Modern Complexity Theory (CS1.405)

Quiz 1 (Monsoon 2025)

International Institute of Information Technology, Hyderabad

Time: 1 hour and 15 minutes Total Marks: 20

Instructions: Answer *ALL* questions.

This is a CLOSED books and notes examination.

NO query in examination hall is allowed.

1 September 2025 (Monday)

1. Show that every NFA can be converted to an equivalent one that has a single accept state.

[5]

2. Let L_1 and L_2 be two languages decided by deterministic Turing machine (DTM). Prove that the concatenation of these languages is also decidable.

[5]

3. Consider the following variant of Turing machine, called the Turing machine with doubly infinite tape.

A ***Turing machine with doubly infinite tape*** is similar to an ordinary Turing machine, but its tape is infinite to the left as well as to the right. The tape is initially filled with blanks except for the portion that contains the input. Computation is defined as usual except that the head never encounters an end to the tape as it moves leftward. Show that this type of Turing machine recognizes the class of Turing-recognizable languages.

[5]

4. Suppose that a Multi-tape Turing Machine (MTM) has four tapes and the tapes contents are shown below:
tape 1: $0 \quad 1^{\downarrow} \quad 0 \quad 1 \quad 0 \quad \sqcup \ldots$
tape 2: $a \quad a \quad a^{\downarrow} \quad \sqcup \ldots$
tape 3: $b^{\downarrow} \quad a \quad \sqcup \ldots$
tape 4: $x \quad y \quad z^{\downarrow} \quad \sqcup \ldots$
where $\downarrow$ is the current tape position for a tape. Design a single-tape Turing machine, S for the above MTM.

[5]

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