Roll Number:____________________

Thapar Institute of Engineering & Technology, Patiala

Department of Computer Science and Engineering

END SEMESTER EXAMINATION

B. E. (Third Year): Semester-I (2017/18) (COE/ SEM)	Course Code: UCS701 Course Name: Theory of Computation
December 12, 2017	
Time: 3 Hours, M. Marks: 100	Name Of Faculty: AKU, VG, NS, AM

Note: Attempt all questions with proper justification.
Assume missing data, if any, suitably.

Q.1(a) Write a regular expression which describes the language of binary numbers from the alphabet $\{0,1\}$ which are either odd or a power of 2 (or both). Design the DFA for the specified regular expression. (7)

Q1(b) Given $L_1 = \{ab, cd\}$. Write down all strings of L_1^2. (3)

Q2(a) Prove that regular languages are closed under Intersection. (4)

Q2(b) Give any one application of finite automata and explain in detail how finite automata are used in the mentioned application. (6)

Q3(a) Design a non-deterministic finite automaton for the language $L_2 = (a \mid b)^* abb$ using Thompson's construction. (5)

Q3(b) Convert the DFA (Fig. 1) into Regular Expression using state elimination method. (5)

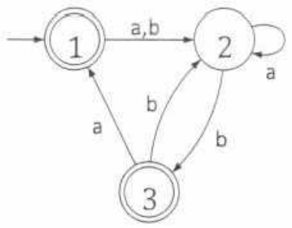

Fig. 1: DFA over $\Sigma = \{a, b\}$

Q4(a) Design Post machine for the language $L_3 = \{a^n b^n c^n \mid n \geq 0\}$. (6)

Q4(b) Convert the NFA (Fig. 2) into DFA (4)

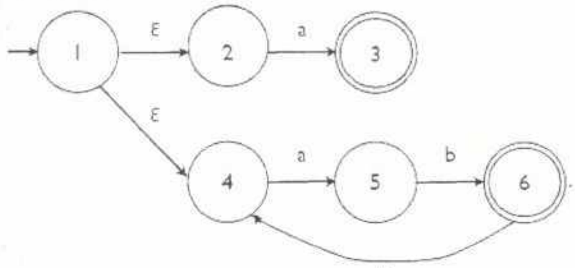

Fig 2: NFA over $\Sigma = \{a, b\}$

Q5(a) Design Pushdown automata for the language L_4. Write transition function for the same. $L_4 = \{a^{2n} b^{3n} \mid n \geq 0\}$ (6)

Q5(b) Prove by an example that context-free language is not closed under intersection. (4)

Q6 Write down the statement of pumping lemma for context-free languages. Explain various conditions specified in the pumping lemma. Using Pumping Lemma prove that the language $\mathbf{L_5 = \{a^n b^n c^i \mid n \geq i\}}$ is not a context-free language. (10)

Q7(a) Convert given language in Chomsky normal form (6)

$$\mathbf{S \rightarrow 0A0 \mid 1B1 \mid BB}$$
$$A \rightarrow C$$
$$B \rightarrow S \mid A$$
$$C \rightarrow S \mid \varepsilon$$

Q7(b) The language $\mathbf{L_6}$ consists of all strings properly balanced left and right brackets: every left bracket can be paired with a unique subsequent right bracket, and every right bracket can be paired with a unique preceding left bracket. Moreover, the string between any such pair has the same property. For example, [ ] [[[ ] [ ]] [ ]] $\in \mathbf{L_6}$. Design context-free grammar for language $\mathbf{L_6}$. (4)

Q8(a) What do you mean by ambiguity? Consider the following grammar with start symbol S: (5)

S → if id then S else S

S → if id then S

S → id

Check whether the given grammar is ambiguous or not?

Q8(b) Given the following grammar (5)

$$\mathbf{S \rightarrow a \mid YZ}$$
$$\mathbf{Z \rightarrow ZY \mid a}$$
$$\mathbf{Y \rightarrow b \mid ZZ \mid YY}$$

Apply CYK algorithm to check whether $\mathbf{w = babba}$ belongs to this language or not?

Q9(a) Differentiate between recursive enumerable and recursive languages. Explain with example. (5)

Q9(b) Draw the diagram of Chomsky Hierarchy and explain relation between different type of grammars and automata. (5)

Q10 Design a single tape Turing machine that takes a number N in binary and add 1 to this number. The tape initially contains a \$ followed by N in binary. The tape head is initially scanning the \$ symbol in state $\mathbf{q_0}$. Your Turing machine should halt with $\mathbf{N+1}$ in binary on its tape. You can destroy the \$ in creating $\mathbf{N+1}$ for example $\mathbf{q_0\$1111 \xrightarrow{*} q_f 10000}$. Develop your logic and give the transition table for the Turing machine. Show the sequence of instantaneous description for the string **\$111**. (10)

***********End of Paper***************