
EEL3701: Digital Logic & Computer Systems
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>Propagation Delay
>Inertial Delay
>Fan-in, Fan-out
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>Race Condition/Hazard
Look into my ...
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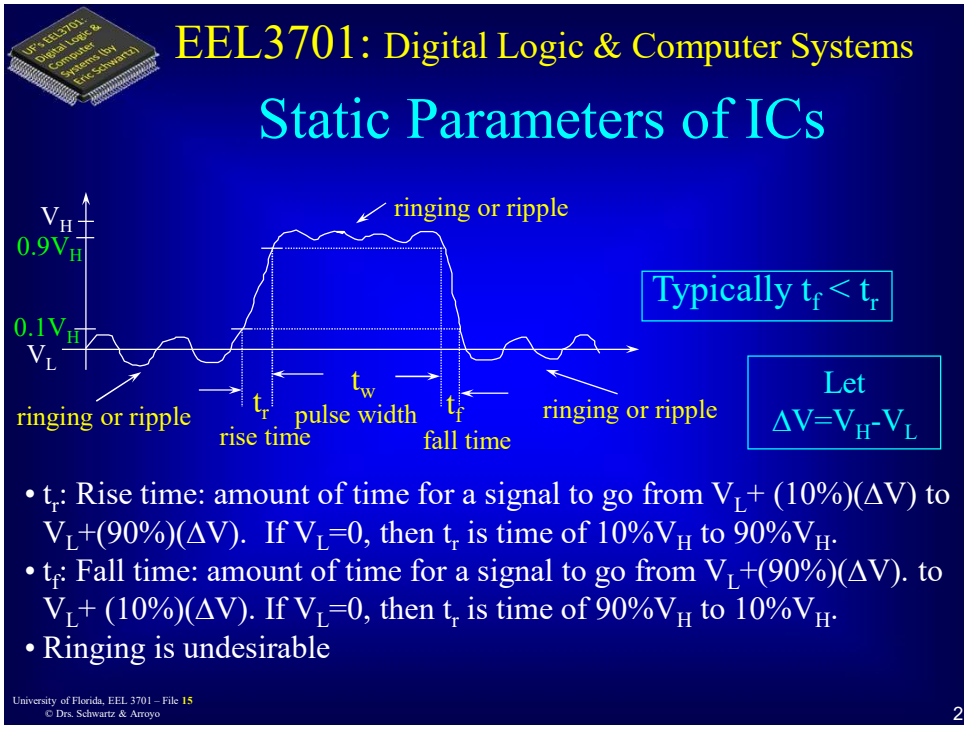
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Static Parameters of ICs
V_H
$0.9V_H$
$0.1V_H$
V_L
ringing or ripple
ringing or ripple
ringing or ripple
t_r
rise time
t_w
pulse width
t_f
fall time
Typically $t_f < t_r$
Let $\Delta V = V_H - V_L$
• t_r: Rise time: amount of time for a signal to go from V_L+ (10%)(ΔV) to V_L+(90%)(ΔV). If V_L=0, then t_r is time of 10%V_H to 90%V_H.
• t_f: Fall time: amount of time for a signal to go from V_L+(90%)(ΔV). to V_L+ (10%)(ΔV). If V_L=0, then t_r is time of 90%V_H to 10%V_H.
