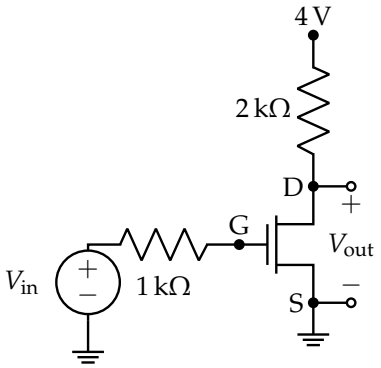
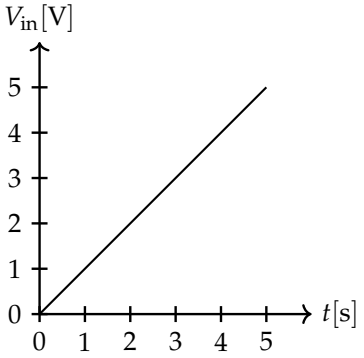
Discussion 2A

1. NMOS Logic Inverter

(a) We have an NMOS logic implementation of an inverter shown below. The circuit has a voltage input $V_{\text{in}}(t) = t$, $t \geq 0$, ($V_{\text{in}}(t) = 0\,\text{V}$ for $t \leq 0$) seen below.



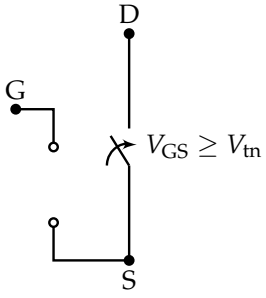
(a) NMOS Inverter



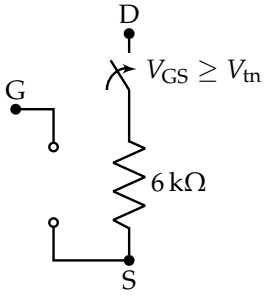
(b) Voltage input, V_{in}

Figure 1: Circuit figure and input signal.

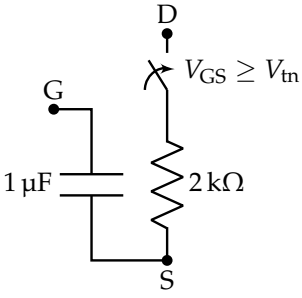
For the transistor models below, define the threshold voltage as $V_{\text{tn}} = 2\,\text{V}$. **Match each NMOS transistor model, plugged into the NMOS inverter circuit, with its corresponding V_{out} plot on the next page.** (Note: All capacitors are fully discharged at $t = 0$.)



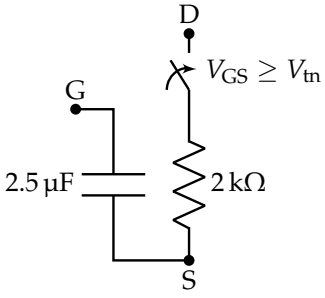
(I) Model I



(II) Model II

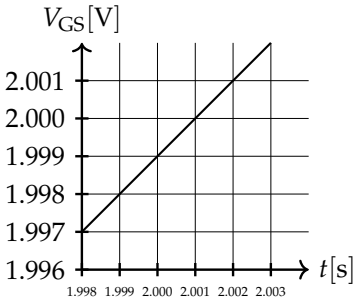


(III) Model III

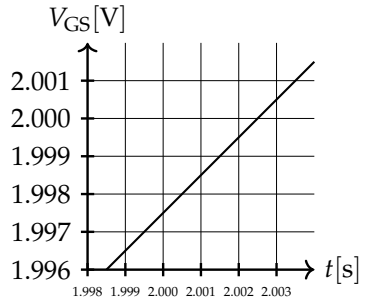


(IV) Model IV

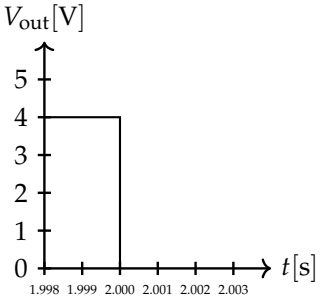
(HINT: You can use the below graphs to evaluate V_{GS} for Models III and IV. We recommend using a scratch page to draw out the NMOS Inverter circuit with the various transistor models plugged in.)



