

# HW #12

1.  $V_{DD} = 5V$ ,  $\gamma = 0.4 V^{1/2}$ ,  $|V_{th}| = 0.6V$ ,  $k'_n = 100 \frac{\mu A}{V^2}$   
 $(\frac{W}{L}) = 10$ ;  $\lambda = 0.1 V^{-1}$

a)  $V_{DS} > V_{GS} - V_T \Rightarrow$  Saturation

$$I_{DS} = \frac{k'_n}{2} \left(\frac{W}{L}\right) (V_{GS} - V_T)^2 (1 + \lambda V_{DS})$$

$$I_{DS} = 50 \left(\frac{\mu A}{V^2}\right) (10) (5 - 1)^2 (1 + 0.1 \times 5) = 12 \text{ mA}$$

b)  $V_{DS} = V_G - V_B = 2.5 - 0 = 2.5V$

$$V_T = 1 + (0.4) (\sqrt{0.6 + 2.5} - \sqrt{0.6}) = 1.394$$

$V_{DS} > V_{GS} - V_T \Rightarrow$  Saturation

$$I_{DS} = \frac{k'_n}{2} \left(\frac{W}{L}\right) (V_{GS} - V_T)^2 (1 + \lambda V_{DS})$$

$$I_{DS} = 50 \left(\frac{\mu A}{V^2}\right) (10) (2.5 - 1.394)^2 (1 + 0.1 \times 2.5) = 764.5 \mu A$$

c)  $Q = I_{av} \times t_{PLH} = C_L \left(\frac{V_{DD}}{2}\right) \Rightarrow t_{PLH} = \frac{C_L \left(\frac{V_{DD}}{2}\right)}{I_{av}}$

$$I_{av} = \frac{1}{2} (12 \text{ mA} + 0.7645 \text{ mA}) = 6.38 \text{ mA}$$

$$t_{PLH} = \frac{75(\text{pF}) \times 2.5}{6.38(\text{mA})} = 29.39 \times 10^{-12} \text{ s}$$

File Edit View Simulation Trace Plot Tools Window Help

HW10

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HW10.cir (active)
* Homework #10
Vg 2 0 DC 5V
M1 1 2 3 0 nch L=0.5U W=5U
C1 3 0 75fF
Vd 1 0 Pulse(0 5V 0ps 0ps 0ps 200ps 400ps)

.model nch NMOS Level=1 VTO=1 KP=100U Gamma=0.4 Lambda=0.1 Phi=0.3
.tran .1ps 200ps
.probe V(1) V(3)
.end

```

HW10 (active)

6.00  
4.00  
2.00  
0.00

0s 40ps 80ps 120ps 160ps 200ps

Time

U(1) U(3)

Probe Cursor

A1 =	69.600p,	2.5019
A2 =	0.000,	0.000
dif =	69.600p,	2.5019

HW10.cir (a... HW10 (active)

```

* Homework #10
Reading and checking circuit
Circuit read in and checked, no errors
Calculating bias point for Transient Analysis
Bias point calculated
Transient Analysis
Transient Analysis finished
Simulation complete

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Time step = 1.338E-12 Time = 200.0E-12 End = 200.0E-12

Analysis Watch Devices

C:\Users\payman\Desktop\Classes\LEdit\_Demo\HW10.dat (active) Time= 200.0E-12 100%