

a) folded cascode OTA \rightarrow see attached schematic

$$b) G_m = 2\pi f_u C_L = 2\pi \cdot 20 \text{ MHz} \cdot 10 \text{ pF} = \underline{\underline{1.256 \text{ mS}}}$$

$$c) (\sqrt{2} + \sqrt{2}) V_{dsat} \leq 600 \text{ mV}$$

$$V_{dsat} \leq 212 \text{ mV} \rightarrow \text{choose } \underline{\underline{200 \text{ mV}}} \quad \textcircled{a} \text{ nominal bias point}$$

$$d) G_m = \frac{2I_D}{V_{dsat}} \Rightarrow I_D = \frac{1}{2} G_m V_{dsat} = \underline{\underline{125 \mu\text{A}}}$$

\rightarrow see attached schematic for bias point

$$e) A_{dm} \approx \frac{1}{3} (g_m r_o)^2 \approx \frac{1}{3 \lambda^2 V_{dsat}^2} \quad (\text{this is just a very rough estimate!})$$

$$\Rightarrow \lambda \leq \sqrt{\frac{1}{3 A_{dm} V_{dsat}^2}} = \sqrt{\frac{1}{3000 \cdot 0.2^2}} = 0.091$$

$$\Rightarrow L_{min} = \frac{0.1}{0.091} \cdot 1 \mu\text{m} = 1.1 \mu\text{m}$$

\rightarrow chose L = 2 μm for simplicity

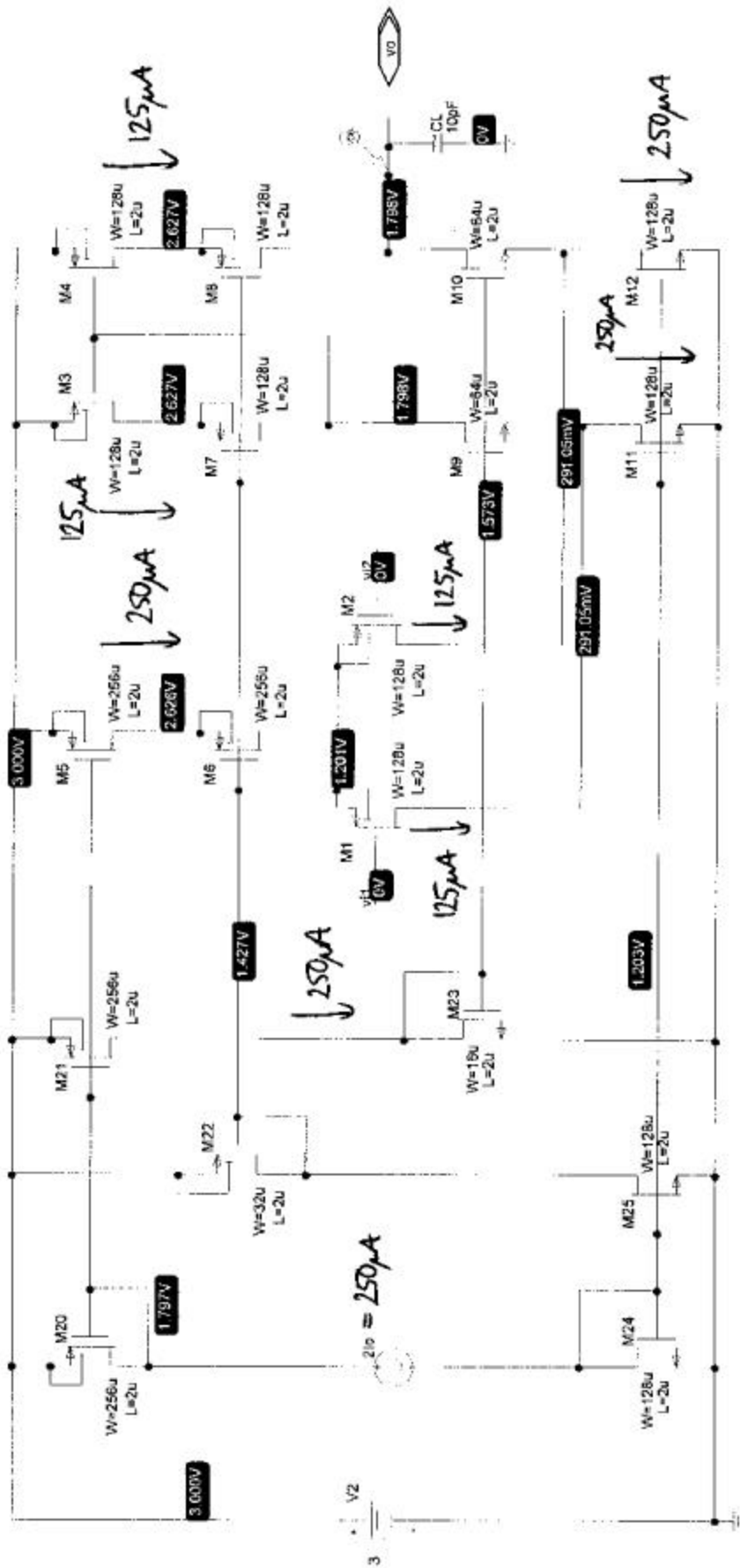
$$f) \left(\frac{W}{L}\right)_n \Big|_{I_D = I_D} = \frac{2I_D}{\mu_n' V_{dsat}^2} = \frac{250 \mu\text{A}}{200 \mu\text{m} \cdot 0.2^2} = 31.25$$

