Formal Languages and Automata Theory (CS303)

Mid-Semester Examination
Indian Institute of Technology, Patna
September, 2020
Full marks- 80 (16 X 5), Duration- 48 Hours
Submission Deadline: 01:00 PM, 02/10/2020

Instruction:
1. Write your answer in very concise manner. To the point short answer will get higher marks. Unnecessary lengthy answers will be penalized heavily even if they are correct.
2. Write your name; roll number and gmail id on top of your answer script.
3. Create a pdf of your answer script and named it as "<yourRollNo>_CS303A1.pdf "
4. Submit that file using the google form (link will be sent to you over email). Fill up all the fields in that form.
5. Do not copy from each other. Sources and Destinations will be penalized mercilessly.
6. Strictly follow the deadline.

1Q. Draw a deterministic and non-deterministic finite automate which accept 00 and 11 at the end of a string containing 0, 1 in it, e.g., 01010100 but not 000111010.

2Q. Construction of a DFA for the set of string over {x, b} such that length of the string |w| is divisible by 2 i.e, |w| mod 2 = 0.

3Q. Construction of a DFA for the set of string over {a, b} such that length of the string |w| is not divisible by 3 i.e, |w| mod 3 = 1.

4Q. Consider the following statements about the context free grammar
G = {S->SS, S->xy, S->yx, S-> λ}

- G is ambiguous or not. Explain
- G produces all strings with equal number of x's and y's. Explain
- G can be accepted by a deterministic PDA or not. Explain.

5Q. Consider the languages L1,L2,L3 as given below.

L1 = { $x^m y^n$ | m, n >= 0 }
L2 = { $x^n y^n$ | n >= 0 }
L3 = { $x^n y^n z^n$ | n >= 0 }

Justify the following statements with proper explanation.

A. Push Down Automata (PDA) can be used to recognize L1 and L2

B. L1 is a regular language

C. All the three languages are context free

6Q. Convert CFG to CNF step by step mentioning proper conversion rules. Consider the given grammar G1:

S → XSY

X → aXS|a| λ

Y → SbS|X|bb

7Q. Write the difference between Ambiguous and Unambiguous Grammar **(explain with example).**

8Q. Convert CFG to GNF with step by step mentioning proper conversion rules.

Consider the given grammar G1:

S → XZ|WW

W → b|SW

X → b

Z → a

9Q. Consider the following NFA as follows:

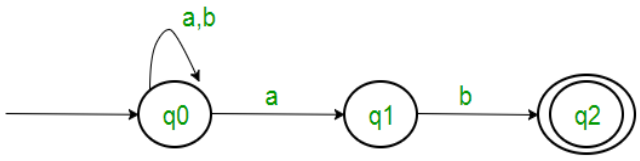


Figure 1

Convert it to DFA. You have to show each step with proper Transition Function.

10Q. The number of states in the minimal deterministic finite automaton corresponding to the regular expression (0 + 1)* (10) is _____. (explanation is needed).

Hint: First you have to make NFA from this regular expression and apply proper algorithm to convert it to DFA.

11Q. Construction of a minimal NFA accepting a set of strings over {a, b} in which each string of the language ends with ‘ab’.

12Q. Construction of a minimal NFA accepting a set of strings over {x, y} in which each string of the language is not ending with ‘xy’.

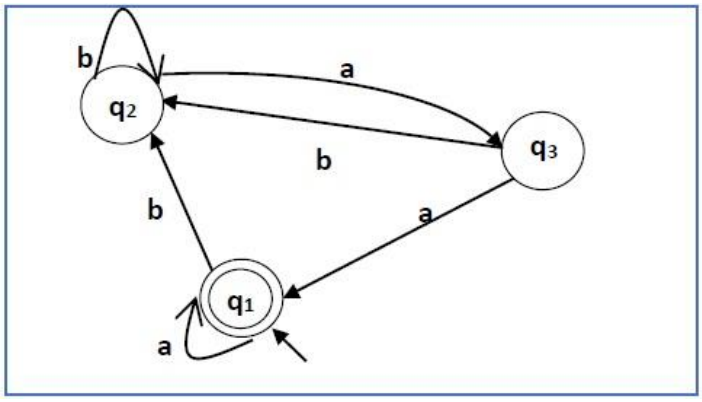
13Q. Consider the following two statements:

S1: { 0^{2x} |x >= 1} is a regular language

S2: { $0^{y}0^{x}0^{(y+x)}$ I y >= 1 and x >= 2} is a regular language

Which of the following statements is correct? Justify your answer.

14Q. Construct a regular expression corresponding to the automata given below −



Here the initial state and final state are q_1

15Q. Which one of the following languages over the alphabet {0,1} is described by the regular expression?

(0+1)*0(0+1)*0(0+1)*

(A) The set of all strings containing the substring 00.
(B) The set of all strings containing at most two 0's.
(C) The set of all strings containing at least two 0's.
(D) The set of all strings that begin and end with either 0 or 1.

Justify your answer.

16Q. Consider the languages L1 = {Ø} and L2 = {a}. Then L1 $L2^{*}$ U $L1^{*}$ _____.(Explanation is needed)

Hint: { Ø } indicates an empty language.