

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Department of Computer Sc & Engg

Theory of Computation (CS31004)

Mid-semester examination (Spring, 2012)

Date: Mon, Feb 20, 2012

Answer all questions

Time: 9am-11am (FN), 2 hours

Students: 5

Full Marks: 60

1. Design a Turing machine with a single tape to recognise the language defined by palindromes over the alphabet $\{0, 1\}$. Starting with the tape alphabet, explain its operation by giving the algorithmic steps and identifying the states(s) corresponding to each step. 10
2. You are required to show that pushdown automata with two stacks (PDS2S) are as powerful as Turing Machines (TM).
 - (a) Given a TM show how an equivalent PDS2S can be constructed 8
 - (b) Given a PDA2S show how an equivalent TM can be constructed 8
3. Show that for a recursively enumerable language L , it is possible to construct a generator which would enumerate the strings of L . 12
4. Design a Post Machine M over $\Sigma = \{a, b\}$ such that
$$\text{accept}(M) = \{w \mid w \in \Sigma^* \text{ and } w \text{ contains twice as many } b\text{'s as } a\text{'s}\},$$
$$\text{reject}(M) = \Sigma^* - \text{accept}(M),$$
$$\text{loop}(M) = \emptyset.$$

Explain what is achieved in each loop of the machine. 10
5. (a) Show that a decision problem class \mathcal{P} is decidable iff both \mathcal{P} and its complement class \mathcal{P}^c are partially (semi) decidable. 6
(b) Assuming that the halting problem of Turing Machines is undecidable, prove that its complement class is not even partially (semi) decidable. 6