$$\rightarrow \approx \frac{64 \mu\text{m}}{2 \mu\text{m}}$$

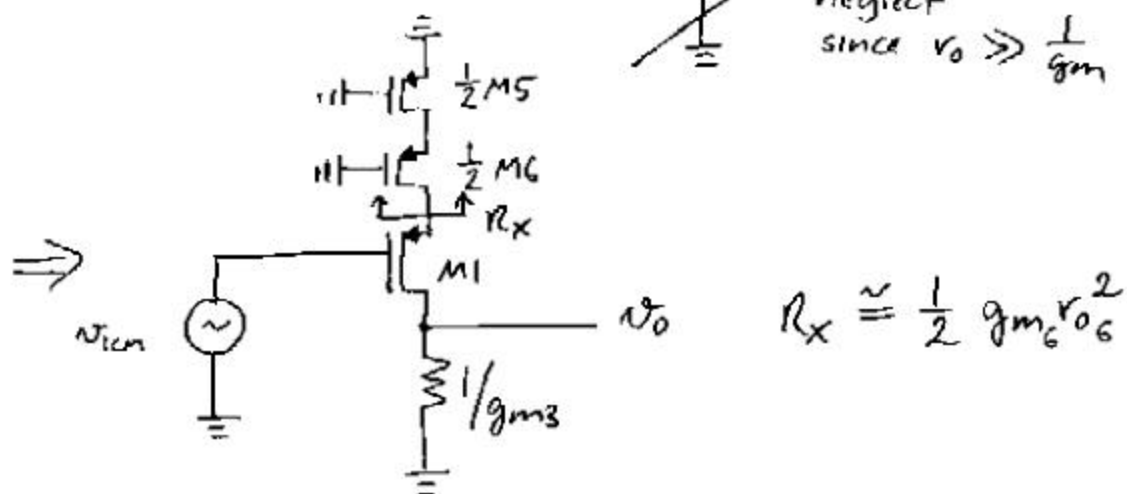
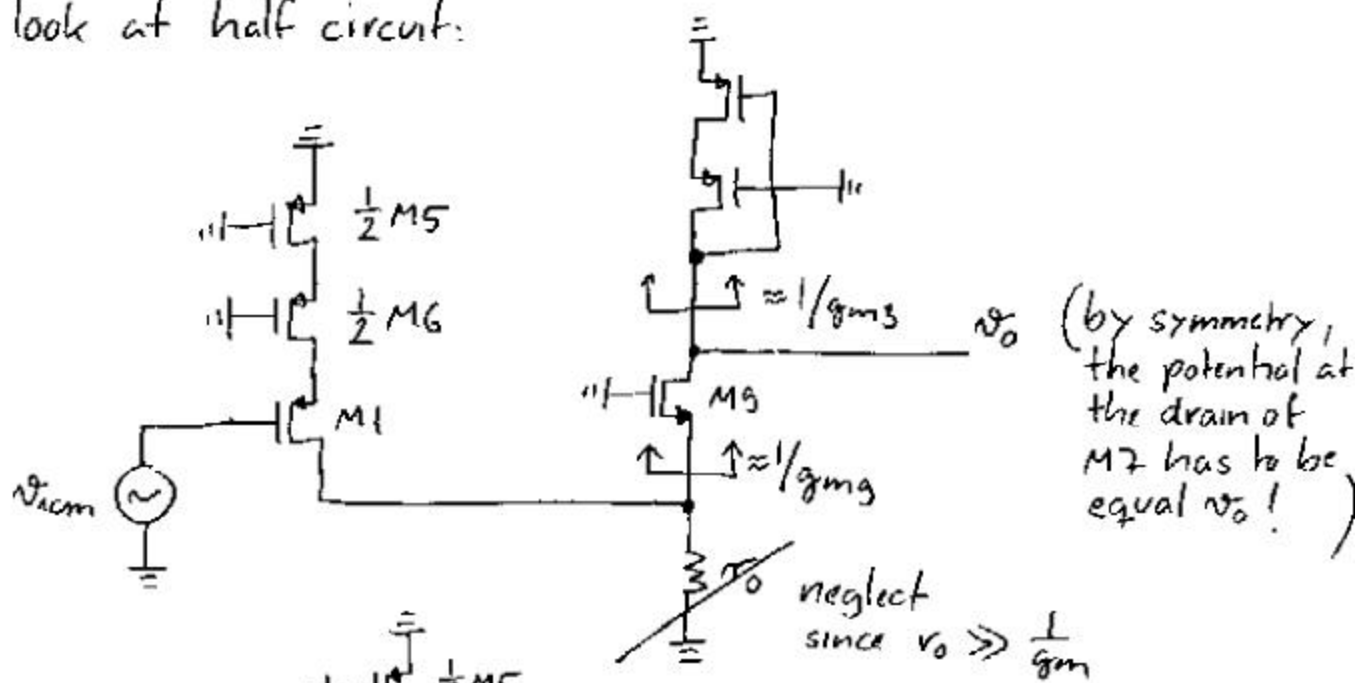
$$\left(\frac{W}{L}\right)_n \Big|_{I_D = 2I_D} = \frac{128 \mu\text{m}}{2 \mu\text{m}}$$

