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Please print clearly :

Name : ANSWERS

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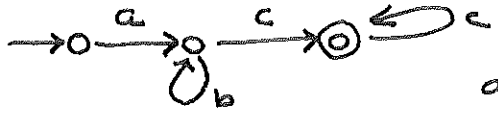
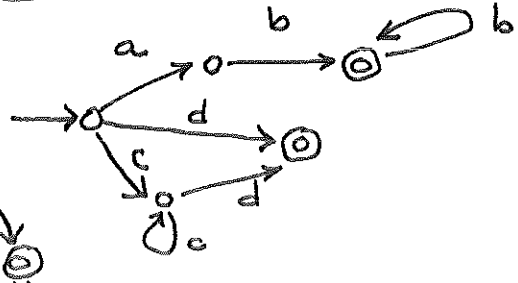
No books ; No calculator ; No computer ; No email ; No internet ; No notes ; No phone. Neatness counts ! Do your scratch work elsewhere and enter only your final answer into the spaces provided.

1. For each of the following `flex` regular expressions, draw an equivalent deterministic finite αὐτόματον, using the *minimum* possible number of states. Do not show garbage states. **[5✓]**

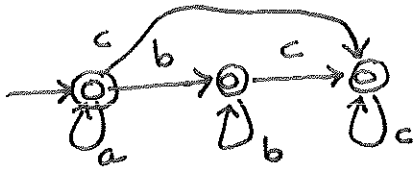
(i) `ab*c+`



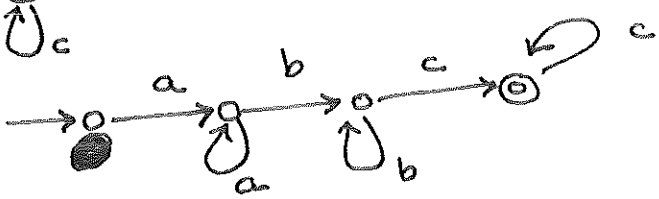
(ii) `ab+|c*d`



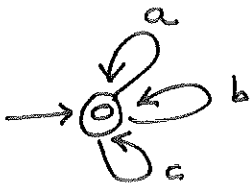
(iii) `a*b*c*`



(iv) `a+b+c+`



(v) `(a|b|c)*`



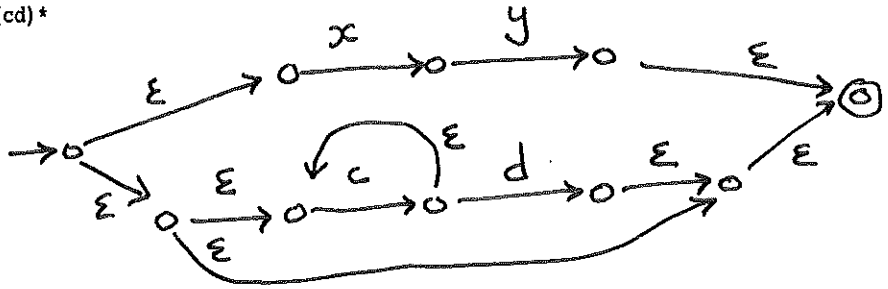
2. Express each of the following `flex` expressions as `flex` expressions, but your answer may use only the Kleene closure (`*`), concatenation, alternation (`|`), and parentheses as metacharacters. **[2✓]**

(i) `[1-4]+` (1|2|3|4)(1|2|3|4)*

(ii) `x{2,4}` xx|xxx|xxxx

3. Use Thompson's construction exactly as in the textbook to convert the following regular expression into a non-deterministic finite αὐτόματον. **[3✓]**

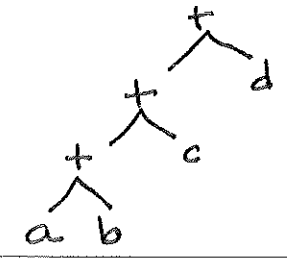
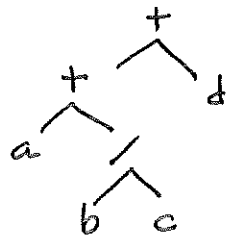
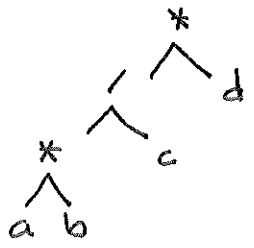
`xy|(cd)*`



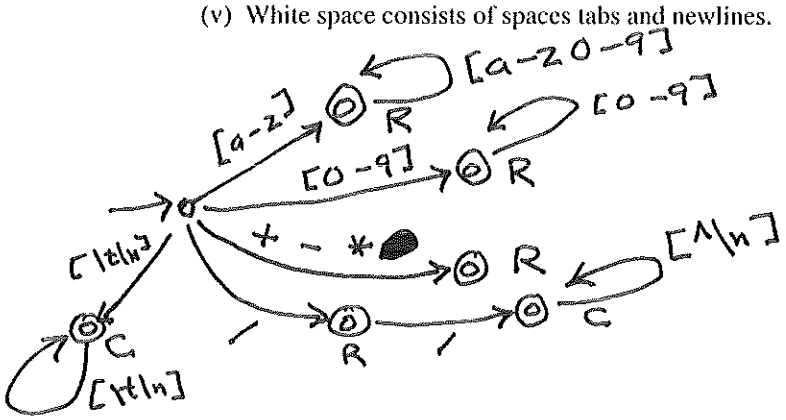
4. Write two files, `export.c`, which declares an external `int foo` variable and exports it, and `import.c`, which makes use of the external variable and declares it as having been created in a different module. Show only declarations. **[1✓]**

export.c	import.c
extern int foo; int foo;	extern int foo;

