

Graduate Assessment Test (Sample)

Programming

1. Fibonacci sequence is defined by a recurrence relation. The series is: 0,1,1,2,3,5,8,13,... Write a complete recursive method/function that returns the fibonacci sequence element for a particular index;

```
int fibonacci(index)
{
```

2. Draw a BST (Binary Search Tree) with the following integer values: 60,55,45,57,59,100,67,107,101.

Give the sequence of the nodes visited by preorder, postorder and inorder traversal algorithms.

3. Give a suitable class definition of a node in BST.

Write a search method/function that determines if the element is present in the BST.

Algorithms and Theory

1. Consider that $T(n) = 2T(n/2) + f(n)$; where $f(n) = n^2$. Find a theta notation for $T(n)$

2. Derive the time complexity (in theta notation) for the number of times the statement $x=x+1$ is executed $j=n$

```
while (j>=1) {
    for i=1 to j
        x= x+1;
    j=j/2
}
```

3. Express the recurrence relation for the Fibonacci sequence (problem #1).

What is the solution in "O" notation.

4. Give the Regular Expression that describes the set of Strings over (0,1) where every 0 is always followed by a 1

Draw a nondeterministic finite automaton (may use null transitions)

5. Consider the following grammar:

$\langle S \rangle \rightarrow a\langle S \rangle b\langle S \rangle \mid a\langle S \rangle b\langle S \rangle c\langle S \rangle \mid d$

Give two distinct derivations on the string: adbadbdc (Show steps) Based on

two distinct derivations, how do you classify this grammar.

6. Using the Chomsky hierarchy of formal languages, (i) name the types of language and (ii) the corresponding automata that accepts the language

$L = \{0^n 10^m 1^* \mid m > n \text{ where } m, n \text{ are positive integers}\}$

Web programming

Complete the following application using any technology. JSP is preferable as its competency is expected for the graduate class. However, you can implement this application using any other technology for which you need to bring your own laptop.

[Introduction]

A local ACM Student Chapter has accumulated a sizable collection of technical books over the last few years. Most of the books are about topics such as software development, networking, and program languages, which would interest many students and faculty. However, due to the lack of a proper distribution mechanism, the books are just collecting dust now on the shelves in the ACM office. To rectify this situation, the ACM chapter has chosen a member to be the librarian to manage these books. To make the life of the librarian a little easier, you are going to develop an online book reservation system, using, of course, JSP without scripting elements. With this system, students and faculty can browse and reserve the books that they are interested in online, and later pick up the physical copies of the books at the ACM office. The system also helps the librarian to keep track of the books in the collection.

In its simplest form, the online book reservation system consists of a Login page, a User page, a Librarian page, and a backend database.

[Database]

The backend database contains the following information: The title and description of each book.

The username and password of each user, and whether the user is a librarian or not.

The status of each book, which could be Available, Reserved, or CheckedOut. And for the books that have been reserved (or checked out), the database also keeps track the user who reserved (or checked out) the book.

For this part of the exam, you need to turn in a library.sql file which include the statements to create all the tables in the database, and the statements to populate the tables so that there are at least four books in the database, and each table has at least two records.

[Login]

A user must login to reserve books online. The Login page validates the username and password provided by a user against the information stored in the database. If the authentication is successful, the Login page redirects the user to the User page or the Librarian page based on whether the user is a librarian or not.

[User]

The User page allows a user to browse, search, and reserve books, as shown below:

<input type="text"/> Search			
Title	Description	Status	
Code Complete	Best practices in the art and science of constructing software. Topics include design, applying good techniques to construction, eliminating errors, planning, managing construction activities, and relating personal character to superior software	Available	<input type="checkbox"/>
Programming C#	Programming C# provides an adept and extremely well conceived guide to the C# language and is written for the developer with some previous C++, Java, and/or Visual Basic experience.	CheckedOut	
Java - How to Program	Enormous, expensive, heavy (I carried it around northern europe for a month so I know this!) and overwrought. Too much bloat and prattle at times. Excellent presentation. May overwhelm a beginner.	Reserved	
Core Servlets and JavaServer Pages	Intended for developers familiar with Java, this guide explains the role of servlets and JavaServer Pages (JSP) in creating e-commerce sites, dynamic web sites, and web-enabled services. Topics include handling missing data, manipulating HTTP status codes, redirecting requests, setting JavaBean properties, and accessing databases with JDBC. The second edition has been updated to servlets 2.4 and JSP 2.0	Available	<input type="checkbox"/>
<input type="button" value="Reserve"/>			

By default the page displays all the books in the database. A user may use the keyword search feature to limit the display to only the books whose title or description contains the keyword.

A user can reserve the books which are currently available. However, the total number of books which are reserved or checked out by the same user cannot be more than 2. For example, a user may reserve at most two books, and if he or she has already reserved or checked out one book, then the user can reserve only one more book. If the reservation fails due to the violation of this rule, an error message should be displayed, and if the reservation succeeds, the status of the reserved books should be changed from Available to Reserved.

[Librarian]

The Librarian page allows a librarian to view and update the status of the books through drop-down lists, as shown below:

<input type="text"/> <input type="button" value="Search"/>		
Title	Status	User
Code Complete	Available	
Programming C#	CheckedOut ▼	cysun
Java - How to Program	Reserved ▼	somebody
Core Servlets and JavaServer Pages	Available	
<input type="button" value="Update"/>		

Note that the Librarian page is designed to allow only three kinds of status updates:
from CheckedOut to Available
from Reserved to CheckedOut
from Reserved to Available

And similar to the User page, the Librarian page also has a keyword search feature, which can be used to limit the display to only the books whose title or description contains the keyword.

[Grading Criteria]

Database (20pt)

Login

- basic username and password validation (10pt)
- redirect based on user type (10pt)

User

- search (15pt)
- display (including proper display of the checkboxes) (20pt)
- reservation (25pt)

Librarian search (10pt)

- display (including proper display of the drop-down lists) (20pt)
- update (30pt)
- final.html is missing or doesn't have the link to your application on the CS server (-10pt)

Only features working correctly on the CS server will receive full credit. Partial credit will be given at my discretion.

The total of the final is 100pt.

Anything above 100 is considered extra credit.