

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Date:FN / AN Time: 2 hours Full marks: 60 No. of students: 41
Autumn Mid Semester Exams, 2012 Dept: Comp. Sc & Engg. Sub No: CS60005
M.Tech (Core) Sub Name: **Foundations of Computing Science**

Instructions: Answer all questions. Answer all parts of a question in the same place.

1. Indicate for each of the following statements, whether it is true / false. If true, then provide a short proof. If false, then simply give a counter-example.

- (a) Every language is either Turing recognizable or Co-Turing recognizable, or both.
- (b) The set of all subsets of a countable infinite set is uncountable
- (c) If we exchange accept and non-accept states of a NFA, then the new NFA recognizes the complement of the language accepted by the original NFA.

[5 X 3 = 15 marks]

2. [Context Free Languages]

- (a) Show that the class of context-free languages is not closed under intersection.
- (b) Draw a PDA for the language $L = \{w \# v \mid w, v \in \{0,1\}^* \text{ and } w \neq v\}$.

[Hint: If $w \neq v$, then there is some k such that $w[k] \neq v[k]$.

Choose this point of difference non-deterministically.]

[4 + 8 = 12 marks]

3. Let $E_{TM} = \{ \langle M \rangle \mid M \text{ is a TM and } L(M) = \emptyset \}$.

- (a) Prove that E_{TM} is Co-Turing recognizable.
- (b) Prove that E_{TM} is not decidable [You are given that A_{TM} is not decidable]
- (c) Explain whether E_{TM} is Turing-recognizable.

[8 + 8 + 5 = 21 marks]

4. State and explain each of the following:

- (a) Pumping Lemma for context free languages
- (b) The Chomsky hierarchy of languages
- (c) Post correspondence problem

[4 X 3 = 12 marks]