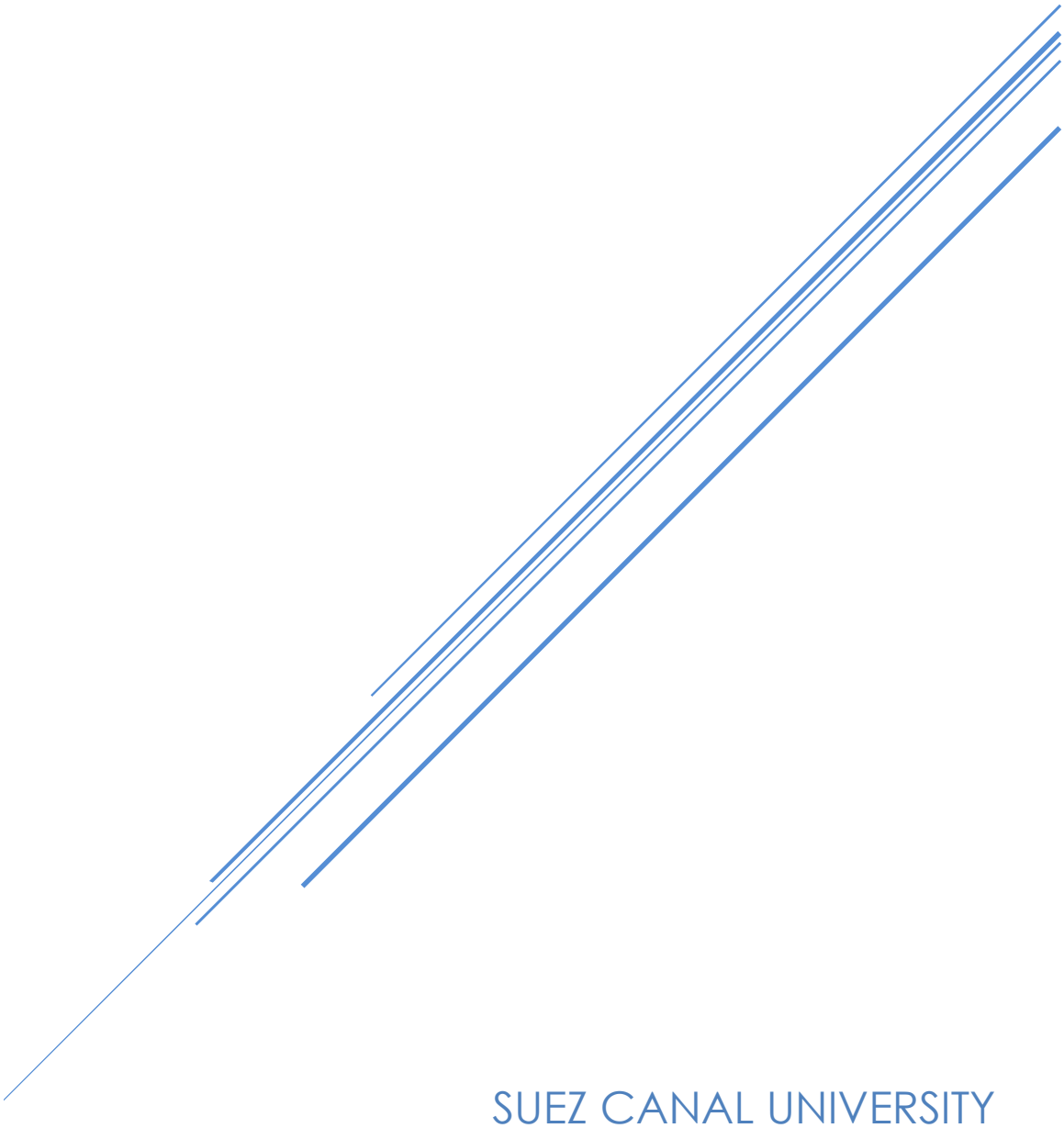
SINGLE ENDED COMMON SOURCE AMPLIFIER



SUEZ CANAL UNIVERSITY

Yossef Nada

Design a single ended amplifier (choose common source with resistive load) to achieve the following specs

Spec.	
DC Gain	$20\,dB$
BW	$\geq 1\,GHz$
Power Consumption	$\leq 0.5\,mW$
Cap Load	$50\,fF$

Design (2)

