King Fahd University of Petroleum and Minerals

Department of Information and Computer Science

ICS 535-01 (051)

Design and Implementation of Programming Languages

Final Exam

7:00 PM
Room 22-130
(120 Minutes)

Dr. Mamdouh Najjar

Name : _____

Student ID :_____

Question No	Maximum points	Student points
1	12	
2	12	
3	10	
4	10	
5	16	
6	10	
7	10	
8	10	
9	10	
10	10	
11	10	
Total	120	

January 22, 2006

Question 1: **(12 points)**

1.a) An *attribute grammar* is a context-free grammar augmented with certain formal devices that enables the non-context-free aspects to be specified by means of a powerful and elegant mechanism. What are these formal devices?

The formal devices are:

Attributes
Evaluation rules
Conditions

1.b) Determine the set of terminal strings generated by the following attribute grammar, where Size is a synthesized attribute of <x string> and an inherited attribute of <y string> and <z string>:

<string> ::= <x string> <y string> <z string>
Size(<y string>) ← Size(<x string>)
Size(<z string>) ← Size(<x string>)

<x string> ::= ***x***
Size(<x string>) ← 1
| <x string>$_2$ ***x***
Size(<x string>) ← Size(<x string>$_2$) + 1

<y string> ::= ***y***
Condition: Size(<y string>) = 1
| <y string>$_2$ ***y***
Size(<y string>$_2$) ← Size (<y string>) -1

<z string> ::= ***z***
Condition: Size(<z string>) = 1
| <z string>$_2$ ***z***
Size(<z string>$_2$ ← Size(<z string>) – 1

The length of string *y* and the string *z* must be equal to the length of string *x*

Question 2: **(12 points)**

2.a) Order the three formal semantic approaches in order of increasing abstraction with respect to the concept of "meaning" underlying them:

1)_____ (least abstract)

2)_____

3)_____ (Most abstract)

2.b) Define the concepts of "meaning" in each of the three approaches:

Operational:

Denotational:

Axiomatic:

2.c) Who benefit form each of the formal semantic formalization:

Operational:

Denotational:

Axiomatic:

Question 3: **(15 points)**

Given the following abstract syntax "rules" for the Pam language:

```
is-series = is-st-list
is-st = is-read-st | is-write-st | is-asmt-st | is-cond-st |
      is-def-loop | is-indef-loop
is-read-st = (<s-r : is-var-list>)
is-write-st = (<s-w : is-var-list>)
is-asmt-st = (<s-lhs : is-var> , <s-rhs : is-expr>)
is-cond-st = (<s-ifpart : is-comp> , <s-thenpart : is-series>,
             <s-elsepart : is-series>)
is-def-loop = (<s-limit : is-expr>, <s-body : is-series>)
is-indef-loop = (<s-test : is-comp> , <s-body : is-series>)
is-comp = (<s-left-opd : is-expr> , <s-right-opd : is-expr>,
           <s-rel : is-EQ | is-GT | is-LE | is-LT | is-GE | is-NE>)
is-expr = is-infix-expr | is-var | is-intg
is-infix-expr = (<s-left-opd : is-expr>, <s-right-opd : is-expr>,
           <s-opr : is-PLUS | is-MINUS | is-TIMES | is-OVER>)
is-var = (<s-addr : is-intg>)
```

Draw a tree diagram of a VDL object satisfying 'is-series' and corresponding to the Pam program

```
read a ;
if a = 0 then read b ; write b else write a fi
```

Question 4: **(10 points)**

Using the Composition rule as well as the Assignment rule, give examples of true assertions of the form

$$\{P\}\ a := b - c + a\ ;\ a := b - c + a\ \{Q\}$$

Hint:

Assignment rule: $\{P^{V}_{E}\}\ V := E\{P\}$

Composition rule:

$$\frac{\{P\}\ S_1\ \{Q\}\ ,\ \{Q\}\ S_2\ \{R\}}{\{P\}\ S_1\ ,\ S_2\ \{R\}}$$

Question 5: **(16 points)**

(from: "**On The Notion of Inheritance**", by Antero Taivalsaari, ACM Computing Surveys, Vol. 28, No. 3, September 1996)

5.a) What is meant by inheritance as a programming language feature and what is it's basic idea?

- **Depending on the viewpoint, inheritance is regarded either as:**
  - **a structuring or modeling mechanism about programs**
  - **a mechanism for code sharing and reuse**

- **Basic idea of inheritance:**
  - **Allows new object definitions to be based upon existing ones;**
  - **When a new kind of an object class is to be defined, only those properties that differ from the properties of the specified existing classes need to be declared explicitly**
  - **The other properties are automatically extracted from the existing classes**

5.b) Given the following statements:

- A *programming language* is a notation and, as such, serves to record and assist the development of human thought in a particular direction.
- For a notation to be *effective*, it must carry a mental load for the user and must have, among other properties, *economy* and the ability to subordinate detail.

What is meant by *economy* in the above context?

Economy **means that a wide range of programs can be expressed using a relatively small vocabulary and simple grammatical rules.**

5.c) Define conceptual modeling of inheritance. What are the four abstraction principles in the conceptual view of inheritance?

- ***Conceptual modeling*** **can be defined as the process of organizing our knowledge of an application domain into hierarchical rankings or orderings of abstractions, in order to obtain a better understanding of the phenomena in concern.**

Abstraction principles:

- **Classification/instantiation**
- **Aggregation/decomposition**
- **Generalization/specialization**
- **Grouping/individualization**

Question 6: **(10 points)**

(From: "On Understanding Types, Data Abstraction, and Ploymorphism" by L. Cardelli and P. Wegner, Computing Surveys, Vol. 17, No. 4, December 1985, pp. 471-522.)

Question 7: **(10 points)**

(From: "Concurrency and Distribution in Object-Oriented Programming" by J-P. Briot, R. Guerraoui, and K. Lohr, ACM Computing Surveys, Vol. 30, No. 3, September 1998, pp. 291-329.)

Question 8: **(10 points)**

(From "**JR: Flexible Distributed Programming in an Extended Java**", A. Keen, ACM Transactions on programming languages and Systems, Vol. 26, No. 3, May 2004, pp. 578-608)

8.a) Java concurrency model is limited. Explain what concurrency features it provides and why is it limited?

Because it only provides:

Threads

Remote method invocation (RMI)

8.b) JR extends Java concurrency model. What does the JR language provides more than what Java provides?

JR language provides the following Features:

Dynamic remote virtual machine creation

Dynamic remote object creation

Asynchronous communication

Rendezvous

Dynamic process creation

8.c) How is JR implemented?

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Question 9: **(10 points)**

You are working as a senior computer advisor in a big company in the retail business (*XB)*, the company has over 1000 retail stores in 35 countries and over 50000 employees. You are asked to form and to chair a team to reduce the high expense in using different computer systems developed in five programming languages, namely: COBOL, FORTRAN, C, Java, VB.

What are the steps you and your team will do to achieve the goal?
What criteria the team will use for the selection of an appropriate language(s)?

Question 10: **(10 points)**

There are four different programming language paradigms, discuss the domain of use for each. What is your opinion about the future existence of these four paradigms, and the future of programming languages in general.

Question 11: **(10 points)**

In brief, what did you learn from this course?