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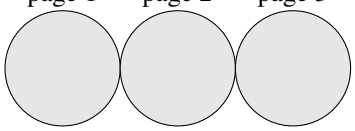

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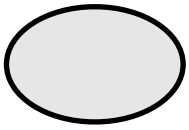

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No books ; No calculator ; No computer ; No email ; No internet ; No notes ; No phone. Neatness counts ! Do your scratch work elsewhere and enter only your final answer into the spaces provided.

1. Given the grammar presented here, and using the style from the LALR(1) handout :
   (a) Construct the characteristic finite state machine (CFSM), sets of items and transition diagram, showing shifts, reductions, and acceptance. **[6✔]**
   (b) Construct the FOLLOW sets. **[3✔]**
   (c) Answer ***yes*** or ***no*** to each of the following questions : **[1✔]**

   Is the grammar LR(0) ? _____ Is the grammar SLR(1) ? _____

0.	**S**	→	**$ A $**
1.	**A**	→	**(L)**
2.	**A**	→	**( )**
3.	**A**	→	**x**
4.	**L**	→	**L A**
5.	**L**	→	

2. Define a grammar for the following language, carefully separating the `bison` grammar from the `flex` grammar. Do not show any semantic a ations. **[5✔]**
   (a) A program is a sequence of zero or more expressions. If more than one expression, they are separated by semi-colons.
   (b) An expression is a function call, or an identifier, or a number.
   (c) A function call is an identifier followed by a parenthesized argument list.
   (d) An argument list is a sequence of zero or more expressions, separated by commas if there are more than one expression.
   (e) An identifier is a sequence of one or more upper and lower case letters.
   (f) A number is a sequence of digits, optionally preceded by a `+` or `-` sign.
   (g) A comment is a hash (`#`) followed by any number of characters not including newline.
   (h) White space is ignored and consists of spaces, tabs, and newlines.

`flex`	`bison`

3. Using the specifications of project 3, draw abstract syntax trees for each of the following. **[5✔]**

```
int f (int n) { // [2 pts.]
   /* This is O(2^n). */
   if (n <= 1) return n;
   return f (n - 1)
        + f (n - 2);
}
```

```
int g (int n) { // [3 pts.]
   /* This is O(n). */
   int a; int b; int c;
   a = 0; b = 1;
   while (n > 0) {
      c = a + b; a = b; b = c;
   }
   return a;
}
```

Multiple choice. To the ***left*** of each question, write the letter that indicates your answer. Write ***Z*** if you don't want to risk a wrong answer. Wrong answers are worth negative points. **[11✔]**

number of correct answers		× 1 =	$= a$
number of wrong answers		× ½ =	$= b$
number of missing answers		× 0 =	0
column total $c = \max(a - b, 0)$	11		$= c$

1. For a grammar $G = \langle V_N, V_T, P, S \rangle$, If LR($k$) analysis generates n states, then the size of the parsing table will be :
   (A) $n \times |V_N|^k$
   (B) $n \times |V_T|^k$
   (C) $n^k \times |V_N|$
   (D) $n^k \times |V_T|$

2. What variable is used to pass semantic information from `yylex` to `yyparse` ?
   (A) `yyerror`
   (B) `yyin`
   (C) `yylval`
   (D) `yytext`

3. The part of the compiler that figures out which declaration of the form `int x;` is being referred to by the statment `x = 3;` is :
   (A) lexical analyzer
   (B) parser
   (C) symbol table manager
   (D) code generator

4. If N is the set of languages recognizable by an NFA, and D is the set of languages recognizable by a DFA, then :
   (A) $N \subset D$
   (B) $N = D$
   (C) $N \supset D$
   (D) none of the above

5. What is a reasonable guess as to what might be printed by :
   `printf (`%p0,`malloc`(1));"
   (A) `0x0`
   (B) `0xdb9b030`
   (C) `0x7fff498c72d9`
   (D) `0xabcdefgh`

6. In order to disambiguate the following grammar consistent with the syntax of C, C++, and Java, we should insert the declaration (x) in the first part of the **bison** grammar, because we need to resolve the shift/reduce conflict in favor of a (y).

```
stmt : IF '(' expr ')' stmt ELSE stmt
     | IF '(' expr ')' stmt %prec ELSE
     | other
     ;
```

   (A) (x) = `%left ELSE` (y) = reduce.
   (B) (x) = `%left ELSE` (y) = shift.
   (C) (x) = `%right ELSE` (y) = reduce.
   (D) (x) = `%right ELSE` (y) = shift.

7. Which statement is true about these languages ?
   (A) $LR(0) \subset LALR(1) \subset SLR(1) \subset LR(1)$
   (B) $LR(0) \subset LR(1) \subset SLR(1) \subset LALR(1)$
   (C) $LR(0) \subset SLR(1) \subset LALR(1) \subset LR(1)$
   (D) $LR(1) \subset LALR(1) \subset SLR(1) \subset LR(0)$

8. Which of these items was entered into a state after having propagated a shift transition ?
   (A) $E \rightarrow \bullet\, E + T$
   (B) $E \rightarrow E \bullet + T$
   (C) $E \rightarrow E + \bullet\, T$
   (D) $E \rightarrow E + T \bullet$

9. Which of the following items in a state will cause a reduction action to be added to the state ?
   (A) $E \rightarrow \bullet\, E + T$
   (B) $E \rightarrow E \bullet + T$
   (C) $E \rightarrow E + \bullet\, T$
   (D) $E \rightarrow E + T \bullet$

10. How many tokens in the following C code ?

```
/* Say hello. */
printf ("Hello, world.\n");
```

    (A) 3
    (B) 5
    (C) 7
    (D) 9

11. The name `bison` is a pun on an earlier program whose name is a homonym for :
    (A) Buffalo : a kind of African stag or gazelle.
    (B) Camel : a ruminant used for carrying burdens and for riding.
    (C) Minotaur : a monster confined to the labyrinth on Crete.
    (D) Yak : a bovine mammal native to the high plains of central Asia.