1. HW #9

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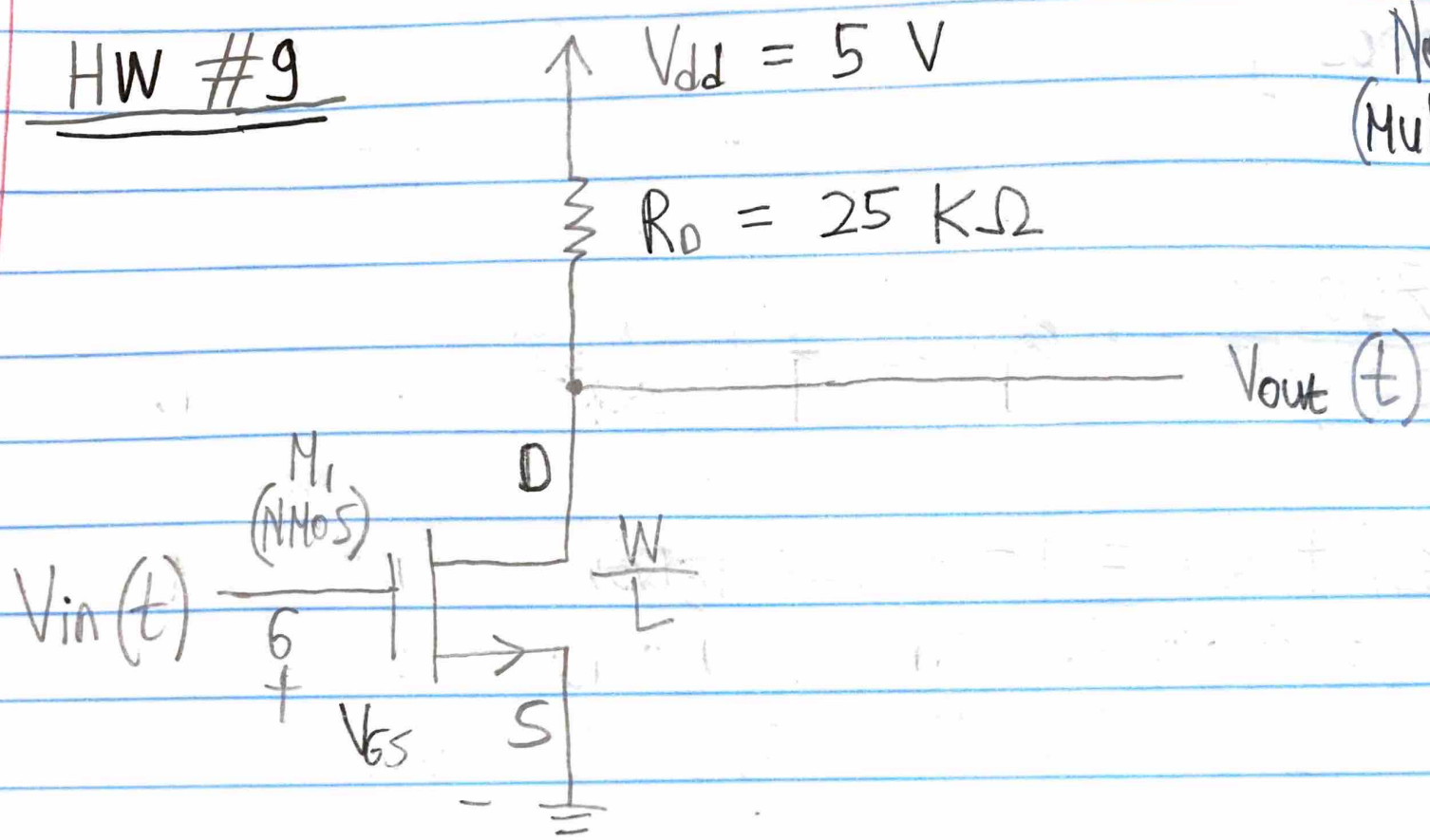
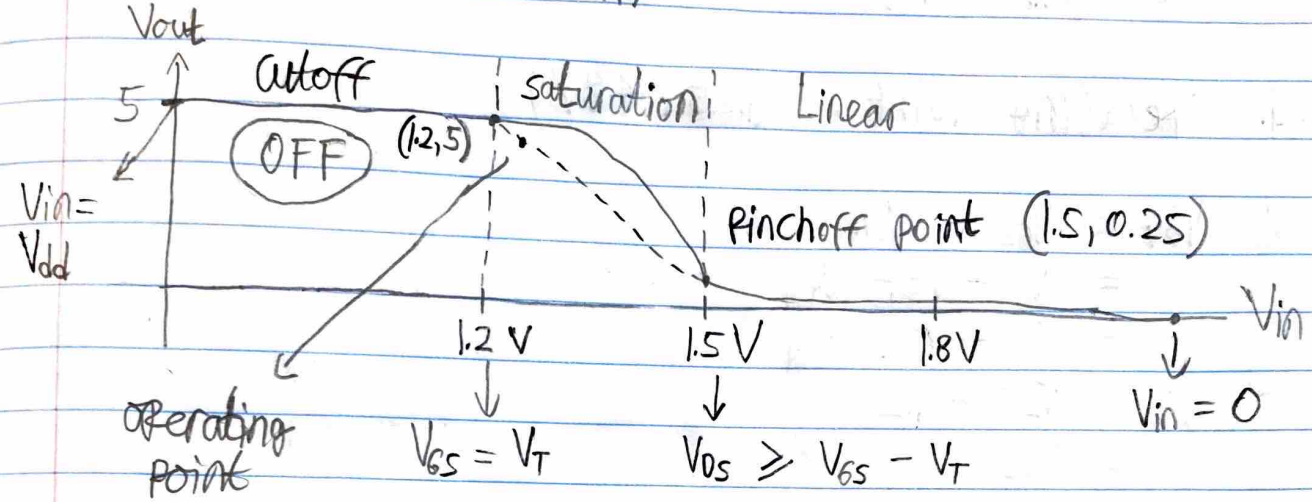


