Birla Institute of Technology and Science, Pilani
Comprehensive Exam, Part A [Closed Book], Dec 09, 2016
Theory of Computation (CS F315)

X

50 Marks **1Hr 45 Mins**

ID		NAME	

[Note: Answer your questions in this sheet itself at the designated places.]

Q1. Over ∑ = {a, b, x} suppose language L_P is defined as:

$L_P = \{w_1xw_2 \mid w_1, w_2 \in \{a, b\}^*$ and $w_1 \neq w_2^R$ (i.e. w_1 is not equal to reverse of w_2)$\}$

For accepting language L_p consider the graphical representation of a PDA as shown in Figure 1. There are only some transitions missing in the PDA. Complete the PDA by showing all the missing transitions in Figure 1 itself.

[**Note**: q1 is the start state. Assume that # is the end marker symbol of input string and $ the bottom marker symbol of stack.]

[**4 Marks**]

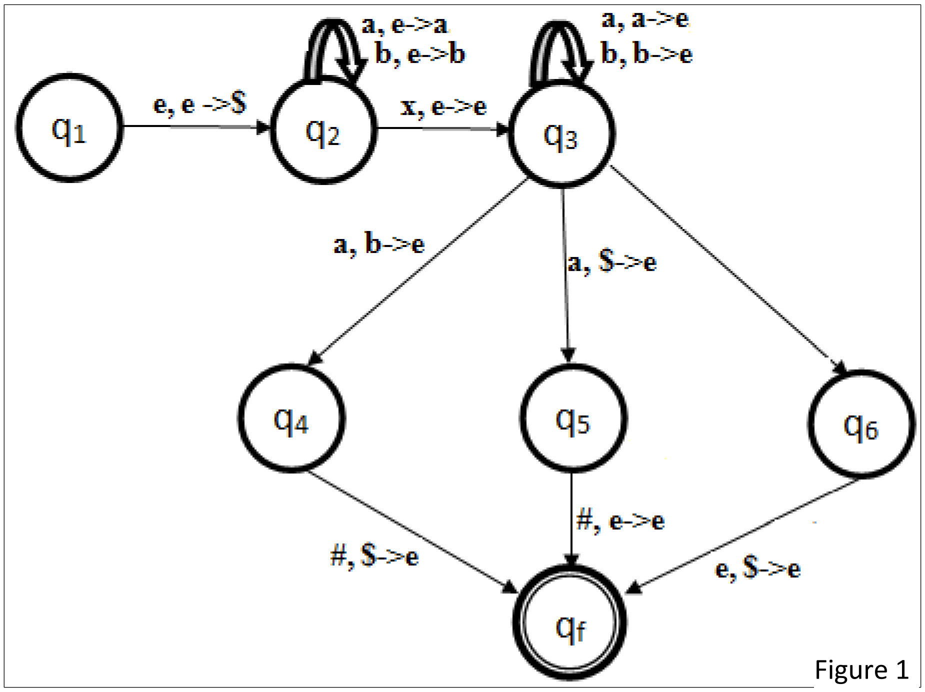


Figure 1

Q2. A CFG G1 = (**{**S, F, +, a,), (**}**, **{**+, a,), (**}** , **{**S -> F | (S+F) , F -> a**}**, S**)**. It is a LL(1) grammar. Complete the deterministic PDA (shown in Figure 2) which is helpful for parsing the string belonging to G1. There are only some transitions missing in the PDA. Complete the PDA by showing all the missing transitions in Figure 2 itself. Also, show the final state.

[**Note**: $ is the bottom of the stack symbol and # is the end marker symbol of input string.]

[**7 Marks**]