• Ringing is undesirable
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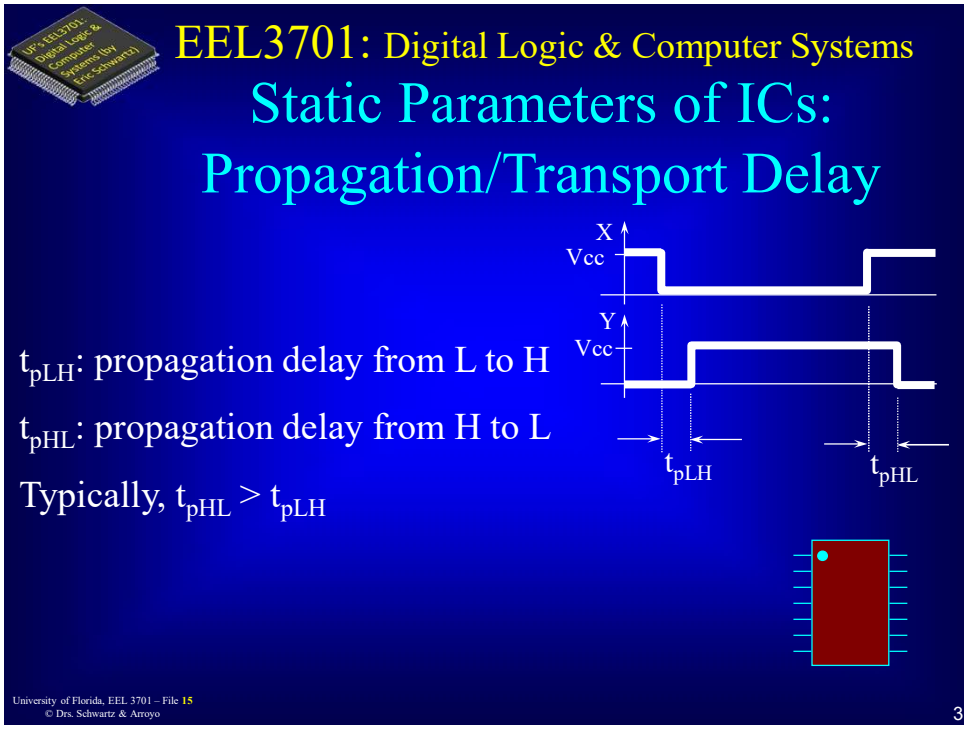
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Static Parameters of ICs:
Propagation/Transport Delay
t_{pLH}: propagation delay from L to H
t_{pHL}: propagation delay from H to L
Typically, $t_{pHL} > t_{pLH}$
X
Vcc
Y
Vcc
t_{pLH}
t_{pHL}
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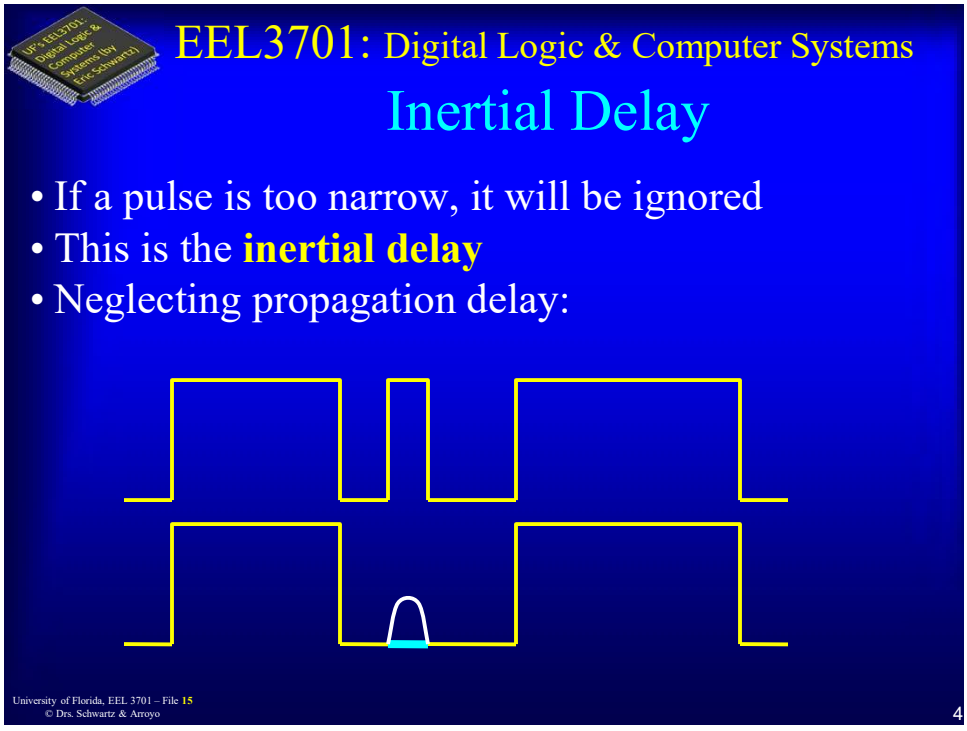
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Inertial Delay
• If a pulse is too narrow, it will be ignored
• This is the **inertial delay**
• Neglecting propagation delay:
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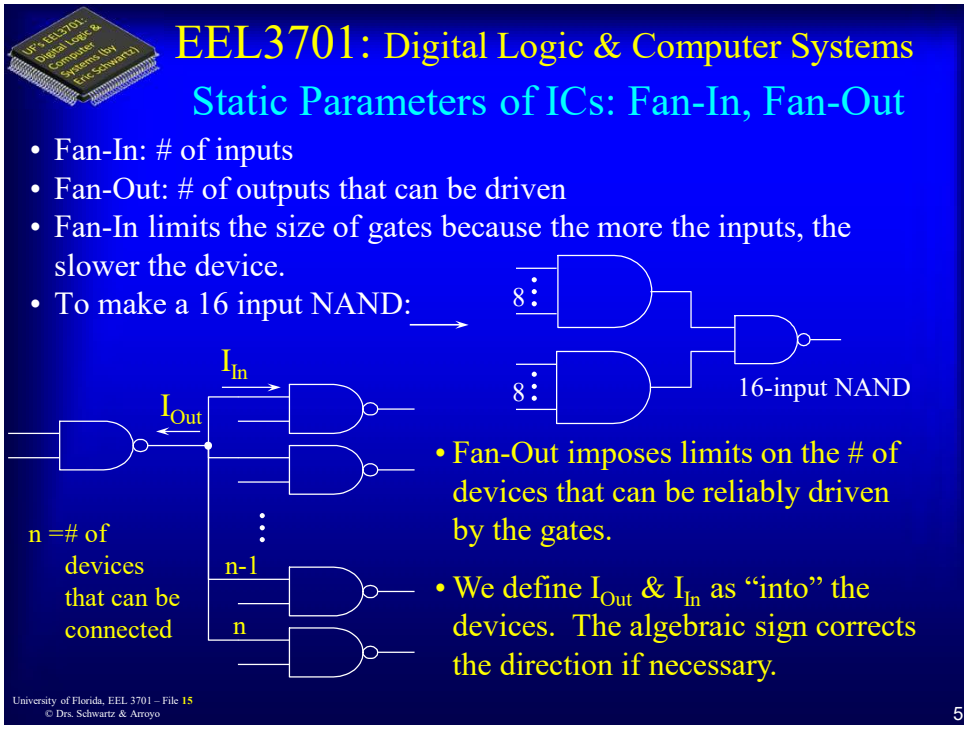
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Static Parameters of ICs: Fan-In, Fan-Out
• Fan-In: # of inputs
• Fan-Out: # of outputs that can be driven