$$\left(\frac{W}{L}\right)_p \Big|_{I_D = I_D} = \frac{128 \mu\text{m}}{2 \mu\text{m}}$$

$$\left(\frac{W}{L}\right)_p \Big|_{I_D = 2I_D} = \frac{256 \mu\text{m}}{2 \mu\text{m}}$$



g) look at half circuit:



$$\Rightarrow A_{cm} = \frac{1}{\frac{1}{g_{m1}} + R_x} \cdot \frac{1}{g_{m3}} \approx \frac{1}{2 g_{m3} g_{m6} r_{o6}^2}$$

neglect

$$g_{m6} \approx \frac{2 \cdot 2 I_0}{V_{dsat}} = \frac{500 \mu}{0.2} = 2.5 \text{ mS}$$

$$r_{o6} \approx \frac{1}{\lambda \cdot 2 I_0} = \frac{1}{0.05 \cdot 250 \mu} = 80 \text{ k}\Omega$$

$$g_{m3} \approx \frac{2 I_0}{V_{dsat}} = 1.25 \text{ mS}$$

$$\Rightarrow A_{cm} = \frac{1}{40000} = -92 \text{ dB}$$

$$\Rightarrow CMRR = \frac{A_{dm}}{A_{cm}} \approx 60 \text{ dB} - (-92 \text{ dB}) = \underline{\underline{152 \text{ dB}}}$$

SPEZ: 130 dB ✓

(3)

g) ctd: Note that w/o the cascode device M6, the A_{cm} would be \approx

$$\frac{1}{2g_{m3} r_{O5}} \approx \frac{1}{2.5 \cdot 80} \hat{=} \underline{\underline{-46 \text{ dB}}}$$

$$\Rightarrow \text{CMRR} \approx 60 \text{ dB} + 46 \text{ dB} = 106 \text{ dB}$$

\Rightarrow SPEC NOT MET w/o cascode device M6 //

SPICE:

a) \rightarrow see attached plot $A_{dmo} \approx \underline{\underline{82 \text{ dB}}}$

b) \rightarrow see attached plot

$$\begin{aligned} \text{for } 2I_0 = 250 \mu\text{A} \quad f_u &= 19.9 \text{ MHz} \quad \text{"near miss" !} \\ 2I_0 = 280 \mu\text{A} \quad f_u &= \underline{\underline{21.2 \text{ MHz}}} \quad \text{O.K.} \end{aligned}$$

c) .TF result: (use .tf v(vo) vcm)

$$A_{cm} = \frac{V_o}{V_{cm}} = -2.031 \cdot 10^{-5} \Rightarrow A_{cm} = -93.8 \text{ dB}$$

$$\Rightarrow \text{CMRR} = 82 \text{ dB} + 93.8 \text{ dB} = \underline{\underline{175.8 \text{ dB}}}$$