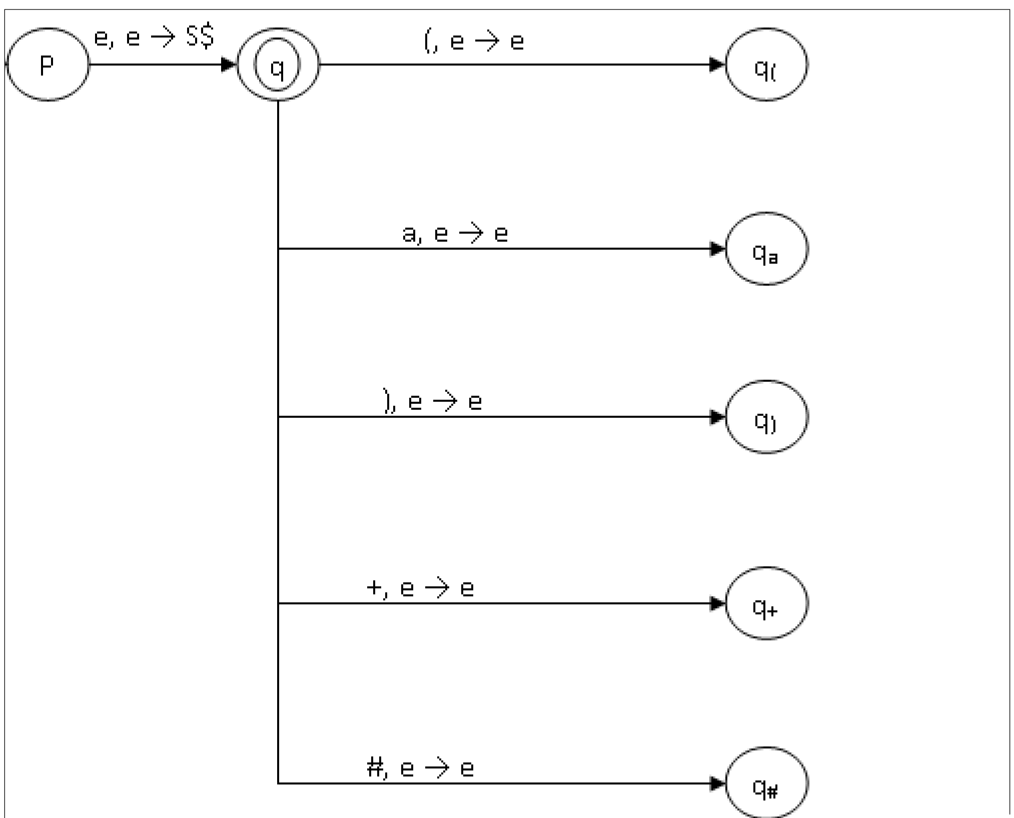


Figure 2

Q3. Consider the following language L and its proof that the language is not regular. Verify if the proof is correct. If it is, write steps (i.e. just an algorithm) to show how a deterministic PDA can accept the language L. If it is not, draw a DFA for the language and argue why proof is not correct.

$$L = \{0^{2n} \mid n \geq 0\}$$

Proof: Suppose L is a regular language. Then there exist pumping length p such that any string $s \in L$ with $|s| > p$ can be written as s=xyz with:

1. $|y| \geq 1$
2. $|xy| \leq p$
3. $xy^iz \in L$ for all $i \geq 0$.

Let's take $s=0^{2p}$ and write it as $s = e\ 0\ 0^{2p-1}$ (i.e., x=e, y=0, $z=0^{2p-1}$). Thus $xy^iz \in L$ for all $i \geq 0$. Now, for i=0, $s = 0^{2p-1}$ which is not in L. Hence, L is not regular. [**4 Marks**]

Ans 3: Whether Proof is correct (YES/NO).

Q4. A language L over $\Sigma = \{0, 1\}$ is defined as:
L = {w ϵ (0 U 1)* | w contains atleast two occurrences of 1's and exactly four occurrences of 0's}. A DFA which accepts L with correct number of states but incorrect number of transitions is shown below (Figure 3). Complete it by showing all the missing transitions in Figure 3 itself. [**4 Marks**]

