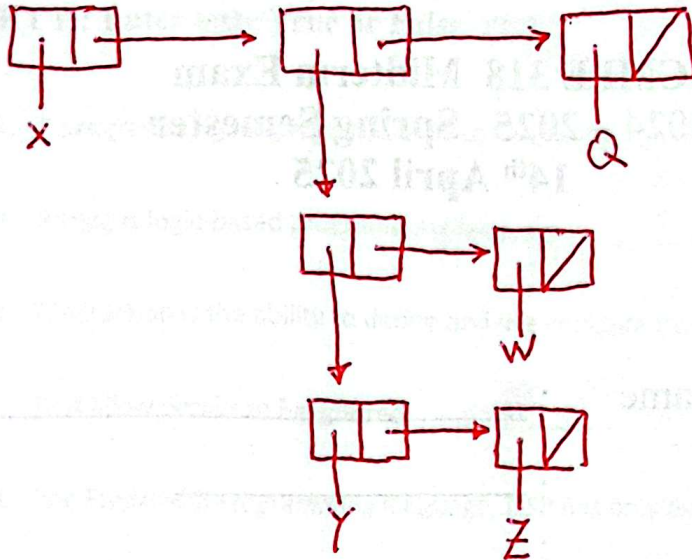


PART I: Short answer questions

1. Give the internal representation of the Lisp list "(X ((Y Z) W) Q)". (8 pts)



2. Give a leftmost derivation for the string "b a c d" from the following grammar. (8 pts)

$S \rightarrow AB$
 $A \rightarrow aA \mid b$
 $B \rightarrow cB \mid d$

(8 pts)

$S \rightarrow AB$
 $\rightarrow aAB$
 $\rightarrow abB$
 $\rightarrow abcB$
 $\rightarrow abcd$

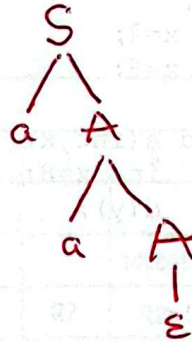
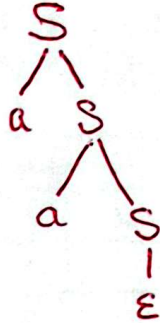
OR

$S \rightarrow AB$
 $\rightarrow bB$
 $\rightarrow bcB$
 $\rightarrow bcd$

3. Given the following grammar:

$$\begin{aligned} S &\rightarrow aS \mid aA \mid \epsilon \\ A &\rightarrow bA \mid aA \mid \epsilon \end{aligned}$$

a. Prove that the grammar is ambiguous. (8 pts)



b. Eliminate Pairwise Disjointness issues in the grammar (8 pts)

$$\begin{aligned} S &\rightarrow aX \mid \epsilon \\ X &\rightarrow S \mid A \\ A &\rightarrow bA \mid aA \mid \epsilon \end{aligned}$$

4. Give an equivalent BNF grammar to the following EBNF. (10 pts)

$$S \rightarrow [x \mid y] \{ (a \mid b) A \}$$

$$A \rightarrow b \{ z \}$$

$$\begin{aligned} S &\rightarrow PQ \\ P &\rightarrow x \mid y \mid \epsilon \\ Q &\rightarrow QaA \mid QbA \\ A &\rightarrow Az \mid b \end{aligned}$$

OR

$$\begin{aligned} S &\rightarrow SaA \mid SbA \mid Q \\ Q &\rightarrow x \mid y \mid \epsilon \\ A &\rightarrow Az \mid b \end{aligned}$$

5. We are given the following program in the language Tau that has a syntax similar to C. Print just prints all of its arguments on a single line.

```

void b() {
    int x=1; y=3; z=5;

    void e() {
        int x=4;
        int z=6;

        void a(int x) {
            int z=8;
            d(y);
        }

        a(y);
    }

    void d(int x) {
        print("d:", x+y+z);
    }

    e();
}

```

b calls e
 e calls a
 a calls d

What is the output of the program if we call b(), and

i) Tau uses static scoping?

(8 pts)

d: 11

ii) Tau uses dynamic scoping?

(10 pts)

d: 14

6. We are given a context free grammar, and its LR parsing tables below.
(pts)

(15

1. $E \rightarrow E + T$
2. $E \rightarrow T$
3. $T \rightarrow T * F$
4. $T \rightarrow F$
5. $F \rightarrow (E)$
6. $F \rightarrow id$

State	Action						Goto		
	id	+	*	()	\$	E	T	F
0	S5			S4			1	2	3
1		S6				accept			
2		R2	S7		R2	R2			
3		R4	R4		R4	R4			
4	S5			S4			8	2	3
5		R6	R6		R6	R6			
6	S5			S4				9	3
7	S5			S4					10
8		S6			S11				
9		R1	S7		R1	R1			
10		R3	R3		R3	R3			
11		R5	R5		R5	R5			

Give the configurations of the LR parser for the input "id * (id + id)".
ONLY THE FIRST 5 CONFIGURATIONS WILL BE GRADED.

Stack	Input	Action
0	id * (id + id) \$	S5
0id5	* (id + id) \$	R6
0F3	* (id + id) \$	R4
0T2	* (id + id) \$	S7
0T2*7	(id + id) \$	S4
0T2*7(4	id + id) \$	

⋮

PART II: Enter only True or False (T/F)

(25 pts)

1. C programming language was built to look like simple English. F
2. Prolog is logic-based programming language. T
3. Abstraction is the ability to define and use complex structures or operations in ways that allow details to be ignored. ~~F~~ T
4. The Functional Programming language, LISP has only two data types: integer and float F
5. Syntax is the meaning of the expressions, statements, and program units.
F
6. Python is an IMPERATIVE programming language T
7. First full implementation of an object-oriented language is in Pascal. F
8. The full meaning of BNF is Binary Normal Form. F
9. Pure Interpretation is programming implementation method. T
10. The scope of a variable is the time during which it is bound to a particular memory cell. F