Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

III SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC. 2016

SUBJECT: FORMAL LANGUAGES AND AUTOMATA THEORY (CS233)

(BRANCH: CS)

Wednesday, 30 November 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Missing data, if any, may be suitably assumed**

1A. Let Σ = {a, b} L_1 = {a, aba, abba} and L_2 = {λ, ab, ba, aabb, abba, abab}. Compute, L_1^R, L_1L_2, $L_2 - L_1$ and L_1^2.

1B. Let Σ = {a, b}, construct DFA for the following languages:

(i) L = { $w_1aw_2bw_3$: w_1, w_2, w_3 Є {a, b}* } (with exactly 3 states) and which of the strings **bbabba**, & **bbbbba** are accepted by the DFA.

(ii) L = { w : $n_a(w)$ mod 3 > 1 } (with exactly three states) and which of the strings **babab**, & **bababa** are accepted by the DFA.

1C. Which of the following strings **01001**, & **10010** are accepted by the following NFA in Fig. 1C.

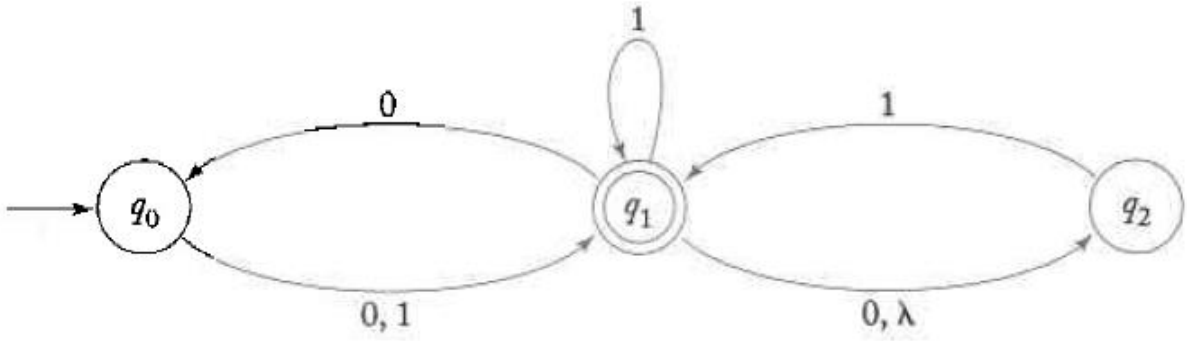

Fig. 1C

1D. Convert the NFA in Fig. 1D into an equivalent DFA.

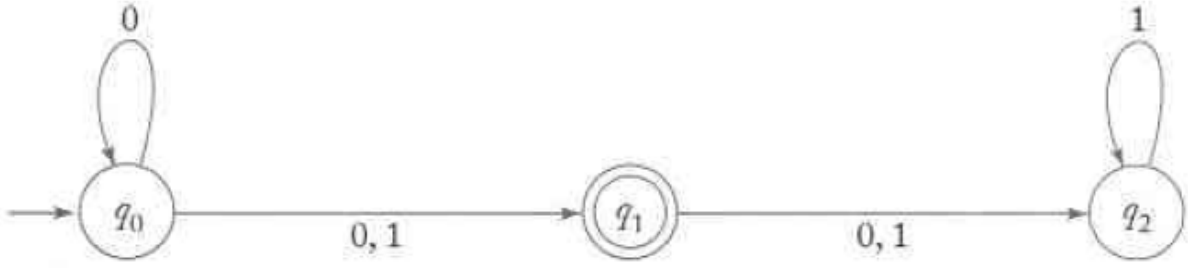

Fig. 1D

(6+6+2+6)

2A.Find the regular expressions for the following languages

(i) L = { a^nb^m : n ≥ 4, m ≤ 3}

(ii) L = { a^nb^m : n < 4, m ≤ 3}

2B. Find the NFA that accepts the language L ((a+b)* b (a+bb)*).

2C. Minimize the DFA in Fig. 2C.

