



Comp/IT

College of Engineering

Wellesley Road Shivajinagar Pune 411005 (MS)

End-Semester Examination Semester V Class: T Y (IT)

Course: Automata Theory (CT309) Maximum Marks: 50

Date: Nov 24, 2012

Time: 02:00 to 05:00

N.B.

- (i) Solve any **five** questions. Question paper contains **six** questions.
- (ii) Figures to the right indicate full marks.
- (iii) Assume suitable data if necessary.
- (iv) Unspecified symbols have usual meanings.

Q.1 (a) Show that if there exists a finite automaton accepting language L , then there exists finite state automaton accepting $L - \{\epsilon\}$. In other words, show that if L is FSA acceptable, then so is $L - \{\epsilon\}$. (05)

(b) Draw the deterministic finite automaton M that accepts the following language,

$$L(M) = \{w \in \{a, b\}^* \mid w \text{ has an even number of } a\text{'s and odd number of } b\text{'s}\}$$

Justify your answer with suitable examples.

(05)

Q.2 (a) Prove the following:

“The class of regular languages is closed under the *concatenation* operation.”

(05)

(b) Let CFG be:

$$S \rightarrow aSb \mid bY \mid Ya$$

$$Y \rightarrow bY \mid aY \mid \epsilon$$

Give a simple description of $L(G)$ in English. Use that description to give a CFG for $\overline{L(G)}$, the complement of $L(G)$. (05)

Q.3 Give separate context-free grammar for each of the following languages. Illustrate your answer with suitable examples.

- (a) The set of strings over the alphabet $\{a, b\}$ with more a 's than b 's.
- (b) The complement of the language $\{a^n b^n \mid n \geq 0\}$,

(10)

Q.4 (a) Define formally Turing machine. With respect to the formal definition, answer the following questions, and explain your reasoning.

- (i) Can a Turing machine ever write the blank symbol \sqcup on its tape?
- (ii) Can tape alphabet Γ be the same as the input alphabet Σ ?
- (iii) Can a Turing machine's head ever be in the same location in two successive steps?
- (iv) Can a Turing machine contain just a single state?

(06)

(b) Give a formal definition of an enumerator. Consider it to be a type of two-tape Turing machine that uses its second tape as the printer. Include the definition of the enumerated language. (04)

Q.5 (a) Let A be the language containing only the single string s , where

$$s = \begin{cases} 0 & \text{if life never will be found on Mars.} \\ 1 & \text{if life will be found on Mars someday.} \end{cases}$$

Is A decidable? Why or why not?

For the purposes of this problem, assume that the question of whether life will be found on Mars has an unambiguous YES or NO answer. (05)

(b) Show that the collection of *decidable languages* is closed under the union operation.

(Hint: Construct Turing machine.) (05)

Q.6 Using Pumping lemma show that the following languages are not regular. (Answer any **two**)

(a) $L(M) = \{a^n b a^m b a^{m+n} \mid n, m \geq 1\}$ (05)

(b) $L(M) = \{ww \mid w \in \{a, b\}^*\}$ (05)

(c) $L(M) = \{a^{2^n} \mid n \geq 0\}$. Here, a^{2^n} means a string of 2^n a 's (05)