# CE-2



## August 2017 QE

1. **(10 points)** Consider the language $L_1$ defined by the expression $a^m b^n c^{m+n}$, $m \geq 0$, $n > 0$. (i.e., any string with *m* a's, *n* b's, and as many c's as a's and b's combined) Give a grammar that matches the language (pay close attention to the constraints on *m* and *n*). For full credit, your grammar should have no more than 5 productions (though it may have fewer) Any grammar with more than 8 productions will not be graded. We will assume that the left-hand-side non-terminal in your first production is the start symbol.

2. Consider the following grammar for the following questions (S is the start symbol):

$$S \rightarrow ABz\$$$
$$A \rightarrow Ax$$
$$A \rightarrow \lambda$$
$$B \rightarrow xy$$
$$B \rightarrow \lambda$$

   **a. (5 points)** Draw the *first state only* of the LR(1) machine used to parse this grammar.

   **b. (10 points)** Suppose you are parsing the string *xz$*. The machine starts in the state you derived in part (b). What action would the machine take first? (If it is a *shift*, just write "shift". If it's a *reduce*, write "reduce" and which rule was reduced.) Draw the state the machine is in after completing this action.

   **c. (10 points)** After winding up in the state after completing the action in part (b), what is the *next* action the parser takes? (follow the same rules for writing out actions as above) Draw the state the machine is in after completing this action.

3. This question pertains to *available expressions* analysis. For each statement below, we want to calculate which expressions are available. Assume that no expressions are available at the beginning of executing this code.

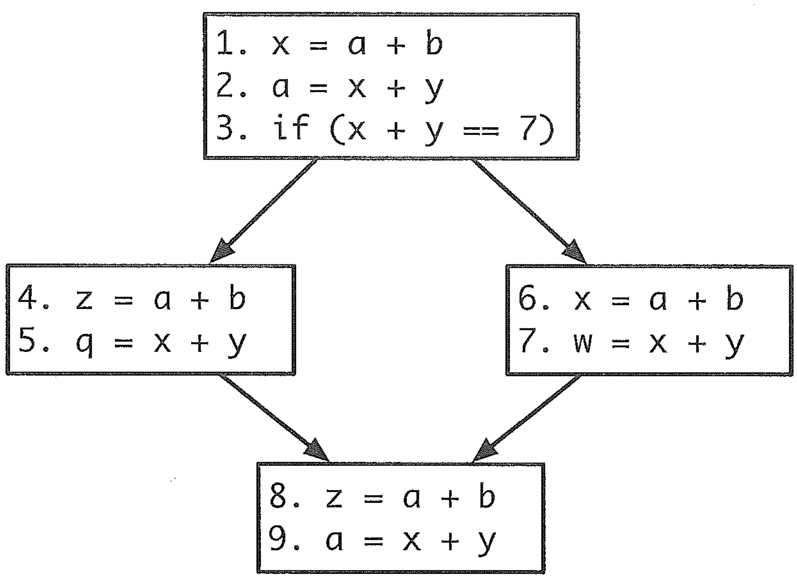
   a. **(18 points)** ***In your blue books,*** fill in a table like the one below, with one row for each statement in the program. ***Do not fill in the table below.*** Assume there is no aliasing.

   b. **(7 points)** What sets of available expressions change (i.e., what IN sets change) if variable q *may* be aliased to variable x? If an IN set changes, list which statement the IN set is associated with, and what the new IN set would be.

   **c. (5 points)** Explain (in one or two sentences) how you would use the results of an available expressions analysis to eliminate redundancy in a program. Your answer must be 50 words or less.

Write in Exam Book Only

| Statement | GEN | KILL | IN | OUT |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| … | | | | |




4. Given the loop nest:

```
for (k = 0; k < 6; k++) {
  for (i = 0; i < 6; i++) {
    a[5 - i, k] = b[8 - i, k];
    b[6 - i, k] = a[5 - i, k + 1];
  }
}
```

a. **(5 points)** Describe the dependences, if any, on the "**a**" array in the loop nest above. Either say "no dependence", or, if one or more dependences exists, give the type(s) (flow or true, output or anti), the direction and the distance.

b. **(5 points)** Describe the dependences, if any, on the "**b**" array in the loop nest above. Either say "no dependence", or, if one or more dependences exists, give the type(s) (flow or true, output or anti), the direction and the distance.

c. **(5 points)** Can the loops be interchanged? Why or why not?

5. Acme doubled the number of registers in their latest computer. For each of the following transformations, say whether this architectural change would make the transformation *more* effective, *less* effective, or make *no change*. (You do not need to provide a reason.

   a. **(5 points)** Loop interchange
   b. **(5 points)** Register allocation
   c. **(5 points)** Common subexpression elimination
   d. **(5 points)** Loop unrolling

Write in Exam Book Only