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**Test ID Number**

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**Student ID Num**

**ID Sheet:** Write your seven-digit BYUH Student ID number in the blank above. Turn in this sheet when you complete the test. It will be kept separate until grading is completed, and will then be used to assign your score to the proper person.

Use exactly the paper that is provided.

For fairness and uniformity in grading, do NOT write your NAME or student ID number anywhere on your answer sheets. A Test ID number is given above for you to use instead. Use one sheet of paper for each problem. If possible, write the complete answer on one side of the sheet and leave the other side blank. If necessary use both sides of one sheet. Do not staple, fold, or tear any of your sheets.

On each answer page, put your Test ID number, then a dash (-), then the problem number, in the upper left corner ( $\swarrow$ ) on the front. Draw a box around it. For example, if your assigned Test ID number is 102 and the problem number is 4, write 102-4 in the upper left corner, about one inch (25mm) down from the top of the paper, and about one inch in from the left edge of the paper.

Avoid using red ink because I use it for grading. Use a good-contrast writing method, e.g., soft-lead pencil or ink. Hard-lead pencils usually make faint marks that are hard for me to read. Faint pencil on top of erasures can be almost impossible to read. It is okay to cross out things clearly instead of erasing them. If necessary, you may draw a circle or box around your answer so I do not grade the wrong things. If your answer sheet becomes too cluttered and time permits, please copy your answer to a fresh sheet of paper before turning it in.

**Problem 1:** (10p) Sketch a grammar for the C programming language. The full grammar has too much detail, so just include the main constructs of the language. Use productions that make sense.

**Problem 2:** (15p) Let  $L = a^i b^j c^k$  where  $i + k < j$

(5p) What are the five shortest words in  $L$ ?

(10p) Give a CFG for  $L$  or explain why it is impossible.

**Problem 3:** (5p) Let AE be the following grammar.

$$E \rightarrow T+E \mid T-E \mid T$$

$$T \rightarrow F*T \mid F/T \mid F$$

$$F \rightarrow (E) \mid n$$

$$n \rightarrow \text{a number}$$

Using the grammar AE, give a parse tree for the string  $2+3*5$ .

**Problem 4:** (15p) Let  $T$  be the set of positive numbers (in base 10) that are exactly divisible by three.  $T = \{3, 6, 9, 12, \dots\}$ .

(5p) How do we know that a CFG exists for this language?

(10p) Give a CFG for this language. The terminals are the digits zero through nine.

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**Leave the space below empty.** It will be used for calculating your exam score, reporting your grade, and other notes (if any) from the instructor.