5. Draw abstract syntax trees for each of the following C expressions. **[3✓]**

a + b + c + d	a + b / c + d	a * b / c * d
		

6. Draw the deterministic finite αὐτόματον for a scanner for the following language. You may use set notation to label transitions. Draw an arrow into the initial state, and label each final state with two circles. For each final state that returns from the scanner, write "*R*" next to it, and for each final state that continues scanning, write "*C*". Ignore invalid or jamming states. Do not show garbage states. **[3✓]**
   (i) An identifier starts with a lower case letter and is followed by any number of digits and lower case letters.
   (ii) An integer is one ore more digits.
   (iii) An operator is any one of the characters add (+), subtract (-), multiply (*), or divide (/).
   (iv) A comment is two slashes (//) followed by all characters up to but not including a newline.
   (v) White space consists of spaces tabs and newlines.



alternately from the init state for ops

the / op and // comment must share state

7. Write a grammar using `flex`, showing only what goes in the second section (between the `%%` symbols. Use regular expressions, but no macros. For semantic actions on each, write `return` or `continue`. **[3✓]**

```
[a-z][a-z0-9]*
[0-9]+
\+|\-|\*|\/   or [-+*/]
"//".*        or \/\/.*
[ \t\n]+
```

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. What external variable should be set to make `yylex` produce debug output?
   (A) `yy_debug`
   (B) `yy_flex_debug`
   (C) `yy_set_interactive`
   (D) `yy_stack_print`

2. The `flex` expression `a|bc*` means:
   (A) `(a|(bc))*`
   (B) `(a|b)(c*)`
   (C) `a|((bc)*)`
   (D) `a|(b(c*))`

3. The `bison` generated parser makes use of a deterministic finite αὐτόματον, plus what data structure?
   (A) hash
   (B) queue
   (C) stack
   (D) tree

4. The machine generated by `flex` comes from a language of what type in the Chomsky hierarchy?
   (A) type 0
   (B) type 1
   (C) type 2
   (D) type 3

5. In your compiler project, how is a node pointed at by a hash table array element allocated?
   (A) `malloc (sizeof (struct node *));`
   (B) `malloc (sizeof (struct node));`
   (C) `malloc (struct node);`
   (D) `new node();`

6. A deterministic finite αὐτόματον with $O(s)$ states will read an input string of length $O(n)$ in how much time?
   (A) $O(\log n \times s)$
   (B) $O(n)$
   (C) $O(s)$
   (D) $O(s \times n)$

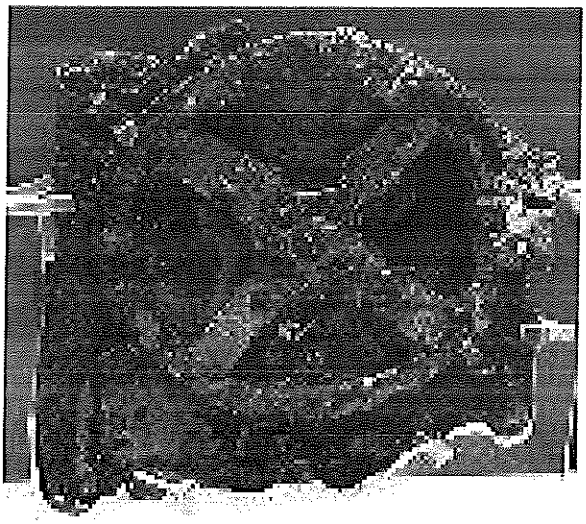
7. A hash table that uses collision resolution by linear probing should be doubled when the loading factor exceeds what? (Choose the best of these answers.)
   (A) 0.02
   (B) 0.30
   (C) 0.90
   (D) 1.20

8. Which `flex` semantic action is clearly incorrect?
   (A) `return "*";`
   (B) `return '*';`
   (C) `return 42;`
   (D) `return STAR;`

9. What kind of grammar does `bison` use?
   (A) context-free
   (B) context-sensitive
   (C) regular
   (D) unrestricted

10. For a grammar $G = \langle V_N, V_T, P, S \rangle$, the left hand side of a rule in the set of productions P consists of one symbol from the set:
    (A) V_N
    (B) $V_N \cap V_T$
    (C) $V_N \cup V_T$
    (D) V_T

11. Comments in `oc` are stripped off by the:
    (A) parser
    (B) preprocessor
    (C) scanner
    (D) string table



The Antikythera mechanism, built ca. 150–100 BCE, is the oldest known complex scientific calculator, and is sometimes called the first known analog computer, with operational instructions written in Greek. [http://en.wikipedia.org/wiki/Antikythera_mechanism]