SUMMARY:

	<u>estimated</u>	<u>simulated</u>
A_{dmo}	$> 60 \text{ dB}$	82 dB
f_u	20 MHz	19.9 MHz \rightarrow 21.2 MHz tweaked
CMRR	$> 152 \text{ dB}$	175.8 dB

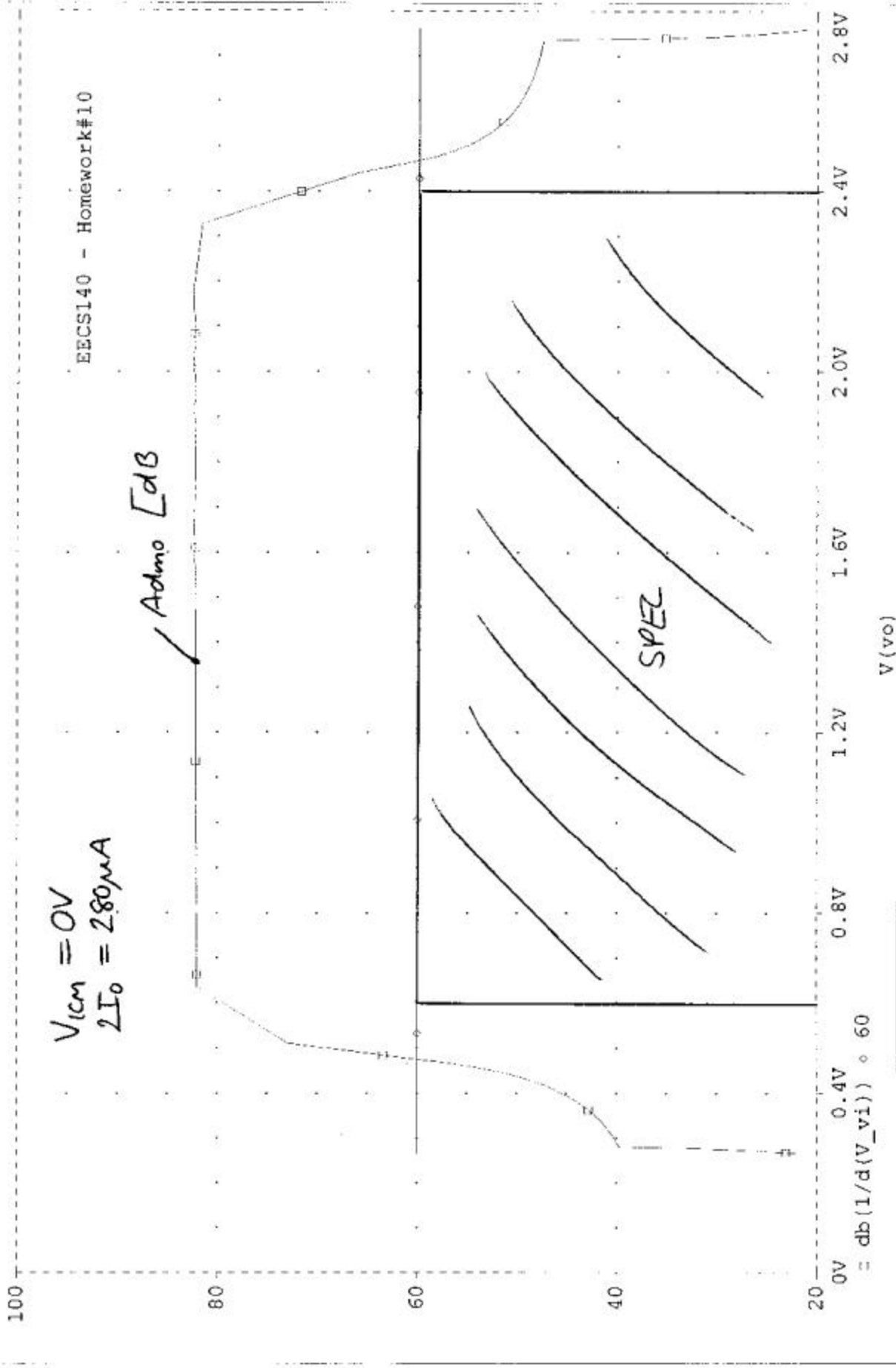