$V_T = 1.2\ V$
$W = 25\ Nm$
$L = 5\ Nm$

$\lambda = 0$
$K_n' = 40 \cdot 10^{-6}\ A/V^2$

a. V_{out} vs. V_{in} $(V_6 = V_{in})$



b. $\text{Gain} = \dfrac{0.25 - 5}{1.5 - 1.2} = -15.8 \longrightarrow$ Saturation Region $\rightarrow$ Amplifier

Cutoff or Linear Region:
Gain = 0

	$V_{in}(t)$	Region of operation	$V_{out}(t)$
i.	$1 + \cos(2\pi \cdot 10^3 t) = 2$	Linear	0
ii.	$1 + 0.25\cos(2\pi \cdot 10^3 t) = 1.25$	Saturation	$-15.8 + 3.95\cos(2\pi \cdot 10^3 t)$
iii.	$1 + 0.1\cos(2\pi \cdot 10^3 t) = 1.1$	Cutoff	0
iv.	$2 + \cos(2\pi \cdot 10^3 t) = 3$	Linear	0
v.	$2 + 0.25\cos(2\pi \cdot 10^3 t) = 2.25$	Linear	0
vi.	$2 + 0.1\cos(2\pi \cdot 10^3 t) = 2.1$	Linear	0

Cases (i), (iii), (iv), (v), (vi):
NOT function properly due to $V_{out}(t) = 0$

Only case (ii):
Function properly (Amplifying due to Gain $= -15.8$ V)

c. i. Operating Point: $(1.25, 4.87)$

ii. $V_{ov} = V_{GS} - V_{TN}$
$= V_G - V_S - V_{TN}$
$= V_{in} - 0 - V_{TN}$
$= 1.25 - 1.2$
$= 0.05$

