BITS, Pilani – Dubai. International Academic City, Dubai

III Year SECOND Semester 2007-2008

Degree: B.E.(Hons.). Branch: C.S.

Comprehensive Examination Question Paper

Course No : CSUC 362 Course Title: Programming Languages and Compiler Construction

Date: 24/05/08 Saturday Time: 10 a.m.- 1 Noon Total marks: 80 Weightage: 40%

Data provided are complete. ***Closed Book***.

This question paper has 5 pages.

Answer **all** Questions

1. Find the NULLABLE, FIRST and FOLLOW sets for the following CFG and then Construct the PREDICTIVE PARSING TABLE: (1+2.5+2.5+4 marks)

(Note: here **ϵ** denotes null)

$S \rightarrow E\$$

$E \rightarrow TE'$ $T \rightarrow FT'$ $F \rightarrow$ **id**

$E \rightarrow +TE$ $T' \rightarrow *FT'$ $F \rightarrow$ **num**

$E \rightarrow -TE$ $T' \rightarrow /FT'$ $F \rightarrow (E)$

$E \rightarrow \epsilon$ $T' \rightarrow \epsilon$

2. Write a JAVA program to generate and find the SUM of the following series: (7 marks)

```
SUM = 1 - 2 - 3  +  4  + 5 + 6 - 7 - 8  - 9 - 10 + ... N th term
```

(You can read the input value for N either through *command line argument* or through *keyboard*). See the following example scenario:

INPUT	OUTPUT
	1
2	-1
3	-4
4	0
5	5
10	-23

PTO

3. Consider a *simple assignment statement*:

$$d := (a+20) + (a - 4) + (d + c)$$

You are required to generate CODE for the above statement using a simple code generation algorithm and tabulate your steps as shown below:

Statements	Code Generated	Register Descriptor	Address Descriptor
..	. .. .	....	....

[5 marks]

4. You are required to **write LEX SOURCE** and **YACC SOURCE** to implement a **four function calculator** that performs addition, subtraction, multiplication and division on input NUMBERS. Assume that the NUMBERS are

positive INTEGERS
or
positive REAL NUMBERS with 2 digits after decimal point.

Example:	INPUT	OUTPUT	
	14.26+26.14	40.40	
	(14.26+26.14)	40.40	
	(14+14.20)	28.20	
	(14.5+2)	16.5	
	(14+14)	28.00	[3+5 Marks]

5. Explain in detail the *mark-and-sweep* garbage collection algorithm. [5 marks]

6. Write a PICO LISP program to implement the following function using recursion

$a_n = (3 * a_{n-}) + 2$ with $a_0=5$ and **n** is a positive integer.

[3 marks]

7. Write a SWI-PROLOG program to implement the following function using recursion

$a_n = (2 * a_{n-}) + n + 1$ with $a_0=5$ and **n** is a positive integer.

[3 marks]

PTO

8. Write the output generated by the following JAVA program: [5 marks]

```
// program T.java
public class T

  public static void main (String[]args)


    int[][] t = new int[10][];
    for (int i = 0; i < t.length; i++

      t[i] = new int[i + 1];


    for (int i = 0; i < t.length; i++

      for (int j = 0; j < t[i].length; j++

          System.out.print (2 * i + t[i][j] + 3 *  );
          System.out.print ('\t');

      System.out.println
```

9. Break the following program into BASIC BLOCKS and Write them.

1. m ← 0
2. v ← 0
3. if v >= n goto 15
4. r ← v
5. s ← 0
6. if r < n goto 9
7. v ← v + 3
8. goto 3
9. x ← M[r]
10. s ← s + x
11. if s <= m goto 13
12. m ← s
13. r ← r + 6
14. goto 6
15. return m

[4 marks]

PTO

10. Write a LEX program [source] to check the output for an Exclusive OR GATE with 2 input values. Your program should handle correct as well as incorrect inputs. [5 marks]

(Test Case shown below will give you an idea about legal/illegal inputs and the expected output, during your program execution. It is just enough if you write the LEX source alone.)

INPUT:	OUTPUT:
0 0	0
0 1	1
1 0	1
1 1	0
A B	invalid input
A	invalid input
9 2	invalid input
9 D	invalid input

11. Draw the layout of a typical STACK FRAME (ACTIVATION RECORD) for a function and briefly explain its contents. [5 marks]

12. Write the output generated by the following C program: (5 marks)

```
#include <stdio.h>
main ()
{
  void e (int *we, int *gg);
  int x[10], i;
  int n = 2;
  for (i = 0; i < 10; i += 1
    {
      x[i] = 2 * n;
      e (&x[i], &n);
      n = n * 2 + 2;
```

```
void
e (int *we, int *gg)
{
  int m, z;
  m = *we * 2;
  z = *gg * 2 + 2 * m;
  m += z;
  printf (" z = %d m= %d \n", z, m);
```

13. Explain the basic principles w.r.t. LIVENESS ANALYSIS. [5 marks]

14. Explain REDUCTION IN STRENGTH w.r.t CODE OPTIMIZATION with an example. [2 marks]

PTO

15. What is an Interference Graph w.r.t. Register Allocation. [2 marks]

16. What are the advantages of DELAYED LINKING w.r.t. Language Systems ? [2 marks]

17. Define FLOW OF CONTROL CHECKS and UNIQUENESS CHECKS in TYPE CHECKING. Mention an example in each category. [2 marks]

18. Briefly explain the following w.r.t. Intermediate Representation tree:
    a) **Mem(e)**

    b) **ESEQ(s,e)** [2marks]

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TEST II Question Paper

Course No : CSUC362 Course Title: Programming Languages and Compiler Construction

Date: 10 Apr., 2008 Thursday Time: 50 minutes Total marks: 20

Data provided are complete. **OPEN *Book***. This qn paper has 2 pages.

