

**#4** Rewrite the BNF of Example 3.4 to add the ++ and -- unary operators of Java.

```
<assign> → <id> = <expr>
           | <pre><id>
<id> → A | B | C
<pre> → ++
        | --
<expr> → <expr> + <term>
        | <term>
<term> → <term> * <factor>
        | <factor>
<factor> → ( <expr> )
          | <id>
```

**#11** Consider the following grammar:

```
<S> → <A> a <B> b
<A> → <A> b | b
<B> → a <B> | a
```

Which of the following sentences are in the language generated by this grammar?

**a. baab**

b. bbbab

c. bbaaaaa

d. Bbaab

**#21** Using the virtual machine instructions given in Section 3.5.1.1, give an operational semantic definition of the following:

**a. Java do-while**

```
...
Do:                                # Start of code
    ...                            # some code
    If: expr == 1 goto Do # while (expression);
...
```

**b. Ada for**

```
...
    Expr1 = expr2                # Set to starting value
Loop: if expr1 > expr3 goto out   # for expr1 in expr2..expr3 loop
    ...                          # Some Code
    Expr1 = expr1 + 1            # Increment
```

```
        Goto loop                # Loop back
Out:
```

### c. C++ if-then-else

```
...
IF:    Expr1 == 0 goto ELSE # Check if false
        ...                # Run if Statement Code
        Goto OUT:          # Jump out of Statement
ELSE:   ...                # Else Statement
        ...                # Run Else Code
OUT:    ...                # End of Statement
```

### d. C for

```
...
    Expr1                # i = num
LOOP: if expr2 == 0 goto out # i < limit ?
    ...                  #
    Expr3                # i++
    Goto LOOP            #Jump to loop
OUT:   ...              #Exit Loop
```

### e. C switch

```
    Expr1;
CASE1:  expr1 != expr2 goto CASE2  #Check if case 1 is true
        ...                    # Code
        Goto OUT                # Break
CASE2:  expr1 != expr3 goto DEFAULT #Check if case 2 is true
        ...                    # Code
        Goto OUT                # Break
DEFAULT:
    ...
OUT:
```