time, logic.	All Units
2. Identify and correct errors.	All Units
3. Employ techniques such as using a debugger, adding extra output statements, or hand-tracing code.	All Units
C. Understand and modify existing code	All Units
D. Extend existing code using inheritance	Unit 7
E. Understand error handling	
1. Understand runtime exceptions.	All Units
2. Throw runtime exceptions	All Units
F. Reason about programs	
1. Pre- and post-conditions	Unit 1
2. Assertions	Unit 1
G. Analysis of algorithms	
1. Informal comparisons of running times	Unit 2
2. Exact calculation of statement execution counts	Unit 2
3. Big-Oh notation	Unit 2
4. Worst-case and average-case time and space analysis	Unit 2
H. Numerical representations and limits	
1. Representations of numbers in different bases	Unit 1
2. Limitations of finite representations (e.g., integer bounds, imprecision of floating-point representations, and round-off error)	All Units
IV. Standard Data Structures	
Data structures are used to represent information within a program. Abstraction is an important theme in the development and application of data structures.	
A. Simple data types (int, boolean, double)	Unit 1
B. Classes	Unit 1
C. One-dimensional arrays	Unit 1 and 2
D. Two-dimensional arrays	Unit 6
E. Linked lists (singly, doubly, circular)	Unit 9
F. Stacks	Unit 10
G. Queues	Unit 10
H. Trees	Unit 11
I. Heaps	Unit 15
J. Priority queues	Unit 15
K. Sets	Unit 13
L. Maps	Unit 14
V. Standard Algorithms Standard algorithms serve as examples of good solutions to standard problems. Many are intertwined with standard data structures. These algorithms provide examples for analysis of program efficiency.	
A. Operations on AB-level data	
1. Traversals	Unit 1,3,6,9 - 15
2. Insertions	Unit 1,3,6,9 - 15
3. Deletions	Unit 1,3,6,9 - 15
4. Iterators	Unit 1,3,6,9 - 15
B. Searching	

1. Sequential	Unit 1
2. Binary	Unit 1
3. Hashing	Unit 12
C. Sorting	
1. Selection	Unit 1
2. Insertion	Unit 4
3. Mergesort	Unit 5
4. Quicksort	Unit 5
5. Heapsort	Unit 15
VI. Computing in Context A working knowledge of the major hardware and software components of computer systems is necessary for the study of computer science, as is the awareness of the ethical and social implications of computing systems. These topics need not be covered in detail but should be considered throughout the course.	
A. Major hardware components	
1. Primary and secondary memory	All Units
2. Processors	All Units
3. Peripherals	All Units
B. System software	
1. Language translators/compilers	All Units
2. Virtual machines	All Units
3. Operating systems	All Units
C. Types of systems	
1. Single-user systems	All Units
2. Networks	All Units
D. Responsible use of computer systems	
1. System reliability	Unit 16
2. Privacy	Unit 16
3. Legal issues and intellectual property	Unit 16
4. Social and ethical ramifications of computer use	Unit 16