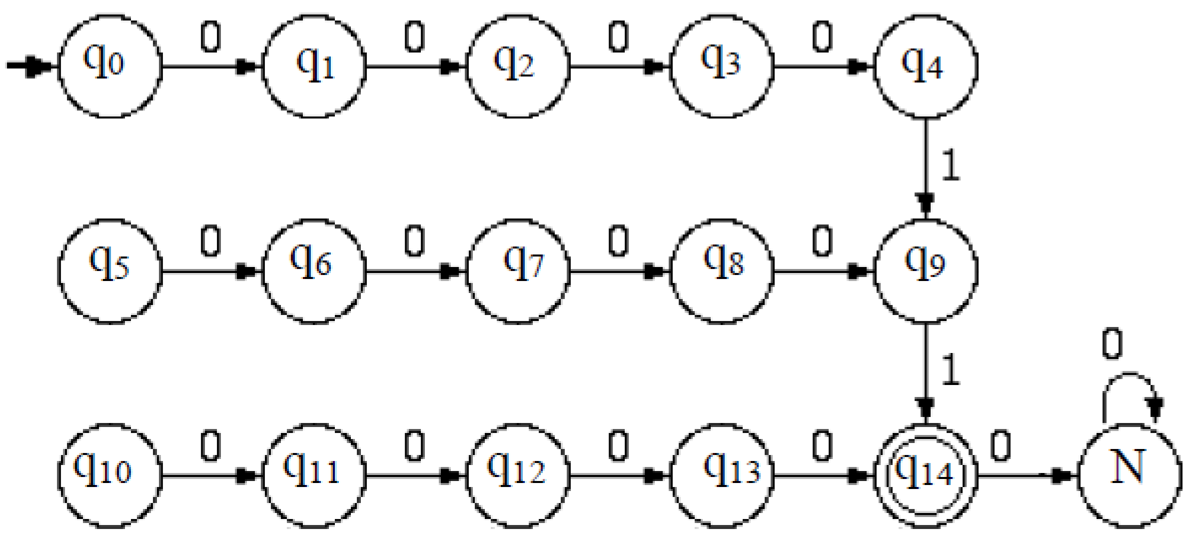


Figure 3

Q5. Consider language L defined for Q4 above and the following (Figure 4) incomplete Turing Machine which should decide L. Complete it. [**4 Marks**]

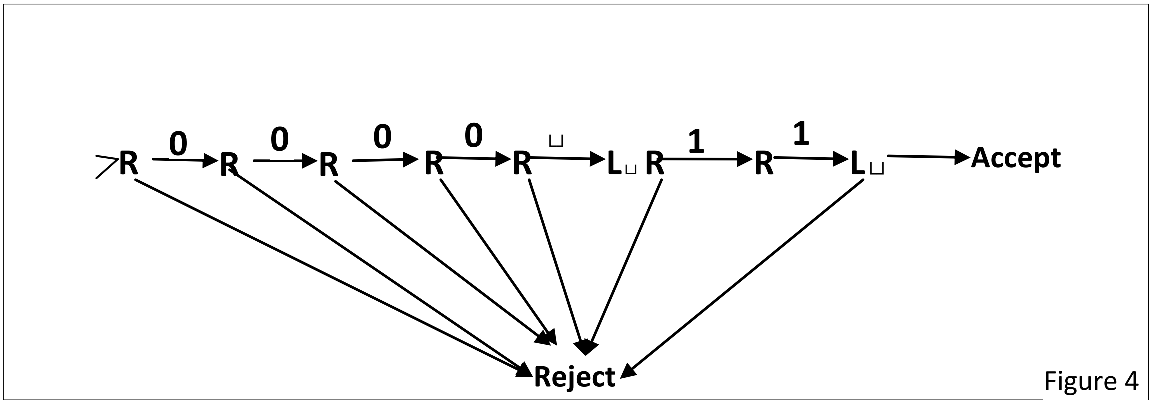


Figure 4

Q6. Complete the following CFG's for the language given. S is the start symbol. [**2.5M x4 = 10 Marks**]

(a) Over ∑ = {a, b}, L = {w |number of a's in w is greater than number of b's in w}. **S → _______ | _______ | _______** **X → aXb | bXa | XX | e** **Y → aY | a**	(b) Over ∑ = {a, b}, L = {w |number of a's in w is not equal to number of b's in w}. **S → A | B** **A → a | Aa | aA | ______ | ______ | ______** **B → b | Bb | bB | ______ | ______ | ______**
(c) Over ∑ = {a, b}, L = {ab(bbaa)^{n}bba(ba)^n | n ≥ 0}. **S → abA** **A → _____________ | ____________**	(d) Over ∑ = {a, b}, L = {w | w is of the form $a^X b^Y a^Z$. Here X, Y, Z = 1, 2, 3 .... and Y = 5X + 7Z}. **S → AB** **A → _____________ | ____________** **B → _____________ | ____________**

Q7. (a) Consider the following DFA (Figure 5) which accepts some language $\mathbf{L_S}$. Q_0 is the start state. Modify the DFA to prove that regular languages are closed under kleene star operation (i.e. if $\mathbf{L_S}$ is regular then $\mathbf{L_S}$***** is also regular).