Textbook, Reference Book and student's own handwritten class notes permitted.

Answer all Questions.

1. It is required to store all PRIME NUMBERS between 1 and 50 in a Symbol Table. Assume a HASH TABLE implementation for the Symbol Table and the hash function is defined as follows:

" **Hash Value** = (INPUT PRIME NUMBER) % 7 ". Here, % means modulus (remainder after division). This hash value will be the position at which the input prime number will be inserted.
Draw the layout of the Symbol Table showing its contents. [3 M]

2. Complete the following statement:

The SEMANTIC ANALYZER uses _____

_____ to check the source program for semantic consistency with language definition. [1 M]

3 Construct the DAG (directed acyclic graph for higher level representation of intermediate code) for the following arithmetic expression:

a * (a + b) + c * (a + b) + d * (g + h) + j * (g + h)

4. Translate the following program segment into Three Address Code (Quadraples):

```
begin
    while ( i <= 10)
      begin
          k = k + 1
          j = k + j
          i = i + 1
      end
    j = j + 10
end
```

Assume that *i,j,k* are all integers whose initial values are zero. [2 marks]

P.T.O.

	SEMANTIC RULES
$L \rightarrow E$ **n**	print(*E*.val)
$E \rightarrow E_1 + T$	*E*.val = E_1.val + *T*.val
$E \rightarrow T$	*E*.val=*T*.val
$T \rightarrow T_1 * F$	*T*.val=T_1.val * *F*.val
$T \rightarrow F$	*T*.val=*F*.val
$F \rightarrow (E)$	*F*.val=*E*.val
$F \rightarrow$ **digit**	*F*.val=**digit**.lexval

Construct an annotated PARSE TREE for the following input expression:

(4 * 7 + 1) * 2 [2.5 M]

6. Find the NULLABLE, FIRST and FOLLOW sets for the following CFG and then Construct the PREDICTIVE PARSING TABLE: (1+2+2+3 marks)

$X \rightarrow S$**$**

$S \rightarrow$ **id(***L***);**

$S \rightarrow$ **if (***E***)** *S* **else** *S*

$L \rightarrow$ **ϵ**

$L \rightarrow E\,C$

$C \rightarrow$ **ϵ**

$C \rightarrow$ **,** $E\,C$

$E \rightarrow$ **id**

$E \rightarrow$ **num**

Note: Here, **ϵ** indicates null and **$** indicates END OF INPUT.

7. Show the steps in evaluating the following expression in an ABSTRACT STACK MACHINE:

a := (c * d) + (2 *d + 2)

[1.5 M]

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TEST I Question Paper

Course No : CSUC362 Course Title: Programming Languages and Compiler Construction

Date: 24 Feb., 2008 Sunday Time: 50 minutes Total marks: 20

Data provided are complete. **Closed *Book***. This qn paper has 2 pages.

Answer all Questions.

1. Write the OUTPUT of the following C Program: [4.5 marks]

```
#include <stdio.h>
main ()
{
  void e (int xx,      *nn, int j);
  int x[9], i;
  int y[9];
  int n = 7;
  for (i = 8; i >= 0;    -= 1)

      x[i] = 1 + (2 * n);
      y[8 - i] = 2 * x[i] + 3;
      e (x[i], &n, y[8 - i]);
    }
}
void
e (int xx,      *nn, int j)
{
  int m, z;
  m = *nn + 1;
  z = xx + 1;
  *nn = (*nn * 2) + 1;
  printf (" m = %d z= %d j = %d \n",     z, j);
```

2. Distinguish between Internal Symbols and External Symbols in PICO-LISP. [2 marks]

[P.T.O.]

3. Consider the following LISP Program:

```
(de a(n)
  ( if (= n 1)
    2
  ( -   ( *  n    ( + 3  (a(- n 1) ) ) )  2 )
 ))
```

Write the result (output) of each of the following LISP Expressions for the above code:
i) **(a 4)** ii) **(a 2)** iii) **(a 1)** iv) **(a 3)** v) **(a 6)** vi) **(a 5)**
[3 marks]

4. Use the following information and **Construct a simple database of relationships** in SWI-PROLOG: [3 marks]

Diet is related to people's priorities. Elderly people concerned about their blood-pressure often avoid fats.

Athletes, who are concerned with energy and body-building, eat sugar and proteins. For similar reasons, growing children are given these foods.

Overweight people who want to lose weight avoid sugar and facts.

5. *Write a SWI-PROLOG program* to find the total of the following series:

1 + 1/2 + 1/3 + 1/4 + 1/5 + ... + 1/N

A *sample execution* scenario (after successful compilation of your program) is shown below:

?- series(4,Total). (This is the input typed by you)
Total = 2.08333 (This is the output of your program) [2.5 marks]

6. Explain DELAYED LINKING with respect to
a) UNIX b) JAVA [3 marks]

7. Distinguish between a PROCEDURAL LANGUAGE and OBJECT-ORIENTED LANGUAGE. [2 marks]