iii. $g_m = \frac{i_d}{V_{GS}} = K_n'(V_{GS} - V_{TN})$

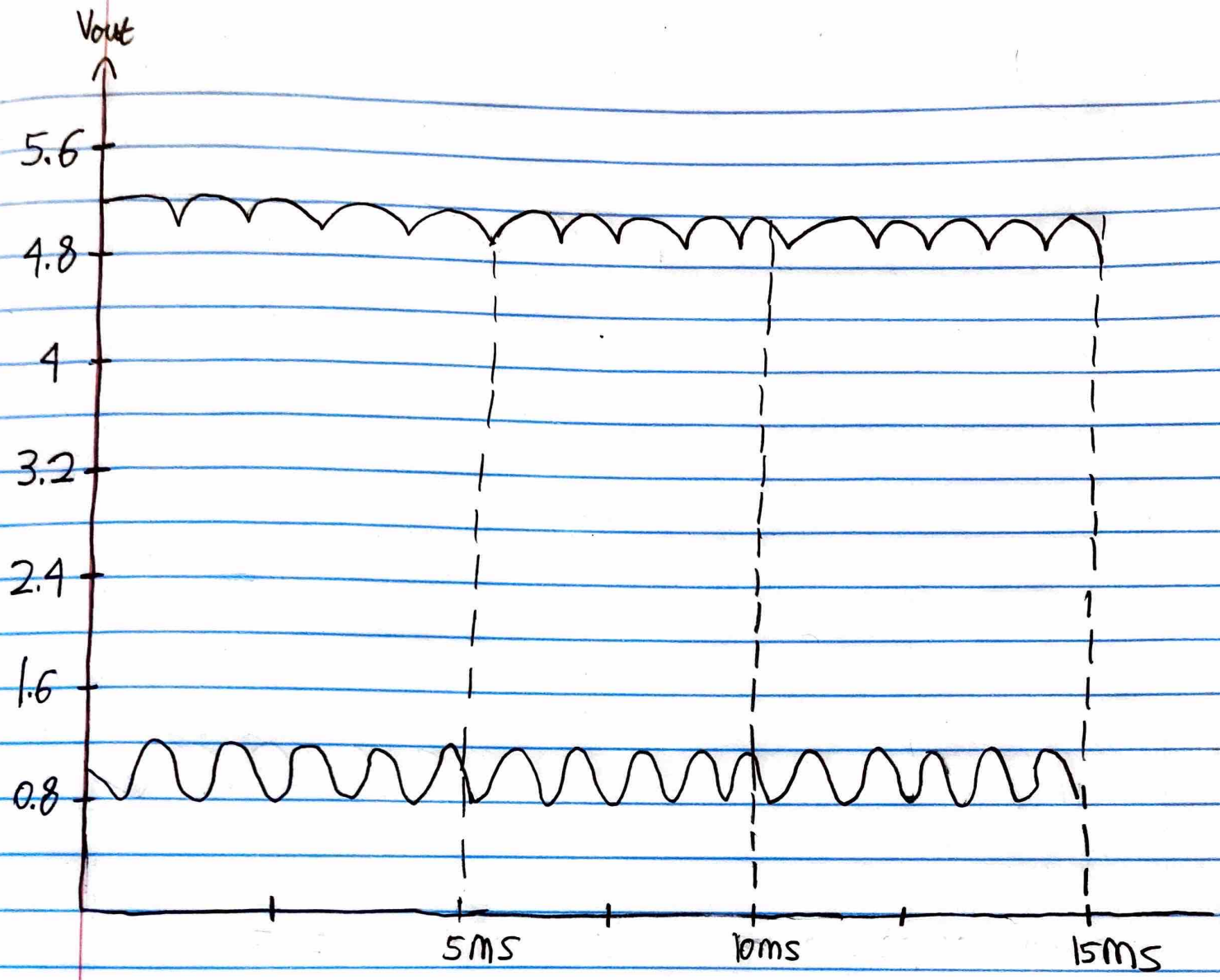
$= (40 \cdot 10^{-6}\ A/V^2)(0.05\ V)$

$= 2 \cdot 10^{-6}\ A/V$

iv. $\text{Gain} = \frac{0.25 - 5}{1.5 - 1.2} = -15.8$

v. $V_{in}(t) = 1 + 0.25 \cos(2\pi \cdot 10^3 t)$

$V_{out}(t) = \text{Gain} \cdot V_{in}(t)$
$= (-15.8)(1 + 0.25 \cos(2\pi \cdot 10^3 t))$
$= -15.8 - 3.92 \cos(2\pi \cdot 10^3 t)$


Vout
5.6
4.8
4
3.2
2.4
1.6
0.8
5ms
10ms
15ms