SCOPE PROBLEMS  C. HAZLEWOOD

13. Assume the following program was compiled and executed using static scoping rules. What value of \( x \) is printed in procedure sub1? Under dynamic scoping rules, what value of \( x \) is printed in procedure sub1?

```plaintext
program main;
  var x : integer;
  procedure sub1;
    begin  { of sub1 }
      writeln('x =', x)
    end;  { of sub1 }
  procedure sub2;
    var x : integer;
    begin  { of sub2 }
      x := 10;
      sub1;
    end;  { of sub2 }
  begin  { of main }
    x := 5;
    sub2
  end.  { of main }
```

15. Consider the following program:

```plaintext
program main;
  var x, y, z : integer;
  procedure sub1;
    var a, y, z : integer;
    begin  { of sub1 }
      ...
    end;  { of sub1 }
  procedure sub2;
    var a, b, z : integer;
    begin  { of sub2 }
      ...
    end;  { of sub2 }
  procedure sub3;
    var a, x, w : integer;
    begin  { of sub3 }
      ...
    end;  { of sub3 }
  begin  { of main }
    ...
  end.  { of main }
```

Given the following calling sequences and the fact that dynamic scoping is used, what variables are visible during execution of the last subprogram activated? Include with each visible variable the name of the unit where it is declared.

a. main calls sub1; sub1 calls sub2; sub2 calls sub3.  
b. main calls sub1; sub1 calls sub3.  
c. main calls sub2; sub2 calls sub3; sub3 calls sub1.  
d. main calls sub3; sub3 calls sub1.  
e. main calls sub1; sub1 calls sub3; sub3 calls sub2.  
f. main calls sub3; sub3 calls sub2; sub2 calls sub1.

14. Consider the following program:

```plaintext
program main;
  var x, y, z : integer;
  procedure sub1;
    var a, y, z : integer;
    procedure sub2;
      var a, b, z : integer;
      begin  { of sub2 }
        ...
      end;  { of sub2 }
    begin  { of sub1 }
      ...
    end;
  procedure sub3;
    var a, x, w : integer;
    begin  { of sub3 }
      ...
    end;  { of sub3 }
  begin  { of main }
    ...
  end.  { of main }
```

List all the variables, along with the program units where they are declared, that are visible in the bodies of sub1, sub2, and sub3, assuming static scoping is used.