1. What is the maximum and minimum numbers of nodes in a binary tree of depth $h$? Prove your answer.

2. Please represent the following graph using adjacent matrix and adjacent list.

```
A ---- B ---- C
 |     |     |
D ---- E
```

3. (a) Describe the algorithms for sorting as followed and write the status of the list $(12, 2, 16, 30, 8, 28, 4, 10, 20, 6, 18)$ at the end of each phase of the algorithms. (1) Quick sort. (2) Natural Merge sort. (3) Heap sort.
(b) What is the meaning “stable sorting algorithm”? Are these algorithms stable or unstable? Please give suitable examples to show unstable case of the unstable algorithm(s).

4. (a) What are the definitions of asymptotic notations, $O$ (big oh), $\Omega$ (Omega), and $\Theta$ (Theta), which are used for time complexity comparison?
(b) Evaluate the $O$ (big oh), $\Omega$ (Omega), and $\Theta$ (Theta) of the program. Prove your answers.

```c
void multiply(int **a, int **c, int n){
    for(int i=0;i<n;i++)
        for(int j=0;j<n;j++)
            c[i][j]=0;
    for(int k=0;k<n;k++)
        c[i][j]=a[i][k]*b[k][j];
}
```

5. There are three algorithms for minimum cost spanning tree, (a) Krusal’s algorithm. (b) Prim’s algorithm. (c) Sollin’s algorithm. Please describe these three algorithms briefly. Draw the status of the graph at the end of each phase of the algorithms.

```
4 15 10
10 3 4
5 10 2
```

void multiply(int **a, int **c, int n){
for(int i=0;i<n;i++)
    for(int j=0;j<n;j++)
        c[i][j]=0;
for(int k=0;k<n;k++)
    c[i][j]=a[i][k]*b[k][j];
}