Masters of Computer Applications
MCAC 401: Compiler Design
Unique Paper Code: 223401402
Semester IV
May-2022
Year of admission: 2020

Time: 3 + 0.5 hours

Max. Marks: 70

Instructions:

1. Parts of a question should be answered together.
2. Attempt any SEVEN questions.

1. ~~a~~. Consider the following Syntax Directed Definition (SDD), with non-terminals {S, A} and terminals {a, b}: **3 marks**

$S \rightarrow a\,A\ \{printf("1");\}$
$S \rightarrow a\quad \{printf("2");\}$
$A \rightarrow S\,b\ \{printf("3");\}$

What is the output for the given input *aab* using bottom-up parser? Show all the intermediate steps.

b. How does the precedence and associativity of operators help to resolve conflicts in the following ambiguous grammar? **3 marks**

$$E \rightarrow E + E \mid E * E \mid (E) \mid id$$

~~c~~. Consider the following C function to compute Fibonacci numbers. The activation record of f includes the elements in order: (return value, argument n, local s, local t). Assume that the initial call is $f(4)$, what are the contents of run-time stack (i.e. sequence of activation records) when $f(1)$ invoked for the first time. **4 marks**

```
int f(int n)
{
  int t, s;
  if(n < 2) return 1;
s ~~a~~ = f(n − 1);
t ~~b~~ = f(n − 2);
  return s + t;
}
```

2. a. Consider the Syntax Directed Definitions: **4 marks**

$T \rightarrow T_1 * F \quad \{T.val = T_1.val \times F.val\}$
$E \rightarrow T \quad \{E.val = T.val\}$
$E \rightarrow E_1 + T \quad \{E.val = E_1.val + T.val\}$
$T \rightarrow F \quad \{\mathrm{T}.val = F.val\}$
$F \rightarrow G \uparrow \mathrm{F} \quad \{F.val = POWER(F.val, G.val)\}$
$F \rightarrow G \quad \{\mathrm{F}.val = G.val\}$
$G \rightarrow digit \quad \{G.val = digit.lexval\}$

Construct annotated parse tree for $1 * 3 \uparrow 2 + 5 * 3$ and give the output.

b. Show that the following grammar: **6 marks**

$S \rightarrow A\ a \mid b\ A\ c \mid B\ c \mid b\ B\ a$
$A \rightarrow d$
$B \rightarrow d$

is LR (1), but not LALR (1).

3. a. Find the $FOLLOW()$ for every non-terminal in the following grammar. **3 marks**
$S \rightarrow B\ b \mid C\ d$
$B \rightarrow a\ B \mid \in$
$C \rightarrow c\ C \mid \in$

b. Consider the following grammar. Give three viable prefixes for the input string $+ * \boldsymbol{aaa}$ **3 marks**

$$S \rightarrow + S\ S \mid * S\ S \mid a$$

c. Write token name, lexeme and attribute value for each token in the following C statement: **4 marks**

$a *= b;$

4. a. Write a type expression for an "array of 4 arrays of 3 integers each". **2 marks**

b. What error recovery actions are performed by Lexical Analyzer? **3 marks**

c. Consider the following augmented grammar **5 marks**

$$S' \rightarrow S$$
$$S \rightarrow iSeS \mid iS \mid a$$

Construct the SLR (1) parsing table.

5. a. Write a Lex program to count the positive numbers, negative numbers and fractional numbers in a file. **4 marks**

b. What is calling and return sequence when a procedure A calls procedure B? Describe using the control stack. **6 marks**

6. a. Define handle pruning with the help of a suitable example. **2 marks**

b. Write regular expressions for an identifier and a floating-point integer. **3 marks**

c. Consider a hypothetical machine with three general purpose registers and an accumulator register. The machine supports load, store, move, arithmetic, and logical operations with two operands. All the arithmetic and logical instructions require both its operands to be in registers. **5 marks**

Generate the machine code for the following quadruples representing intermediate code. Determine the cost of each machine instruction. Clearly, state the assumptions, if any.

Operation	Operand1	Operand2	Result
-	p	q	t1
*	r	s	t2
*	t	u	t3
/	t1	t2	t4
+	t4	t3	t5
=	t5		a

7. a. Translate the expression $a = (-c) * b + (-c)$ to Quadruples. **2 marks**

b. Draw the transition diagram of the following: **3 marks**
   i. Identifier ii. Whitespace

c. Write the semantic rules for the following productions: **5 marks**

(i) $S \rightarrow while\ (B)\ S_1$

(ii) $S \rightarrow if(B)\ S_1$

Where B is an expression evaluated to either true or false and S denotes a statement.

8. a. What are the benefits of using quadruples over the triples in three address code generator? **2 marks**

b. Consider the augmented expression grammar **8 marks**

$$E' \rightarrow E$$
$$E \rightarrow E + T \mid T$$
$$T \rightarrow T * F \mid F$$
$$F \rightarrow id$$

Construct the LR (0) automaton and parse the input string *id*id* using shift/reduce parser.