

FOUNDATIONS OF COMPUTING SCIENCE

Tutorial – 4

PROBLEMS

- Using the *pumping lemma* for CFL, show that the following languages (\mathcal{A} , \mathcal{B} , \mathcal{C} and \mathcal{D}) are *not* context-free:

1) $\mathcal{A} = \{ 0^n 1^n 0^n 1^n \mid n \geq 0 \}$

2) $\mathcal{B} = \{ 0^n \# 0^{2n} \# 0^{3n} \mid n \geq 0 \}$

3) $\mathcal{C} = \{ w \# t \mid w \text{ is a substring of } t, \text{ where } w, t \in \{a, b\}^* \}$

4) $\mathcal{D} = \{ w t w^R \mid w, t \in \{0, 1\}^* \text{ and } |w| = |t| \}$

PUMPING LEMMA

- If A is a context-free language, then there is a number p (the pumping length), where, if s is any string in A of length at least p , then s may be divided into five pieces $s = uvxyz$ satisfying the following conditions:
 1. For each $i \geq 0$, $uv^ixy^iz \in A$
 2. $|vy| > 0$, and
 3. $|vxy| \leq p$