1. [25 marks] Describe the symbol and type table entries that a typical compiler would make for the following declarations:

```c
1   #define ABOUND1 10
2   #define ABOUND2 20
3   float * getMember( float X [], const int i );
4   const float waterlooPi = 3.0 ;
5   int iaa[ABOUND1][ABOUND2], **ipp, *(if()) ;
6   typedef struct person {
7       char * name ;
8       int iaa ;
9       double if ;
10      union cupe {
11           int memberNo ;
12           char * membRec ;
13      } unionRec ;
14   } PERSON ;
15   PERSONClass[100], * persPtr ;
```

2. [20 marks] List all of the semantic analysis checks that a typical compiler would perform when processing the declarations in Question 1.

3. [20 marks] The programming language Modula-3 allows the programmer to specify an optional base for integer constants by prefixing the constant with an base specifier of the form: $N_-$ (i.e. base specification digit(s)($N$) followed by the underscore (_) character). Integer constants without this optional specifier are assumed to be decimal numbers.

Legal values for the base specifier $N$ are 2 .. 16. The number following the base specification is written in base $N$ notation. For any given base $N$, only the digits 0 .. ($N-1$) can legally occur in the constant. The letters A, B, C, D, E, F are used to represent the "digits" 10, 11, 12, 13, 14, 15 respectively.

Examples: 2_10101 16_DEADBEEF 13_CBC941 8_4775 123456789

Sketch the design of the part of a lexical analyzer that will correctly processes integer constants in Modula-3.
4. [15 marks] The grammar shown below is LL(k) for some value of k. Determine the value of k for the grammar. Explain your answer (i.e. why is your value of k the smallest k for which this grammar is LL(k)).

1. $S \rightarrow a\ A\ a\ B$
2. $\rightarrow b\ A\ b\ B$
3. $A \rightarrow a$
4. $\rightarrow a\ b$
5. $B \rightarrow a\ B$
6. $\rightarrow a$

5. [20 marks] Construct the director sets for the following LL(1) grammar:

1. $S \rightarrow B\ C\ c$
2. $\rightarrow g\ D\ B$
3. $B \rightarrow b\ C\ D\ E$
4. $\rightarrow \lambda$
5. $C \rightarrow D\ a\ B$
6. $\rightarrow c\ a$
7. $D \rightarrow d\ D$
8. $\rightarrow \lambda$
9. $E \rightarrow g\ S\ f$
10. $\rightarrow c$