Specs
gain 20 dB
BW ≥ 1GHz
Power ≤ 0.5mw
Cap. Load 50 fF

Then,

$$I \leq \frac{0.5\,mW}{(1.2)} \leq 400\,mA$$

↓

we chose $V_{DD} = 1.2\,V$

$$GBW = \frac{g_m}{2\pi C_L} = 10 \times 10^9$$

$$\therefore g_m = 3.14\,ms$$

$$\frac{g_m}{I_d} = 7.85 \quad \text{up to} \quad 8$$

$$V^* = 0.25\,V$$

let $V_{DS} = \frac{V_{DD}}{2} = 0.6\,v$ ∴ $R_D = \frac{0.6}{400\,u} = 1500\,\Omega$

∴ we will sweep V_{GS} over $L = 100\,n, 150\,n, 200\,n, 175\,n, 300\,n$

∴ $A_v = g_m(R_{out}) \geq 10$

take $g_m = 3.2\,ms$

But this g_m would need $R_{out} \geq 3000\,\Omega$ to get the specified gain

∴ $R_D = 1500\,\Omega$

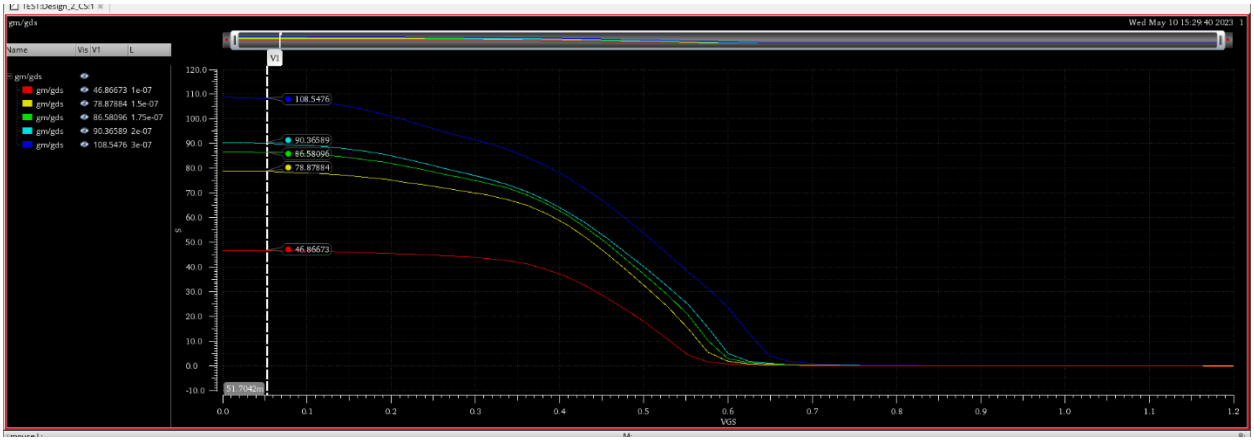
put $\frac{g_m}{I_D} = 20$ ∴ $g_m = 8\,ms$

