_____ **Test ID Number**

_____ **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 (↘) 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.

Definitions:

Let $L_1 = (a|b)*$ with odd number of a, even number of b.

Let $L_2 = (a|b)*$ with at least as many a as b (in any order).

Let $L_3 = \{a^n b^m c^{2n+3m} \mid n, m > 0\}$.

Let G_1 be the following grammar:

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S   →   ASB | BSA | λ
A   →   aA | λ
B   →   bB | λ
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Problem 1: Give a DFA for L_1 and explain clearly why it is correct.

Problem 2: Give a Regular Expression for L_1 and explain clearly why it is correct.

Problem 3: Give a CFG for L_2 and explain clearly why it is correct.

Problem 4: Give a grammar whose language is L_3 and explain clearly why it is correct.

Problem 5: Create a grammar G_2 that generates the same language $L(G_1)$ but with no "embedded" lambda productions. That is, the original S can produce lambda, but nothing else can. Explain clearly why it is correct.