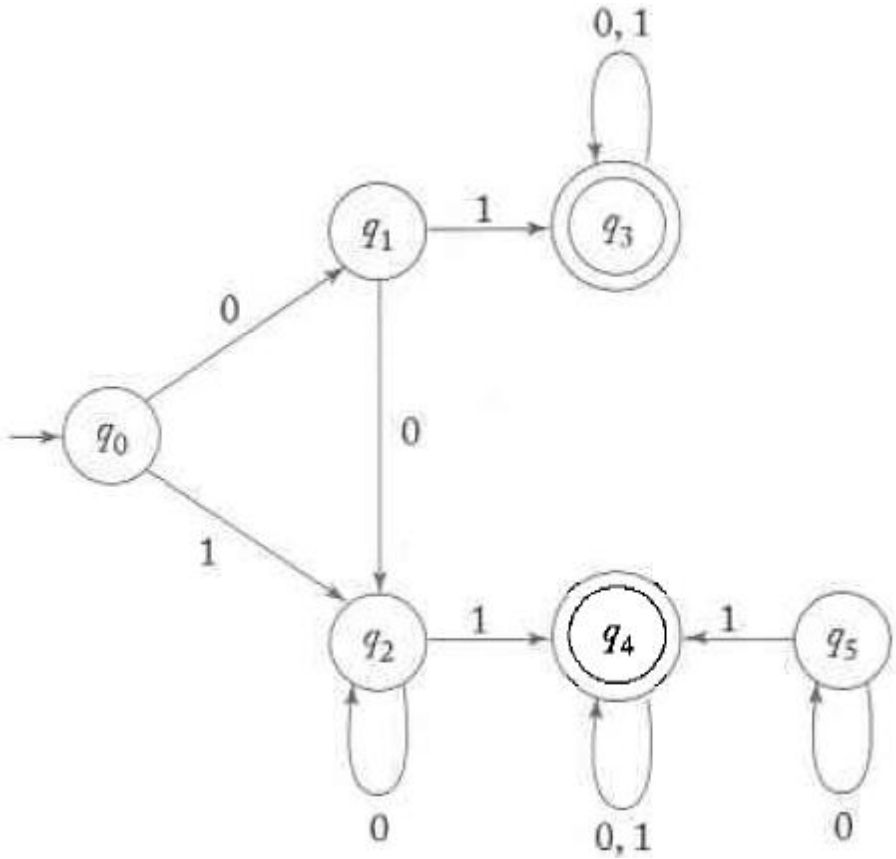

Fig. 2C

2D. Find the regular expression for the language accepted by the following NFA in Fig 2D.

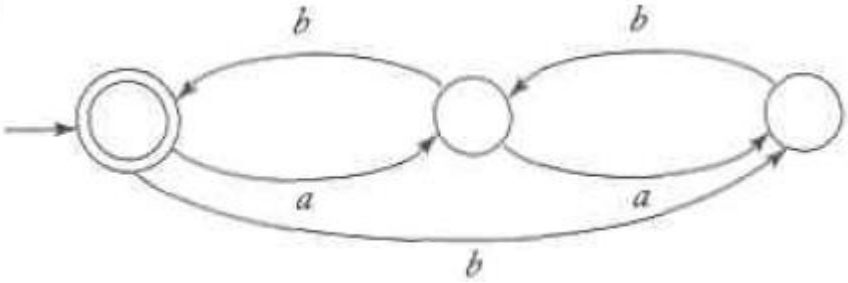

Fig 2D

(6+2+6+6)

3A. Find a right- and left-linear grammars for the language L (aab(ab)*). Also derive the string **aabab** using right- and left-linear grammars.

3B. If $L_1 = \{a^n b^m : n \geq 1, m \geq 0\} \cup \{ ba \}$ and $L_2 = \{ b^m : m \geq 1\}$. Find DFA for L_1/L_2 and hence find L_1/L_2.

3C. Show that the language $L = \{ a^n b^k c^{n+k} : n \geq 0, k \geq 0\}$ is not regular.

(6+6+8)

4A. Find context-free grammar for the following languages (with $n \geq 0$, $m \geq 0$).

(i) $L = \{ a^n b^m : n \leq m + 3 \}$ and derive the string **aaaab**

(ii) $L = \{ w \in \{a, b\}^* : n_a(w) = n_b(w)\}$ and derive the string **bbaaba**

4B. Consider the CFG:

$S \longrightarrow SS+ \mid SS^* \mid a$ and the string aa+a*

(i) Give a leftmost derivation for the string.

(ii) Give a rightmost derivation for the string.

(iii) Give the leftmost derivation tree for the string

(iv) Is the grammar ambiguous?

4C. Eliminate all λ-productions, unit productions and useless productions from the grammar

S ⟶ a|aA|B|C
A ⟶ aB|λ
B ⟶ Aa
C ⟶ cCD
D ⟶ ddd

What language does this grammar generate? (8+4+8)

5A.Convert the grammar into CNF

S ⟶ AB|aB
A ⟶ aab|λ
B ⟶ bbA

5B.Construct the NPDA with transition diagram with exactly three states for the language

$L = \{ ww^R : w \in \{a, b\}^* \}$

Show that the string **abba** will be accepted while the string **aabb** will be rejected.

5C. Construct NPDA with transition diagram with exactly three states for the grammar.

S ⟶ aSbb|a

Show the acceptance of the string **aabb**.

(6+8+6)

6A. Show that $L = \{a^n b^{2n} : n \geq 0\}$ is a deterministic CFL. Show the acceptance of the string **aabbbb**

6B. Show that $L = \{ww : w \in \{a, b\}^*\}$ is not context-free.

6C. Show that $L = \{w \in \{a, b\}^* : n_a(w) = n_b(w)\}$ is not linear.

(6+8+6)

7A. Design a TM with transition diagram with five states that accepts following language.

$L = \{ a^n b^n : n \geq 1\}$

Show that the string **aabb** will be accepted.

7B. With neat diagram explain multitape TM and multidimensional TM

(12+8)

8A. With neat diagram explain Chomsky Hierarchy for formal languages.

8B. Let A = {001, 0011, 11, 101} and B = {01, 111, 111, 010} Does the pair (A, B) have a PC-solution? Does it have an MPC-solution?

8C. Define the following with an example.

(i) Unrestricted grammar (ii) Context-sensitive grammar

(iii) Recursive enumerable language

(8+6+6)