

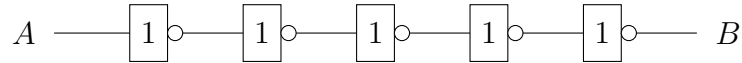
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**Task 2.1**

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An inverter exhibits a measured delay of 2ns.

- a) Calculate the delay of 5 inverters connected in series (Fig. 2.1):



**Figure 2.1:** Chain of 5 inverters

- b) When  $A$  and  $B$  are connected, a clock can be excited. Specify period and frequency:

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**Task 2.2**

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Create the structure and symbol of an NMOS transistor and calculate the cross current  $I_{DC}$  in steady state:

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**Task 2.3**

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In 130nm, carrier concentrations are used in the p-substrate in the range of  $3 \cdot 10^{17} \text{cm}^{-3}$ . The thickness of the oxide is  $t_{\text{ox}} = 22 \text{\AA}$ , the doping of the gate is  $N_D = 10^{20} \text{cm}^{-3}$ .

- Estimate the degree of band-bending for strong inversion at room temperature (relative to the flat-band condition):
- Calculate the maximum width and charge of the space charge region for strong inversion:
- Provide the values of the oxide capacitance  $C_{\text{ox}}$  and the body factor  $\gamma$ :
- $N_{\text{ox}} = 2 \cdot 10^{10} \text{cm}^{-2}$  is given. Provide the threshold voltage of  $V_{\text{SB}} = 0 \text{V}$  and discuss the gate doping:
- Determine the ions to be implanted ( $N_I$  in units  $[\text{ion}/\text{cm}^2]$ ) required to reach a threshold voltage of 0.4V: