Answer the following questions in the space provided. The exam has 150 points total, 25 points for each of the six questions. No notes, no book, and no neighbors.

1. Hacker Hank is designing a new programming language based on C. For types he wants to include pointers, arrays, and classes. His grammar defines a declaration statement for these as follows. (The curly braces are the EBNF representation of a loop). Can you see any problem that his parser is going to encounter in dealing this his grammar?

```plaintext
<declaration> ::= <type> <identifierList> <semicolon>

<identifierList> ::= <identifier> { <comma> <identifier> }

?type> ::= * <type>
    | <type> [ integerConstant ]
    | <identifier>
```
2. Many programming languages (such as C) disallow nested function definitions. Explain why. What problems do nested function definitions introduce, and how are these problems solved?
3. Explain the optimization termed peephole optimization. Give an example source input and its resulting assembly language (any reasonable format) and show how peephole optimization could improve the assembly language.
4. Show the control flow graph that would be generated for the following source program. Assume that A ends up at location 40 in the AR, and B at location 104.

var: dp : real;
begin
    dp := 0;
    for i := 1 to 8
        dp := dp + (a[i] * b[i])
end
5. Using the control flow graph you described in question 4, point to an example of each of the following optimizations, explaining what effect it would have:
   a) Algebraic transformations
   b) common subexpressions
   c) reduction in strength
6. Although the Venerable Bede knew already in 730 AD that the Julian year was 11 minutes and 14 seconds too long, it was not until 1582 that Pope Gregory XIII approved the rule we now use for determining if a year is a leap year. This rule says that a year is a leap year if it is divisible by 4, unless it is divisible by 100, in which case it is not, unless it is also divisible by 400. We can write this as follows:

if (((year mod 4 == 0) and (year mod 100 != 0)) or (year mod 400 == 0)) then
    printStr("leap year")

show the assembly code our compiler would generate for this statement. (Again, any reasonable approximation is accepted). Assume year is found at location 4 relative to the frame pointer. (Your chances of getting partial credit are improved if you show your intermediate steps).