1. (30 points)

a) Write an unambiguous grammar for the language consisting of strings with 'a's and 'b's where there are even number of 'b's.

For example, a, aaabaabababa, aaabaabaaaa are in this language, whereas aaabaaaaa or abaaababaaa are not in this language.

Hint: You can use the following rule <non-terminal> → E (empty string)

b) Use the grammar that you write in (a) to show the derivation for the string aaabaabababa.

2. (40 points)

a) Write a BNF description for simple assignment statements involving binary operators (/, + and *), the increment (++) and decrement (--) unary operators and the parentheses. Let +, / and * be the precedence of the binary operations from high to low and they all are right associative. Suppose the identifiers can be A, B, C, D or E.

b) Show the rightmost derivation for statement: A = --C / (B + ++E * D) and the equivalent parse tree.

3. (30 points) Assume a machine can operate only the following instructions:

ident = var
ident = ident + 1
ident = ident - 1
goto label
if var relop var goto label

a) Use the above instructions and write the while statement of Java in terms of operational semantics definition.

b) Convert the following C code to low-level instructions.

```c
int c = 1;
do {
a = b--; if(a <= 0) --c;
}while(c)
```

Notes:
- See [http://www.cmpe.boun.edu.tr/~gungort/informationstudents.htm](http://www.cmpe.boun.edu.tr/~gungort/informationstudents.htm) for general information about the assignments and the course policy.
- The sole purpose of this assignment is to familiarize you with the processes involved in answering questions related to programming languages. Thus, please work on them by your own.