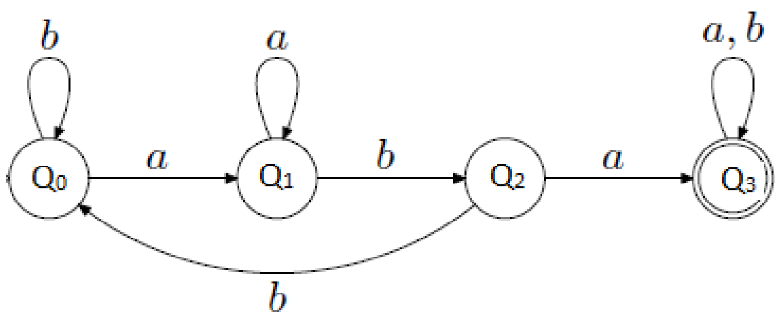
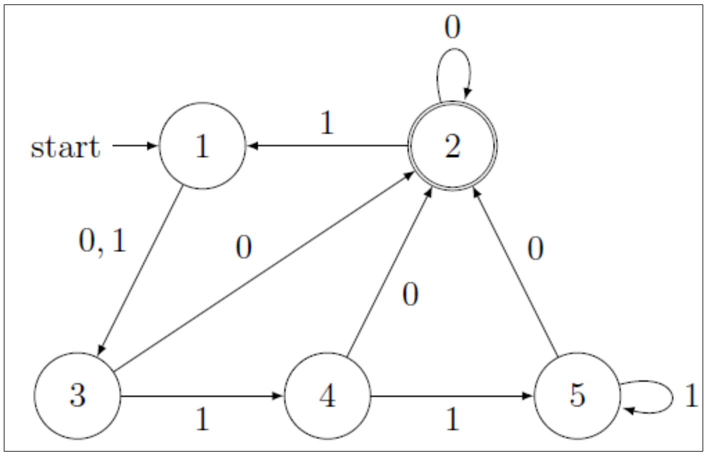


Figure 5

(b) **Rev(L_S)** is the language which is the set of strings whose reversal is in L_S. To prove that regular languages are closed under reversal operation, draw a DFA below by modifying the DFA of Figure 5 for the language **Rev(L_S)**.

[3**M** + **3M** = **6 Marks**]

Q8. Consider the Finite Automaton given below. Minimize it and redraw it. [**4 Marks**]



Ans 8.

Q9. Choose the correct option(s) for the following and write answers below. There may be more than one correct option.

Ans (i)	Ans (ii)	Ans (iii)	Ans (iv)	Ans (v)	Ans (vi)	Ans (vii)

[**1M x 7 = 7M**]

(i) Find which of the following equations is correct:

(A) (0*U1*Ue)* = (0U1)* (B) (111*)* = (11 U 111)*

(C) $(0^+ U\ 1^+ U\ e)^+ = (0U1)^+$ (D) (11*00*)* = e U 1(1U0)*0

(ii) Which of the following statements are False? All parts refer to same alphabet ∑ = {0, 1}.

(A) If L is non-regular then complement of L is also non-regular.

(B) If L1 is a subset of L2 and L1 is not regular, then L2 is also not regular.

(C) If L1 is a subset of L2 and L2 is not regular, then L1 is also not regular.

(D) If L1 and L2 are non-regular, then L1 U L2 is also non-regular.

(iii) Let L = {01, 00, 100}. Which of the following strings are in L*?

(A) 01001000100 (B) 000010000

(C) 100000100001 (D) 100000100

(iv) Which of the following statements are False? All parts refer to same alphabet ∑ = {0, 1}.

(A) If L1 ∩ L2 is regular, then L1 and L2 are regular.

(B) Every subset of a regular language is regular.

(C) Set of Deterministic Context free languages is a proper subset of the set of Context Free Languages.

(D) Set of Recursive languages is a proper subset of the set of Recursively Enumerable Languages.

(v) If Class-P = Class-NP then which of the following is correct:

(A) P = NP-Complete (B) P = NP-Hard

(C) NP-Complete = NP-Hard (D) NP-Complete is not equal to NP-Hard

(vi) With respect to the CFG **S -> S * F | F+S | F** **F -> F- F | id** , choose the correct option(s).

(A) * has higher precedence than + (B) – has higher precedence than *

(C) + and — have same precedence (D) + has higher precedence than *

(vii) Which of the following algorithms (*as discussed in the class*) does not belong to class P?

(A) NFA to DFA conversion

(B) Algorithm to decide whether a CFL is empty

(C) Algorithm to decide whether the language of a given Turing Machine is empty

(D) For a given ***grammar*** G and string w, whether w ϵ L(G).