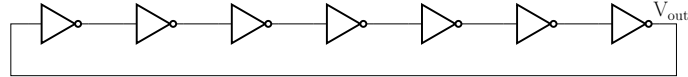


EC 5311 Digital IC Design: Assignment 4
Ring oscillator

$V_{Tn} = 0.7, \quad \mu_n = 0.025 \text{ m}^2/\text{V} \cdot \text{s}, \quad C_{oxn} = 8.34 \text{ fF}/\mu\text{m}^2, \quad v_{satn} = 8 \times 10^4 \text{ m/s}, \quad \lambda_n = 0.2$ $ V_{Tp} = 0.7, \quad \mu_p = 0.009 \text{ m}^2/\text{V} \cdot \text{s}, \quad C_{oxp} = 8.16 \text{ fF}/\mu\text{m}^2, \quad v_{satp} = 3 \times 10^4 \text{ m/s}, \quad \lambda_p = 0.2.$

1. Using the CMOS inverter with the minimum delay from Assignment 3, construct a seven stage ring oscillator as shown below and find the oscillating frequency.



To ensure oscillation in the transient simulation, set the node $V_{out} = 0\text{V}$ initially using: `.ic v(Vout)=0`

- (a) Measure the oscillating frequency for $V_{DD} = 1.8\text{V}$.
- (b) Plot the oscillating frequency and time period as a function of V_{DD} for $V_{DD} = 1\text{V}$ to 1.8V in steps of 0.1V .
- (c) Repeat the experiment (b) with nine inverter stages.