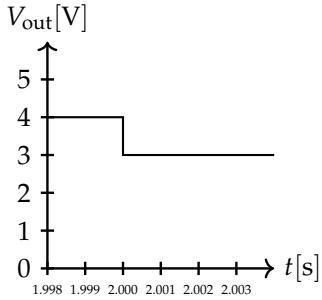
(a) V_{GS} for Model III



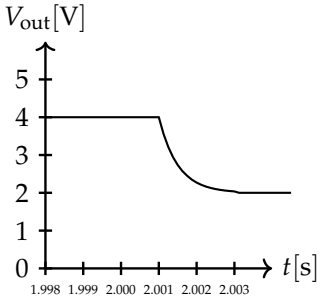
(b) V_{GS} for Model IV



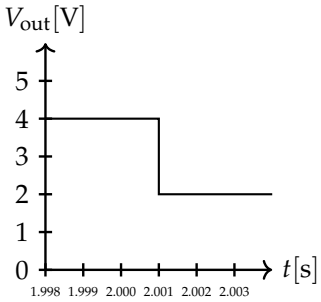
(A) Plot A



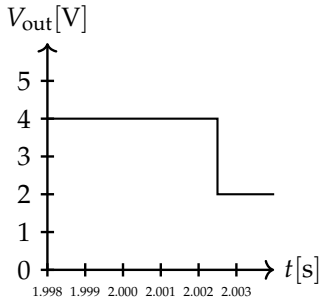
(B) Plot B



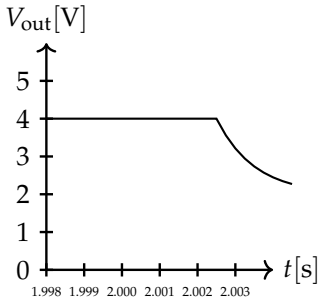
(C) Plot C



(D) Plot D



(E) Plot E



(F) Plot F

Model #	Plot A	Plot B	Plot C	Plot D	Plot E	Plot F
I	◯	◯	◯	◯	◯	◯
II	◯	◯	◯	◯	◯	◯
III	◯	◯	◯	◯	◯	◯
IV	◯	◯	◯	◯	◯	◯

2. An RC Circuit with a Dependent Source

Consider the following circuit ($V_{out}(0) = 0$):

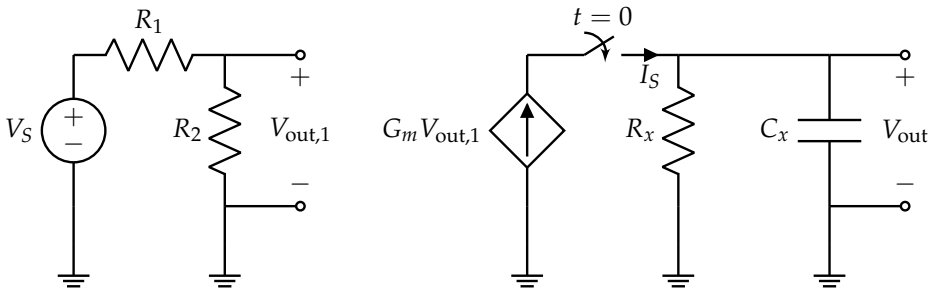


Figure 5

(a) **Find the differential equation for V_{out}.**

(b) **Find the time constant τ of the circuit**.

(c) **Draw a sketch of $V_{out}(t)$ for $t > 0$.** Make sure to include the initial value, asymptotic value, and the approximate value at the time constant (all in terms of the given variables). *(HINT: You can do this without solving the differential equation.)*

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