• Fan-In limits the size of gates because the more the inputs, the slower the device.
• To make a 16 input NAND:
8
8
16-input NAND
I_{In}
I_{Out}
n =# of devices that can be connected
n-1
n
• Fan-Out imposes limits on the # of devices that can be reliably driven by the gates.
• We define I_{Out} & I_{In} as "into" the devices. The algebraic sign corrects the direction if necessary.
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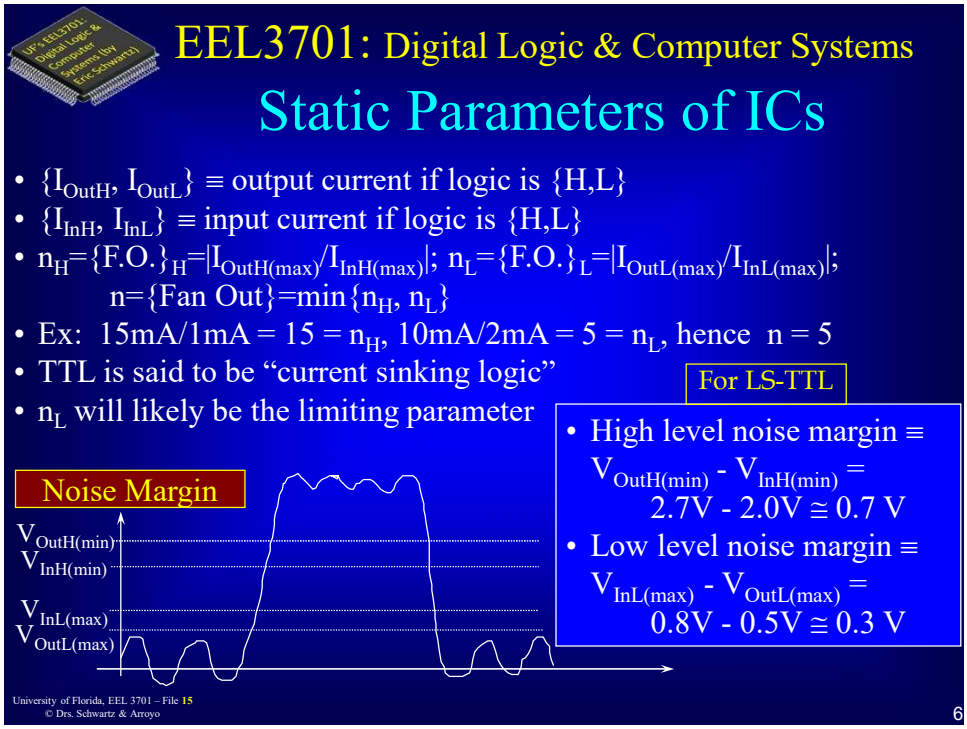
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Static Parameters of ICs
• $\{I_{OutH}, I_{OutL}\}$ ≡ output current if logic is {H,L}
• $\{I_{InH}, I_{InL}\}$ ≡ input current if logic is {H,L}
• $n_H=\{F.O.\}_H=|I_{OutH(max)}/I_{InH(max)}|$; $n_L=\{F.O.\}_L=|I_{OutL(max)}/I_{InL(max)}|$;
n={Fan Out}=min{n_H, n_L}
• Ex: 15mA/1mA = 15 = n_H, 10mA/2mA = 5 = n_L, hence n = 5
• TTL is said to be "current sinking logic"
