VII [4]. Consider the following two Pascal sequences:

```
(a)                  (b)
                     Z:=M*B;
A:=A+C*D;            T1:=C*D;          ← (i)
while B>0 do         A:=A+T1;
   begin             while B>0 do
   A:=A+C*D;            begin
   while A>0 do         A:=A+T1;
      begin             while A>0 do
      A:=A-1;              begin
      Y:=Y+C*D             A:=A-1;
      end;                 Y:=Y+T1
   B:=B-1;                 end;
   Z:=M*B;              B:=B-1;
   end;                 Z:=Z-B            ← (ii)
write(Y,Z)              end;
                        write(Y,Z)
```

(a) What are all of the optimizations represented by (i) in column (b)?

(b) What are all the optimizations represented by (ii) in column (b)?

VIII [10]. Code generation issues:

(a) For the infix expression *a+b*, its postfix is *ab+*, its prefix is *+ab* and its reverse prefix (prefix backwards) is *ba+*. Give an example of why the reverse prefix might be preferable to either of the other two formats in some code generators.

(b) Using the hac430 activation record structure described in class, the maximum number of instructions needed to load any variable into a register is: ____.

(c) Using the hac430 activation record structure described in class, the minimum number of instructions needed to load any variable into a register is: ____.

(d) Assume you wish to create activation records without display vectors. Describe the code needed to access non-local variables. As an example, consider the following nip program:

```
Proc1 procedure
        integer A, B, C;
        ...
        Proc2 procedure
                integer D, E, F;
                ...
                Proc3 procedure
                        integer G, H, I;
                        ...
                        --- Generate code here ---
                        A:=(B+D)+G
```

****** End of Exam ******

IV [9]. Consider the following attribute grammar:

$T \rightarrow D\ S$
  $S.n = 3 * D.m$
  $T.p = S.p * D.p$

$D_1 \rightarrow D_2\ V$
  $D_1.m = 2 * D_2.m$

$D \rightarrow V$
  $D.m = 1$

$V \rightarrow a$

$S_1 \rightarrow S_2\ S_3$
  $S_2.n = S_1.n$ (*) -- See below
  $S_3.n = S_1.n$ (*) -- See below
  $S_1.p = S_2.p + S_3.p$

$S \rightarrow E$
  $S.p = 5 * S.n$

$E \rightarrow b$

(a) Which attributes are inherited and which are synthesized?

(b) What is the value of T.p for:
(i) ab (ii) aaabbbb

(c) Explain what happens if the (*) rules are changed to:
$S_2.n = 2 * S_1.n$
$S_3.n = 3 * S_1.n$

V [8]. If X is regular, show that X^R is regular, where X^R is X reversed. (abc $\in$ X^R if and only if cba $\in$ X).

VI [4]. Place the terms: Regular language, LR(0), LR(1), SLR(1), LALR(1) in the correct order:

_____ $\subset$ _____ $\subset$ _____ $\subset$ _____ $\subset$ _____

I [20]. For each of the following, determine whether the language is regular or not. Prove your answer:

(a) $\{ (ab)^{2n} \mid n \geq 0 \}$

(b) $\{ a^n b^{2n} \mid n \geq 0 \}$

(c) $X \rightarrow aXa \mid bXb \mid aX \mid bX \mid a \mid b$

II [10]. For each of the following, give the deterministic finite state automaton that accepts the same set:

(a) $01^*(0|1)1^*0^*01$

(b)

III [35]. For each of the following three grammars, determine whether they are: (i) LL(1), (ii) LR(0), (iii) LR(1), (iv) SLR(1) and (v) LALR(1), and prove your answer. You only need to generate parse tables when necessary. Your answer should consist of the following 15 member table, where each entry corresponds to *yes* (it is of that type) or *no* (it is not), and any justification for each answer follows the table:

	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**
grammar a	a.i	a.ii	a.iii	a.iv	a.v
grammar b	b.i	b.ii	b.iii	b.iv	b.v
grammar c	c.i	c.ii	c.iii	c.iv	c.v

Grammars:

(a) $S \rightarrow SS \mid (S) \mid ( )$

(b) $S \rightarrow ST \mid (S) \mid ( )$
$T \rightarrow (S) \mid ( )$

(c) $A \rightarrow AB \mid B$
$B \rightarrow (AB) \mid C$
$C \rightarrow i \mid (C)$

CMSC 430 **Final Exam** **May 17, 1988**

Before you are told to start, do the following:

1. Put your name on the exam book. Only answers in this book will be graded.

2. If you want your grade posted with your social security number, then you must do all of the following: Inside the front cover of the exam book write: "Post my grade with my social security number." and then sign your name under this statement. If you do not do all of this, no grade will be posted. Grades should be available outside of room 4121 AVW by Friday afternoon, May 20.

3. If you want to enter your compiler into the performance trials, then do one of the following:

(a) Write your account number, password and name of your executable compiler inside the front cover of your answer book.

(b) make your account executable by others: In your account, do:
cd (get to your home directory)
cd .. (go to parent directory)
chmod 711 mvznn (make your executables accessible to others, mvznn is your account)
Also, write inside the front cover of your answer book the name of your executable compiler.

Awards will be given to: (i) The fastest compiler, (ii) The one generating the least amount of code, and (iii) The one generating the fastest executing programs on the hac430 machine. Tests will be run on Wednesday, so any changes to your account must be done today. *Decisions of the judge will be final and not subject to appeal.*

DO NOT OPEN THIS EXAM PAST THIS FRONT PAGE UNTIL TOLD TO DO SO.