

Computer Science & Engineering Department
IIT Kharagpur
Theory of Computation: CS41001
Tutorial IX

Date: 14th, October, 2014

1. Prove that $\mathbf{P} = \cup_{i \geq 1} DTIME(n^i)$ is closed under union, complement, concatenation, and Kleene star.
2. State a few of the closure properties of the class $\mathbf{NP}$. Justify your claim using the verifier model. Which important closure property is unknown for the class?
3. $PERM - POWER = \{ \langle p, q, n \rangle : p = q^n \text{ where } p \text{ and } q \text{ are permutations on } \{1, \dots, k\} \text{ and } n \text{ is a positive integer in binary} \}$. Prove that $PERM - POWER \in P$.
4. We define the language $CLIQUE = \{ \langle G, k \rangle : \text{where } G \text{ is a undirected graph with a complete subgraph of size } k \}$.
Prove that $CLIQUE$ is $\mathbf{NP}$ -complete. Assume that 3SAT is $\mathbf{NP}$ hard.
5. Give a polynomial time reduction of $CLIQUE$ to SAT. Find the length of the CNF formula in terms of the input length.

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