Compiler Design
Final Exam , Spring 1995.

May 8, 1995

Answer All Questions:

NAME:

LOGIN NAME:

This is an open book, open notes examination. There are **eight** questions. All questions carry 15 points. Some questions have a and b parts in which case they are weighed equally. If you get 100 points, then you have max-ed the paper. It is possible that you get more than 100 points, which will be counted as extra points towards your grade. Goodluck and have a happy summer.

Problem	Points Scored	Points Possible
1	____________	15
2	____________	15
3	____________	15
4	____________	15
5	____________	15
6	____________	15
7	____________	15
8	____________	15

1. a)Construct minimum state DFA for the following regular expression: $(a|b)^*a(a|b)$

b) Write a Lex program to reverse the letters in each word for a given text. (e.g. if the input is : begin I am Smart end the output is: ngieb I ma tramS dne) A word is a bunch of letters and digits separated by spaces or newlines or tabs.

2. a) Consider the grammar

```
S -> ( S ) S | ) S ( S | epsilon
```

The terminal symbols are (and). Is the above grammar ambiguous and explain with examples.

b) Construct a SLR parsing table for the following grammar.

```
E -> E + T | T
T -> T F | F
F -> F * | a | b
```

3. Give a syntax directed translation scheme (a pseudo yacc program will suffice) to differentiate expressions formed by applying the arithmetic operators + and * to the variable x and constants. Assume no simplification takes place. As an example if the input is $x*(x+1995)$, the output will be $1*(x+1995)+x*(1+0)$. The rules for differentiation: diff(E1+E2) = diff(E1)+ diff(E2); diff(E1*E2) = E2* diff(E1) + E1*diff(E2);

4. a) Find the most general unifier for the following type expressions:

$$(pointer(\alpha)) \times \beta \to \gamma$$
$$\beta \times \gamma \to \delta$$

b) What is the type of the following function (please derive the steps in the style of 6.12

```
fun member(a,x) =
if null(x) then error
else if a = hd(x) then x
else member(a, tl(x));
```

Assume the type of error is void.

5. a)Suppose the procedure swap2 is declared as follows:

```
procedure swap2(x,y: integer);
procedure f() : integer;
var x:integer;
begin (* f *)
z := x; x: = y; return z
end f;
begin (* swap2 *)
y := f()
end swap2;
```

Describe the effect of the procedure call swap2(i,A[i]) under each of the following parameter-passing methods:

- call-by-value
- call-by-reference
- call-by-value-result
- call-by-name

b) Do problem 7.8 page 457 just the b) part only.

6. a) Do problem 8.14 page 510.

b) Convert the following into three address statements.

```
main()
{ int i, a[5],b[5];
 for (i=0;i<5;i++)
 a[b[i]] = b[a[i]];
}
```

7. a) What information should be maintained in an abstract syntax tree, so that assembler code can be generated by walking down the tree.

b) For this C program segment, construct the tree and generate the assembler code you are allowed to use pseudo assembler code.

```
for (i=0;i<10;i++)
a[i] = random() % 2;
```

8. a) Find the optimal code on a single register machine. You are allowed to rearrange the statements but preserve the same functionality.

```
a:=b+c; d:=e; f:= a* c;
```

b) For Fig 10.74 (page 713) Compute the live variables at the end of each block.