

Course Code: CS301	Course Name: Theory of Automata
Instructor Name: Mr. Shahzad, Ms. Shaharbano, Ms. Bakhtawar, 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.

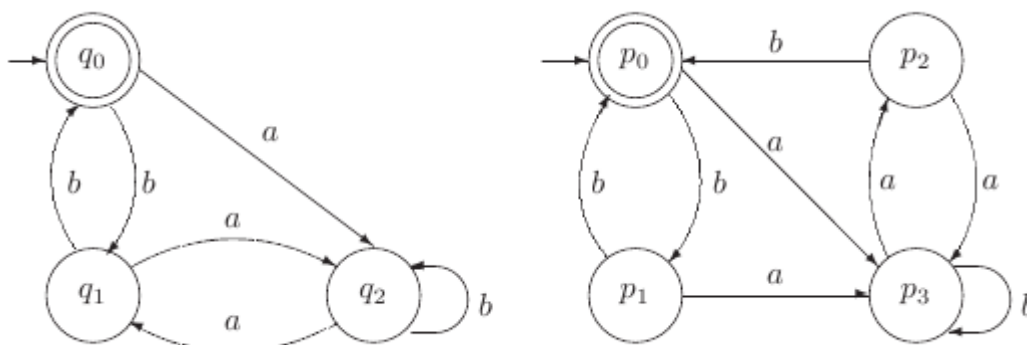
1. $(b + bb)^* a (b + bb)^*$
2. $(bb)(bb)^* a^*(bb) + (bb)^+ a^* (bb)^*(bb)$

b) Let $L_4 = L_1 \cup L_2$. If L_1 is regular and L_2 is not regular, then L_4 is regular. Discuss with an example.

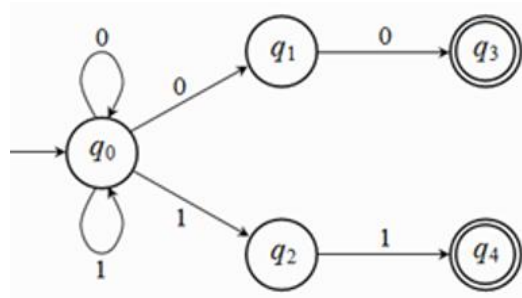
Question 2: Finite Automata

(10+10+10) Points

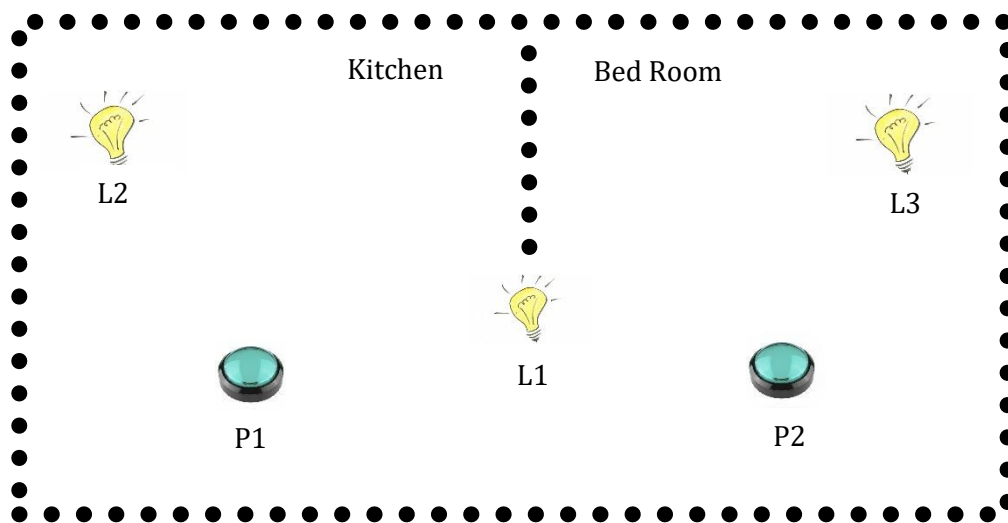
a) Find out the union and intersection of the following FAs.



b) Convert the following NFA to equivalent DFA.



c) Provide the Deterministic Finite Automata and transition table also mark the initial and final states for the following real world scenario:



We have a house, with one door, 2 push buttons and 3 lights. At the default state the lights are all turned off. In your case consider buttons as p1 and p2, lights as l0 (no lights on), l1, l2 and l3 and you must consider l1 as the entrance light.

- When you enter the house, you can press one of the 2 push buttons you have, p1 or p2. When you press any of those buttons, the l1 light turns on.
- Now you have entered the house and you want to move to the house rooms. (Kitchen or bedroom).
- If you press the button p1, l1 turns off and l2 turns on. Instead if you press the button p2, l1 turns off and l3 turns on.
- Pressing another time any of the 2 buttons, p1 or p2, the light that is currently on will turn off, and we'll get back at the initial state of the system.
- In your case you may consider l0, l1, l2 and l3 as states, p1 and p2 as the alphabet.

Question 3: CFG**(5+5+5+5+5+5) Points****Construct a CFG which generates the following languages:**

- $L_4 = \{ 0^i 1^j 2^k \mid i, j \geq 0, k \geq 2 \}$
- $L_1 = \{ 0^i 1^j 2^k \mid k \leq i \}$
- $L_2 = \{ 0^i 1^j 2^k \mid k \leq j \}$
- Find $L_3 = L_1 \cup L_2$
- Construct left most derivation tree for string 001122 for language L_1 and L_2 .
- Check whether the grammar L_3 is ambiguous, take expression $W=001122$.

Question 4: CNF**(10+10) Points****Consider the following CFG for non-empty language:**

$S \rightarrow a \mid aAb \mid abSb$
 $A \rightarrow bS \mid aAAb \mid Cab \mid \epsilon$
 $B \rightarrow ab \mid AS \mid \epsilon$
 $D \rightarrow bS \mid Cab \mid \epsilon$

- Simplify showing each steps clearly.
- Convert the above CFG into CNF.

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

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

$$S \rightarrow 0S11 \mid 0S111 \mid \wedge$$

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

- Construct a PDA for language $L = \{ a^n b^m c^k d^1 \mid n+m = 2(k+1) \geq 0 \}$. 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**

- Design Turing machine for language:

- $L = \{ 0^n 1^m \mid 2n \leq m \leq 3n \}$
- $L = \{ abb (a + b)^* \}$
- Draw Chomsky Hierarchy and discuss.

- Give Pseudocode and its corresponding TM for the following functions:

(15+10) Points

$$1. \quad f(x, y) = \begin{cases} x+y & \text{if } x > y \\ 0 & \text{if } x \leq y \end{cases}$$

$$2. \quad A = \{ 0^n \mid n \text{ is a power of } 2 \}$$

BEST OF LUCK!