Course Code: CS301	Course Name: Theory of Automata
Instructor Name: Mr. Musawar	
Student Roll No:	

Instructions:

- Return the question paper.
- Attempting of the question in the given order is highly encouraged.
- Read each question completely before answering it. There are **6 questions on 3 pages.**
- In case of any ambiguity, you may make assumption. But your assumption should not contradict any statement in the question paper.

Time: 180 minutes.   **Max Marks: 160 points**

Question 1: Regular expression & Properties   **(5+5) Points**

a) Give the equivalent REs for the following regular expressions other than the given one.
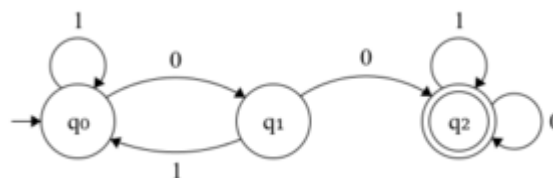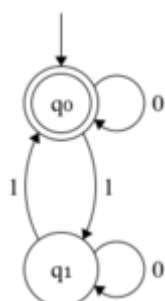
```
1.  (bbb)* a (bb)*+ (bb)* a (bbb)*
2.  a*(a+b)*a* + b*(a+b)*bb*
```

b) Let $L_4 = L_1 \cap L_2$. If L_1 is context free and L_2 is context, then L_4 is not context free. Discuss with an example.
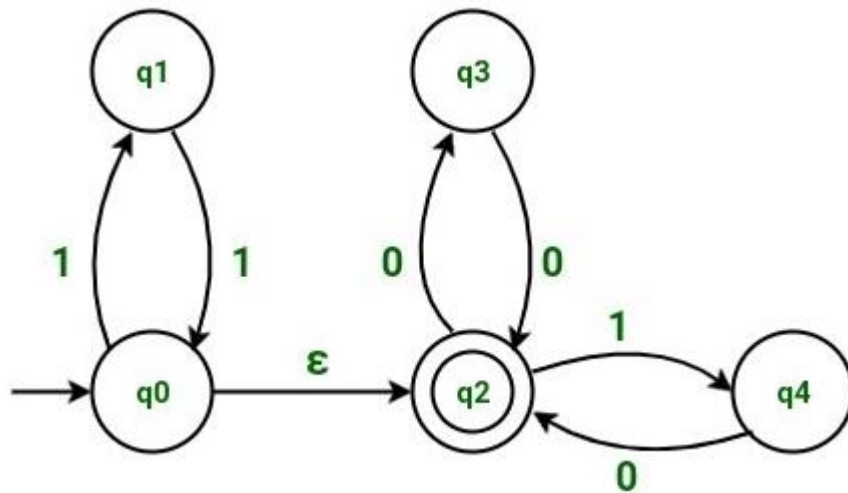
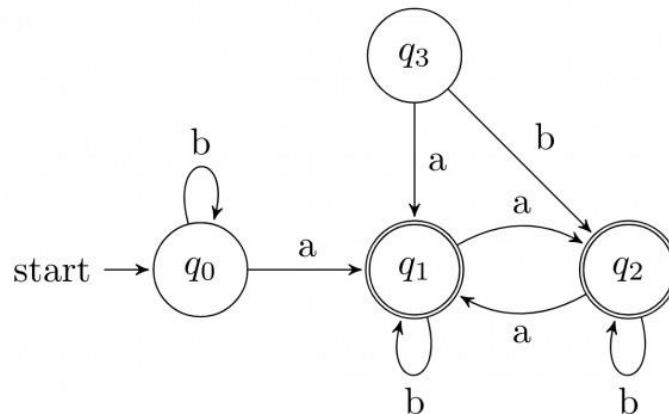**Question 2: Finite Automata**   **(10+10+10) Points**

a) Find out the union and intersection using Kleen's Theorem of the following FAs.

b) Convert the following NFA to equivalent DFA.

c) Minimize the following DFA using the method of your own choice.

Question 3 (a):   **CFG**   **(5+5+5+5) Points**

Construct a CFG which generates the following languages:

a) `L4 = { 0ⁱ1ʲ2ᵏ| I >=2,j,k>=0}`

b) `L1 ={ 0ⁱ1ʲ2ᵏ|j <=i }`

c) `L2 ={ 0ⁱ1ʲ2ᵏ|j <=k }`

d) Find L3 = L1∪L2

Question 3 (b):   **CFG**   **(10) Points**

Check the ambiguity in the following grammar with the help of at least 3 derivation trees.

```
E -> I

E -> E + E

E -> E * E

E -> (E)

I -> ε | 0 | 1 | 2| 3 | 4 | 5 | 6 | 7 | 8 | 9
```

Question 4: **CNF**   **(10+10) Points**

Consider the following CFG for non-empty language:

```
S→ASA|BSB|AA|BB|A|B
S→ASA|BSB|AA|BB|a|b
Q→CA|DB|AA|BB|a|b
N → ab |AS | ε
M → bS| Cab| ε
```

a) Simplify showing each steps clearly.
b) Convert the above CFG into CNF.

Question 5: P.D.A.   **(10+10) Points**

a) Identify language of given CFG, construct a P.D.A. and trace the input string ------
using stack :

```
S➔ 0S111| 0S1111 |^
```

Trace the input string "0011111" using stack. Is the string accepted by the grammar?

b) Construct a PDA for language L ={ aⁿbᵐcᵏdˡ|n+m = (k+l)/2 ≥0}. Trace the input string, which belong to language (length of string should be at least 6) using stack.

Question 6: Turing Machine.   **(10+10+5) Points**

a) Design Turing machine for language:

```
1. L = {0ⁿ1ᵐ2ⁿ | 2m<=n<=4m}
2. L = {   abc (a + b)*cba}
```

3. Draw Chomsky Hierarchy and discuss.

b) Give Pseudocode and its corresponding TM for the following functions:

                                                           (15+10) Points

1.
$$f(x,y) = \begin{cases} xy & if\ x < y \\ 2x & if\ x \geq y \end{cases}$$

2. A = {0ⁿ | n is a power of 3}

BEST OF LUCK!