COMP S265F Design and Analysis of Algorithms
Assignment 2 – Suggested Solution

Question 1 (30 marks).

(a)

```python
def createGraph(self):
    for u,v in self.edges:
        self.graph[u].append(v)
```

(b)

```python
def bfs(self):
    self.dist = [None] * self.n
    queue = []
    self.dist[self.s] = 0
    queue.append(self.s)
    while queue:
        u = queue.pop(0)
        for v in self.graph[u]:
            if self.dist[v] == None:
                self.dist[v] = self.dist[u] + 1
                queue.append(v)
```

(c)

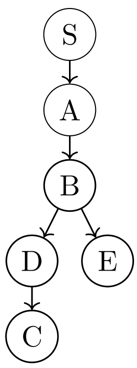
```python
def printResult(self):
    if self.dist[self.d] == None or self.dist[self.d] > self.dl:
        print(-1)
    else:
        print(self.dist[self.d])
```

Question 2 (15 marks).

(a) The required information of each vertex is shown below:

discovered order	1	2	3	4	5	6
vertex v	S	A	B	D	C	E
$d[v]$	1	2	3	4	5	8
$f[v]$	12	11	10	7	6	9
$\pi[v]$	–	S	A	B	D	B

Below is the depth-first tree obtained:



(b) Classification of edges:

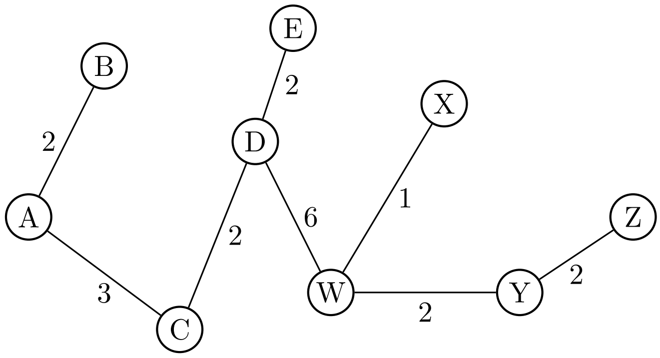
Type	Edges
tree edge	$(S, A), (A, B), (B, C), (B, E), (D, C)$
back edge	–
forward edge	$(S, C), (A, C)$
cross edge	(E, D)

(c) The topological sort order is: S, A, B, E, D, C.

Question 3 (15 marks). The Kruskal's algorithm sorted all edges in non-descending order and consider whether to include it in the resultant minimum spanning tree (MST) one by one:

order	edge	weight	include or not?
1	(W,X)	1	Yes
2	(A,B)	2	Yes
3	(C,D)	2	Yes
4	(D,E)	2	Yes
5	(W,Y)	2	Yes
6	(X,Y)	2	No
7	(Y,Z)	2	Yes
8	(A,C)	3	Yes
9	(B,C)	3	No
10	(B,D)	3	No
11	(X,Z)	3	No
12	(D,W)	6	Yes
13	(E,X)	6	No

The resultant MST is as follows:



The weight of the MST is 20.

Question 4 (40 marks).

(a) The transition table f_ε of the NFA including the lambda closure of the states is, as follows:

f_ε	s	a	b	c	ε	$\lambda(s)$
start	0	$\varnothing$	$\varnothing$	$\varnothing$	$\{1\}$	$\{0,1,3\}$
	1	$\{2\}$	$\varnothing$	$\varnothing$	$\{3\}$	$\{1,3\}$
	2	$\varnothing$	$\{1\}$	$\varnothing$	$\varnothing$	$\{2\}$
	3	$\{4\}$	$\varnothing$	$\{4\}$	$\varnothing$	$\{3\}$
final	4	$\varnothing$	$\varnothing$	$\varnothing$	$\varnothing$	$\{4\}$

(b) Let f_D be the transition function of the DFA.

f_D	s	a	b	c
start	$\{0,1,3\}$	$\{2,4\}$	$\varnothing$	$\{4\}$
final	$\{2,4\}$	$\varnothing$	$\{1,3\}$	$\varnothing$
final	$\{4\}$	$\varnothing$	$\varnothing$	$\varnothing$
	$\{1,3\}$	$\{2,4\}$	$\varnothing$	$\{4\}$
	$\varnothing$	$\varnothing$	$\varnothing$	$\varnothing$

Then, we replace the names of the states to obtain the transition table f_D of the DFA:

f_D	s	a	b	c
start	0	1	4	2
final	1	4	3	4
final	2	4	4	4
	3	1	4	2
	4	4	4	4

(c) We can combine state 0 and 3 into a new state $\{0, 3\}$.

f_D	s	a	b	c
start	$\{0,3\}$	1	4	2
final	1	4	$\{0,3\}$	4
final	2	4	4	4
	4	4	4	4

Renaming:

f_D	s	a	b	c
start	0	1	3	2
final	1	3	0	3
final	2	3	3	3
	3	3	3	3

(d) The DFA is shown, as follows: