

Homework 3 - ECE 1238  
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① (a) First, let's calculate  $V_T$ :

$$V_T = V_{T0} + \gamma \left( \sqrt{|-2\phi_f + V_{SB}|} - \sqrt{|2\phi_f|} \right)$$

$$= 0.48 + 0.52 \left( \sqrt{|-1.01 + 0|} - \sqrt{1.01} \right)$$

$$V_{SB} = V_S - V_B = 0 \text{ V}$$

So  $V_T = 0.48 \text{ V}$

Now,  $V_{GS} = V_G - V_S = 0.6 \text{ V} \Rightarrow V_{GS} > V_T$

and  $V_{DS} = V_D - V_S = 0.22 \text{ V}$   
&  $V_{GS} - V_T = 0.6 - 0.48 = 0.12 \text{ V}$  }  $\Rightarrow V_{DS} > V_{GS} - V_T$

$\Rightarrow$  So we are in saturation region

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

$$\Rightarrow \frac{W}{L} = \frac{I_D}{\frac{1}{2} k' (V_{GS} - V_T)^2 (1 + \lambda V_{DS})}$$

$$= \frac{24}{\frac{1}{2} \times 168 \times (0.12)^2 (1 + 0.05 \times 0.22)} \approx 19.625$$

$V_S = 0V$  and  $V_B = 0V$ . So here too,  $V_{T0} = V_T$

⑥ Now,  $V_{GS} = 1V \Rightarrow \boxed{V_{GS} > V_T}$

and  $V_{DS} = 0.4V$  ;  $V_{GS} - V_T = 1 - 0.48 = 0.52V$

$\Rightarrow \boxed{V_{DS} < V_{GS} - V_T}$

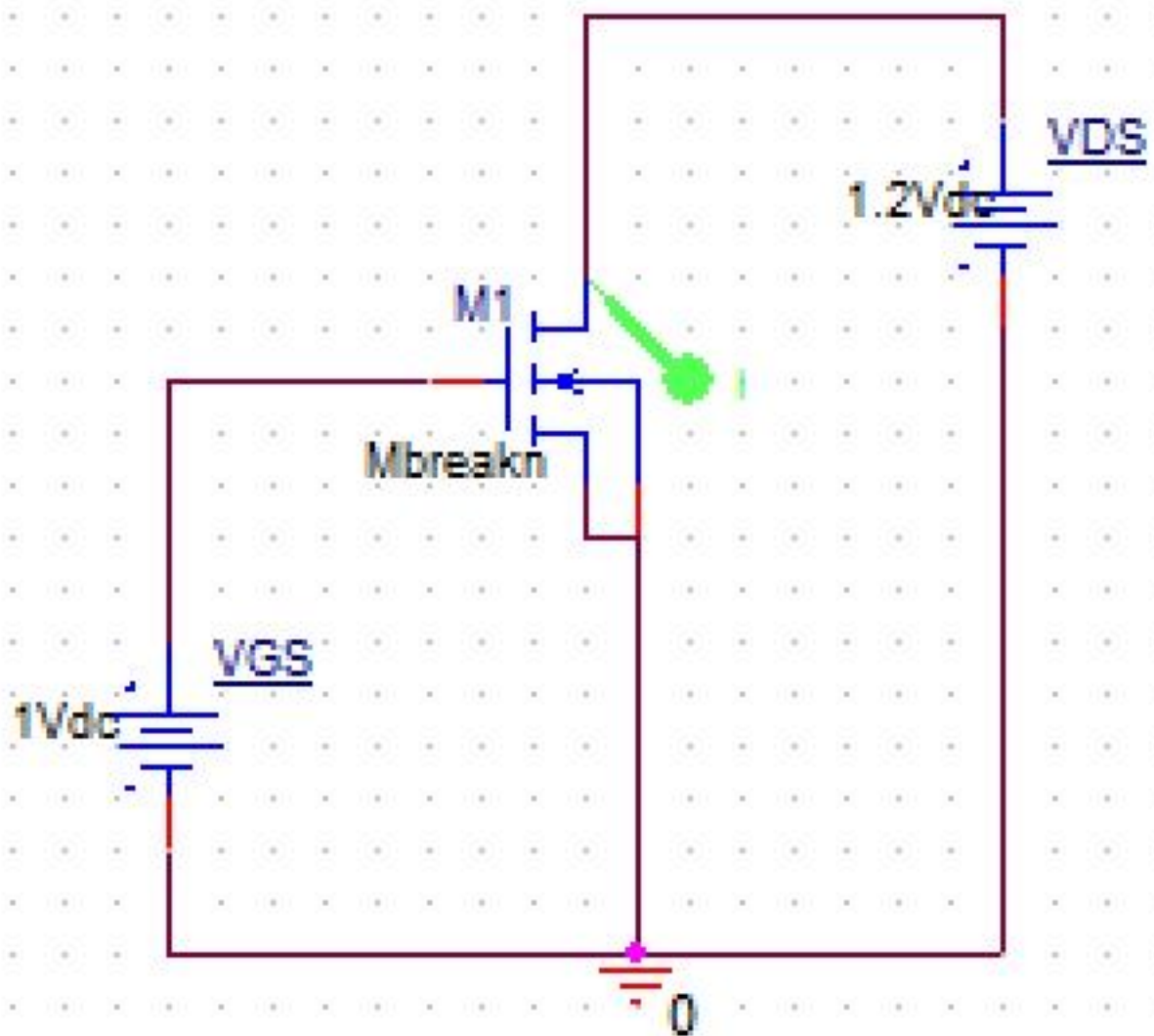
So we are in linear region

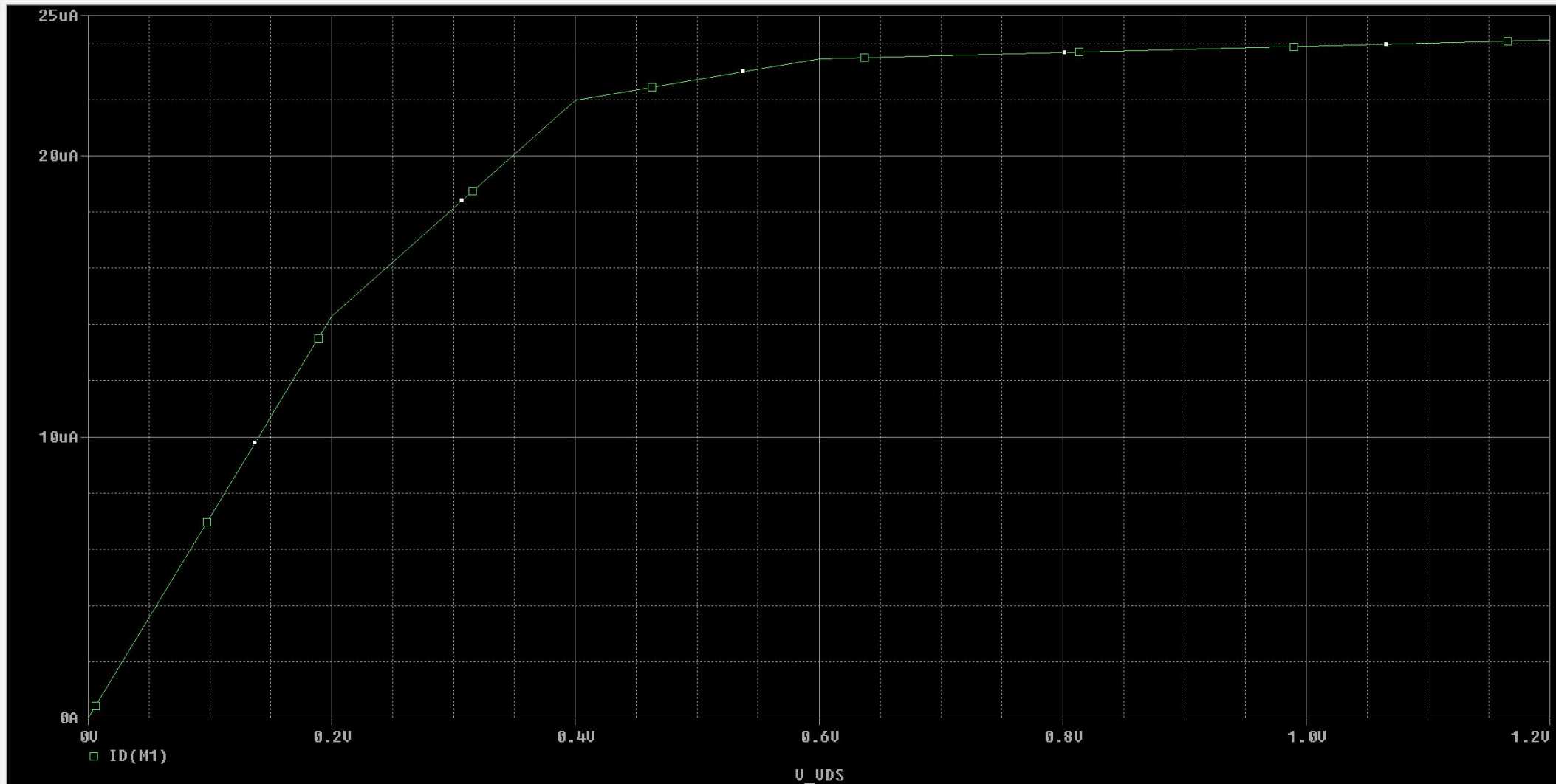
$$\Rightarrow I_D = \frac{1}{2} k' \frac{W}{L} \left[ 2 (V_{GS} - V_T) V_{DS} - V_{DS}^2 \right]$$

$$= \frac{1}{2} \times 168 \times 19.625 \times \left[ 2 \times 0.4 \times 0.52 - 0.4^2 \right]$$

$$\boxed{I_D = 422.016 \mu A}$$

② SPICE





```
008 *****
009
010
011
012
013
014 ** Creating circuit file "JYFYUE.cir"
015 ** WARNING: THIS AUTOMATICALLY GENERATED FILE MAY BE OVERWRITTEN BY SUBSEQUENT SIMULATIONS
016
017 *Libraries:
018 * Profile Libraries :
019 * Local Libraries :
020 .LIB "C:/Users/RAYAN/Desktop/SDVQWE.lib"
021 * From [PSPICE NETLIST] section of C:\Users\RAYAN\AppData\Roaming\SPB_Data\cdssetup\OrCAD_PSpice\17.2.0\PSpice.ini file:
022 .lib "nomd.lib"
023
024 *Analysis directives:
025 .DC LIN V_VDS 0 1.2 0.2
026 .OPTIONS ADVCONV
027 .PROBE64 V(alias(*)) I(alias(*)) W(alias(*)) D(alias(*)) NOISE(alias(*))
028 .INC "..\SCHEMATIC1.net"
029
030
031
032 **** INCLUDING SCHEMATIC1.net ****
033 * source SDVQWE
034 M_M1          N00098 N00091 0 0 Mbreakn
035 V_VGS         N00091 0 1Vdc
036 V_VDS         N00098 0 1.2Vdc
037
038 **** RESUMING JYFYUE.cir ****
039 .END
040 ^
041 **** 09/30/21 00:14:06 ***** PSpice Lite (March 2016) ***** ID# 10813 ****
042
043 ** Profile: "SCHEMATIC1-JYFYUE" [ C:\Users\RAYAN\AppData\Roaming\SPB_Data\sdvqwe-PSpiceFiles\SCHEMATIC1\JYFYUE.sim ]
044
045
046 ****      MOSFET MODEL PARAMETERS
047
048
049 *****
050
051
```

044  
045  
046 \*\*\*\*\* MOSFET MODEL PARAMETERS

047  
048  
049 \*\*\*\*\*

050  
051  
052  
053  
054 Mbreakn  
055 NMOS  
056 LEVEL 1  
057 L 100.000000E-06  
058 W 100.000000E-06  
059 VTO .48  
060 KP 168  
061 GAMMA .52  
062 PHI 1.01  
063 LAMBDA .05  
064 IS 10.000000E-15  
065 JS 0  
066 PB .8  
067 PBSW .8  
068 CJ 0  
069 CJSW 0  
070 CGSO 0  
071 CGDO 0  
072 CGBO 0  
073 TOX 0  
074 XJ 0  
075 UCRIT 10.000000E+03  
076 DIOMOD 1  
077 VFB 0  
078 LETA 0  
079 WETA 0  
080 UO 0  
081 TEMP 0  
082 VDD 5  
083 XPART 0

084  
085  
086  
087 JOB CONCLUDED