Problem 1:

Assume that L is a CFL → p is the pumping length

Pumping lemma for CFL state that for any string (s) in L with length ≥ p can be divided into 5 pieces $s = uvxyz$ where

- → for each $i \geq 0$, $uv^ixy^iz \in L$
- → $|vy| > 0$
- → $|vxy| \leq p$

Choose $s = 0^p1^p0^p1^p \in L$

vxy must contain the midpoint of the string

- → If vxy was purely in the left half, pumping up to uv^2xy^2z puts a 1 in the first position of the second half
- → If vxy was purely in the right half, pumping up to uv^2xy^2z puts a 0 in the ~~second~~ last position of the first half

Pumping down to uxz gives $0^p1^i0^j1^p$

i and j cannot both be p as $|vxy| \leq p$

This string is not of the form ww, and therefore s cannot be pumped

∴ L is not a CFL