• n_L will likely be the limiting parameter
For LS-TTL
• High level noise margin ≡ $V_{OutH(min)} - V_{InH(min)}$ = 2.7V - 2.0V ≅ 0.7 V
• Low level noise margin ≡ $V_{InL(max)} - V_{OutL(max)}$ = 0.8V - 0.5V ≅ 0.3 V
Noise Margin
$V_{OutH(min)}$
$V_{InH(min)}$
$V_{InL(max)}$
$V_{OutL(max)}$
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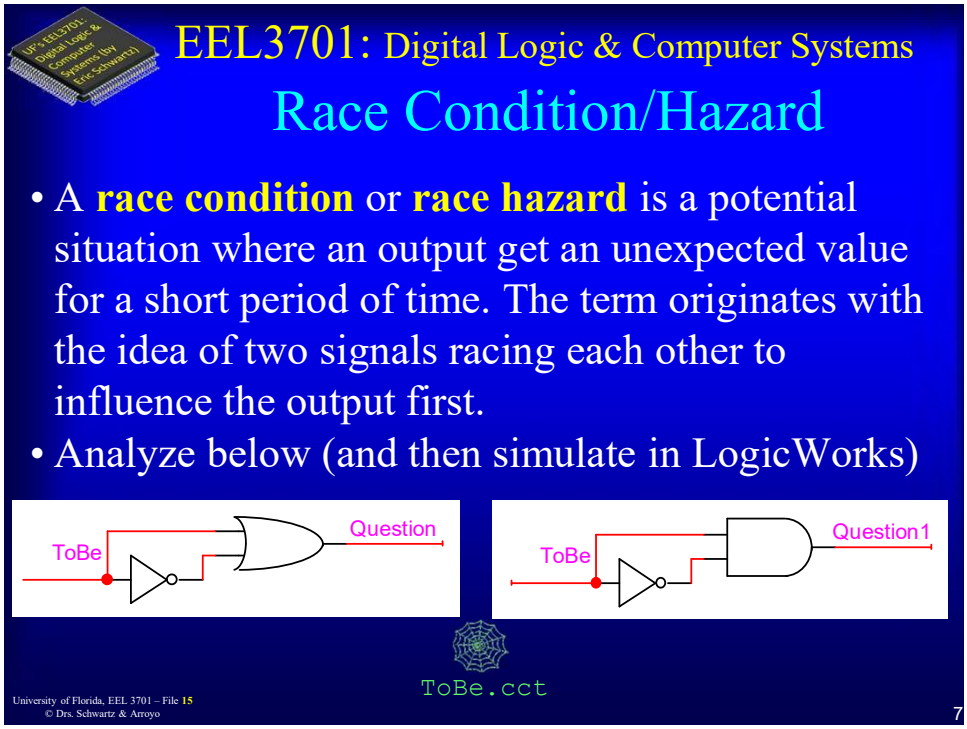
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Race Condition/Hazard
• A race condition or race hazard is a potential situation where an output get an unexpected value for a short period of time. The term originates with the idea of two signals racing each other to influence the output first.
• Analyze below (and then simulate in LogicWorks)
ToBe
Question
ToBe
Question1
ToBe.cct
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The End!
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