∴ $R_{out} \geq 1250$

∴ $\frac{1}{R_D} + g_{ds} \leq \frac{1}{1250}$ ∴ $g_{ds} \leq \frac{1}{7500}$

∴ $\boxed{\frac{g_m}{g_{ds}} \geq 60}$

Studying $\frac{g_m}{g_{ds}}$ curves we found that $L = 150\,nm$



$\frac{g_m}{I_D} = 20 \quad \therefore V^* = 0.1\ V$

$\therefore V_{GSQ} = 344.233m$

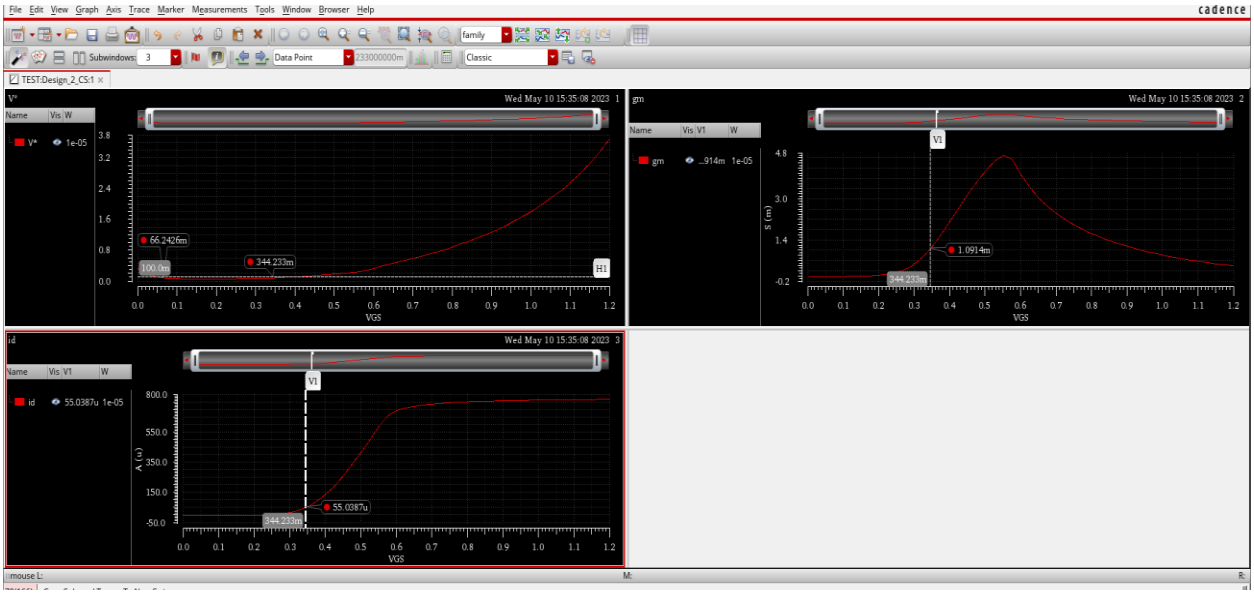
$I_{DQ} = 55.0387\ uA$

$g_{mQ} = 1.0914\ ms$

$\therefore$ at $W = 10\ u$ $\quad I_{DQ} = 55.0387\ uA$

$W = ?$ $\quad I = 400\ uA$

$\therefore \boxed{W = 72.676\ um}$



discussing gain and BW

BW = 1.322 G

Gain = 18.66 dB

Managing R_D : put R_D = 1800 Ω

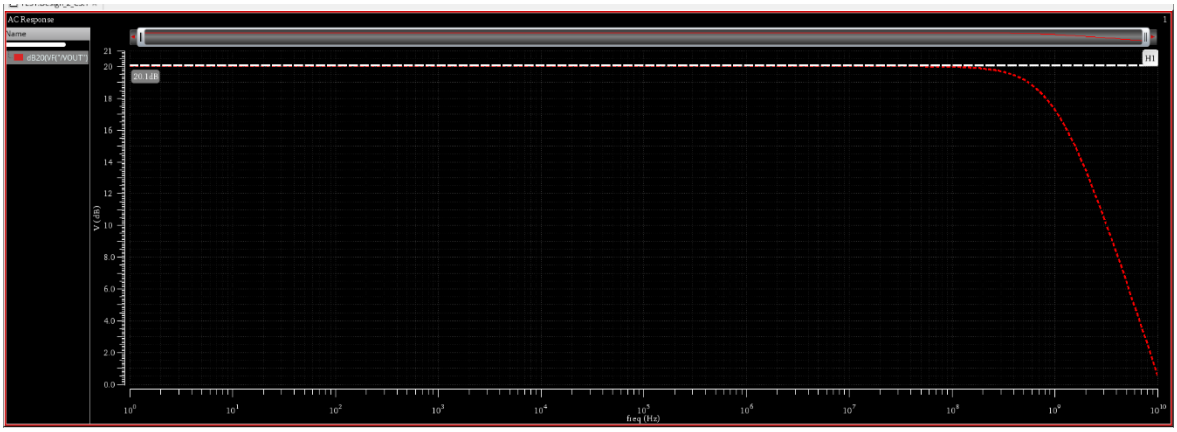
gain = 19.67 dB

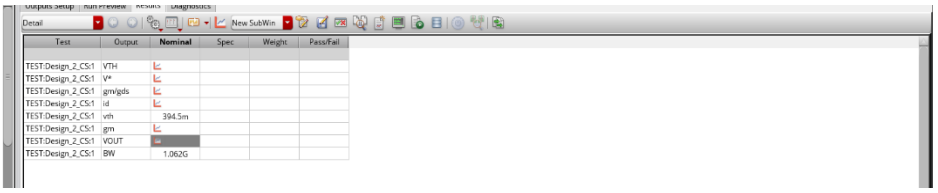
BW = 1.133 G

put R_D = 1950 Ω

BW = 1.062 G

gain = 20.07 dB





Specs desired	obtained
gain = 20 dB	gain = 20.07 dB
BW ≈ 1 GHz	BW = 1.062 GHz
power ≤ 0.5mw	power = 0.3822 mw

desired specs achieved