

**10 marks**

Hardness is given as  $[x]$ . Higher number means harder. Marks as  $(x)$ . Assume the input alphabet is  $\{0, 1\}$  unless mentioned otherwise.

1. Define the complexity class IP. [1] (1)
2. Prove that graph non-isomorphism is in IP. [1] (1)
3. Construct the arithmetized polynomial for the formula  $(x_1 \vee x_2) \wedge (\overline{x_2} \vee x_3) \wedge \overline{x_1} \wedge \overline{x_3}$ . [1] (1)
4. Describe the interactive proof to prove unsatisfiability of the above formula. You must write down the polynomials sent by prover at each step. You can choose arbitrary numbers as random numbers chosen by the verifier. [2] (2)
5. Consider the directed graph with four vertices and edges  $(1, 2)$ ,  $(3, 4)$ ,  $(3, 1)$ ,  $(4, 2)$ . Describe the whole read-once proof for proving that 4 is not reachable from 1. [3] (3)
6. Define BPP and P/poly. State and prove how they are related. [1] (2)

**Computational Complexity Theory (E)****2h30m****Student's Scores**

(To be filled by the instructor)

1   2   3   6   [1]  
/1   /1   /1   /2   /5

4   [2]  
/2   /2

5   [3]  
/3   /3

**Instructor's Remarks**

(To be filled by the instructor)

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