Reg. No.										

MANIPAL UNIVERSITY

THIRD SEMESTER B.S. (ENGG.) DEGREE EXAMINATION – DECEMBER 2015

SUBJECT: FORMAL LANGUAGES AND AUTOMATA THEORY (CS 233)

(BRANCH: CE/CS)

Wednesday, December 16, 2015

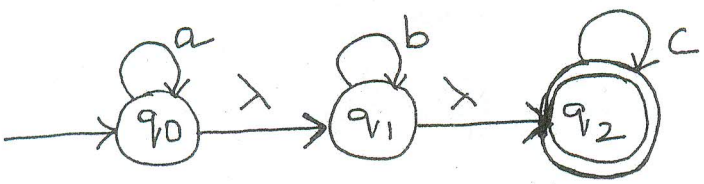
Time: 10:00 – 13:00 Hrs. Max. Marks: 100

- **Answer any FIVE full questions.**
- **Missing data can be suitably assumed.**

1A. Prove by mathematical induction that any binary tree of height 'n' can have at most 2^n leaves.

1B. Convert the following NFA to DFA and Final state is q2:

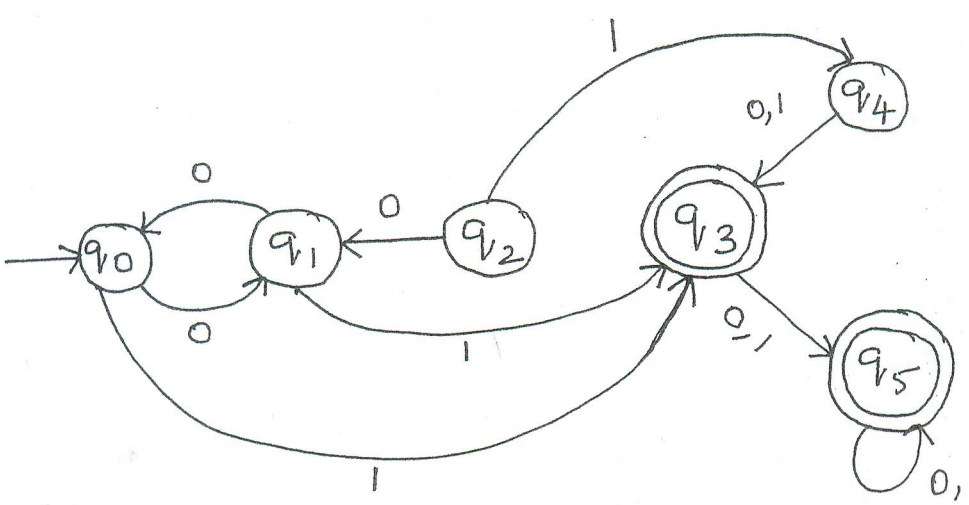
Fig Q.1B



1C. Draw a DFA to accept a strings of a's and b's with at most two consecutive b's. (Include transition table also).

1D. Minimize the states in the DFA given in the following diagram:

Fig Q.1D



(4+6+5+5 = 20 marks)

2A. Obtain regular expressions for the following:

i) L(R) = { w | w ϵ {0,1}* } with at least three consecutive 0's.

ii) To accept strings of a's and b's of length ≤ 10.

iii) To accept strings of a's and b's starting with 'a' and ending with 'b'.

2B. Obtain a NFA which accepts strings of a's and b's starting with the string ab.

2C. Find L1/ L2 for L1=L (a*baa*) and L2 = L (ab*).

2D. State and prove the theorem pumping lemma for regular languages.

((2+2+2)+4+6+4 = 20 marks)

3A. Find a simple grammar for the following:

i) $L = \{a^n b^n \mid n \geq 1\}$ ii) $L = \{ a^n b^{n+1} \mid n \geq 2\}$

3B. Find the Context Free Grammar for the language:

i) $L = \{ a^n ww^R b^n \mid w \in \{a,b\}^* \}, n \geq 1\}$ ii) $L = \{01(1100)^n 110(10)^n \mid n \geq 0 \}$

3C. Is the following grammar ambiguous? (Use derivation tree)

S → aS | X

X → aX | a

3D. Obtain a right linear grammar for the following:

$L = \{ a^n b^m \mid n \geq 2, m \geq 3\}$

((3+3)+(3+3)+ 5+3 = 20 marks)

4A. Eliminate λ, Unit and Useless productions from the following:

S→ a | aA | B | C

A→ aB | λ

B→ Aa

C→ cCD

D→ ddd

4B. Convert the following grammar into CNF:

S→ AB | aB

A→ aab | λ

B→ bbA

4C. Draw a NFA which accepts the language associated with the regular expression $0^*1(0+10^*)1^*$.

4D. Give the regular expression for the following:

i) L= {a, ab, abb, c, cb, cbb.....}

ii) $L = \{a^n ba^{2m} c^{3p} : m \geq 0, n \geq 1, p \geq 1 \}$

(7+6+3+(2+2) = 20 marks)

5A. Convert the following grammar into Greibach Normal Form:

S → abSb | aa

5B. Obtain a Deterministic Pushdown Automaton to accept a language $L(M) = \{w C w^R \mid w \in \{a,b\}^*\}$ where w^R is the reverse of w. Show the acceptance of the string with one example.

5C. Is the Pushdown automaton corresponding to the language $L = \{a^n b^n \mid n \geq 1\}$ is deterministic?

5D. Show that the language $L = \{ww : w \in \{a,b\}^*\}$ is not context free using pumping lemma.

(3+7+7+3 = 20 marks)

6A. Show that the family of context-free languages is closed under union, concatenation and star-closure.

6B. Obtain the corresponding non-deterministic Pushdown automaton for the following grammar:

$S \rightarrow aABC$

$A \rightarrow aB \mid a$

$B \rightarrow bA \mid b$

$C \rightarrow a$

Check the acceptance of the string for 'aabba'

(12+8 = 20 marks)

7A. Design a Turing Machine with no more than three states that accepts the language $L(a\ (a + b)^*)$. Assume that $\sum = \{a,b\}$

7B. Design a Turing Machine that accepts the language $L = \{w : |w| \text{ is even}, w \in \{a,b\}^*\}$.

7C. Explain Off-Line Turing machine with neat diagram.

7D. Explain about Universal Turing Machine with neat diagram.

(6+6+4+4 = 20 marks)

8A. Explain with suitable diagrams:

i) Turing machine with Semi Infinite Tape ii) Linear Bounded Automata

iii) Nondeterministic Turing Machine

8B. Construct a Turing machine that accepts the language L(aa*).

8C. Explain Chomsky Hierarchy with diagrams that shows the relationship among different languages.

8D. Explain the following:

i) Unrestricted Grammar ii) Context-Sensitive Grammar

((3+3+3)+3+4+(2+2) = 20 marks)