1. Consider the following attribute grammar:

\[
\begin{align*}
S & \rightarrow A \ B \ C \\
A & \rightarrow a \\
B & \rightarrow b \\
C & \rightarrow c \\
S.u &= S.u \\
C.u &= B.v \\
A.u &= B.v \times C.v \\
S.v &= A.v \\
A \rightarrow a & \\
B \rightarrow b & \\
C \rightarrow c & \\
A.v &= 2 + A.u \\
B.v &= B.u \\
C.v &= C.u - 3
\end{align*}
\]

a. (5 marks) Draw the parse tree for the string abc and draw the dependency graph for the associated attributes. Describe a correct order for the evaluation of the attributes.

b. (2 marks) Suppose that S.u is assigned the value 5 before attribute evaluation begins. What is the value of S.v when evaluation has finished?

c. (1 mark) Is the above grammar L-attributed Grammar?

d. (2 marks) If S.v is our main concern, and assume that S.u is constant which is 5, rewrite the grammar above to have only synthesized attributes.
2. Draw a possible organization for the runtime environment of the following C program assuming the following layout of the activation record: return address, control link, parameters, and then local variables:

```c
int a[10];
char *s = "Welcome";

int f(float i, int b[ ] )
{
    float j = i;
    char c = b[i];
    ....
    ........
    return 0;
}

void g(char * s, float w)
{
    char c = s[0];
    a[2] = f(w, a)
    ....
    ....
}

main( )
{
    float x;
    g(s, x);
}
```

a) After entry into function g

b) After entry into function f
3. Consider the following grammar for case statement:

\[
\text{<case-stat>} \rightarrow \text{case} \ \text{<var>} \ \text{of} \ \text{<select-list>} \ \text{end};
\]
\[
\text{<select-list>} \rightarrow \text{<label>} ; \ \text{<stat>} ; \ \text{<select-list>} | \text{<label>} : \ \text{<stat>}
\]
\[
\text{<label>} \rightarrow \text{num} | \text{other}
\]

a) Write an attribute grammar for generating three-address code for the above grammar.

b) Give the sequence of three-address code instructions corresponding to the following fragment using the above attribute grammar

\[
\text{Case} \ x \ \text{of}
\]
\[
1: \ s1;
2: \ s2;
\text{other: } s3
\]
\[
\text{end};
\]