(A) hw10sim

$V_{icm} = 0V$
 $2I_o = 280\mu A$

EECS140 - Homework#10

Admo [dB

SPEC



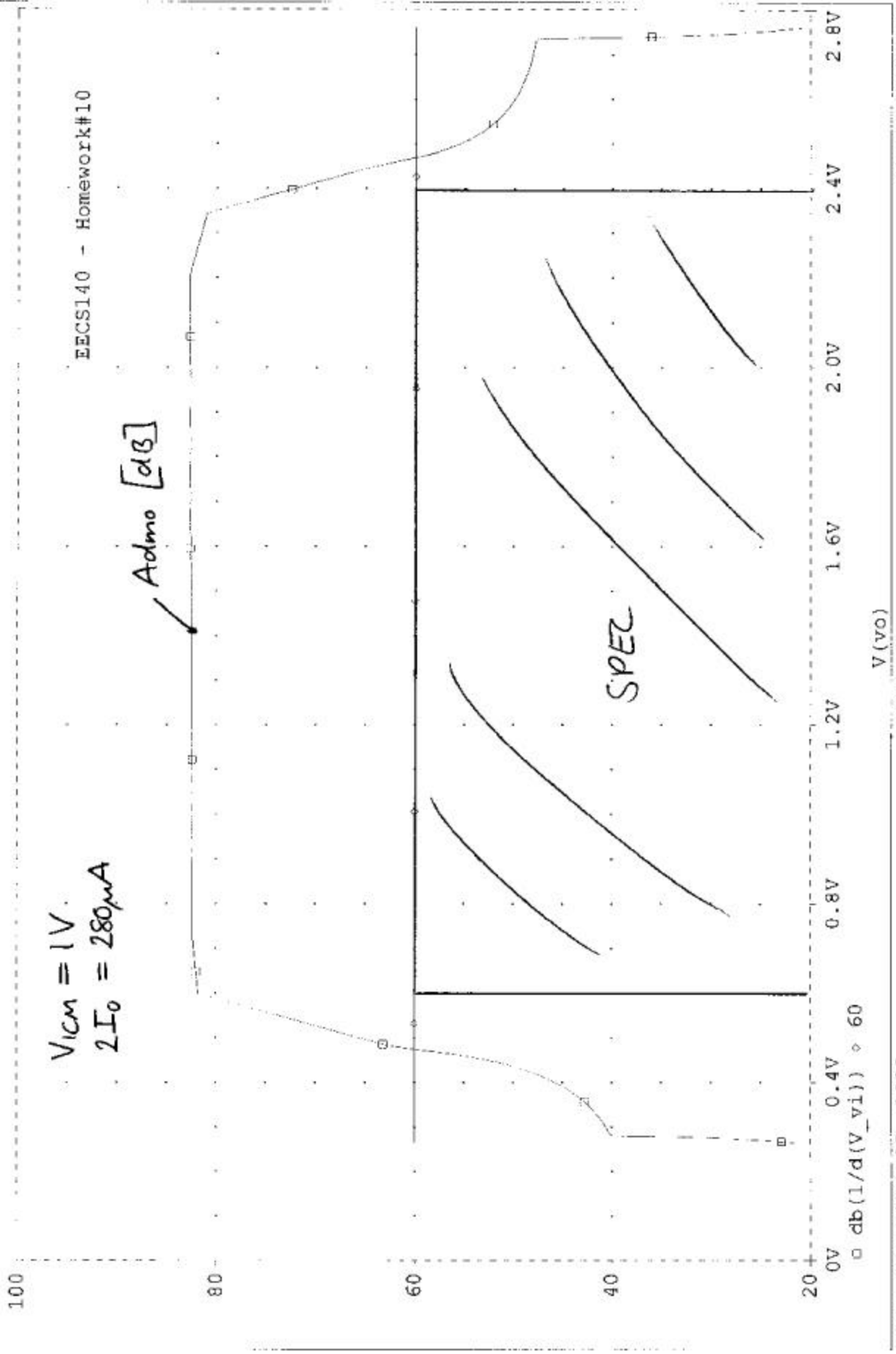
(A) hw10sim

$V_{ICM} = 1V$

$2I_{O} = 280\mu A$

EECS140 - Homework#10

Admo [dB]

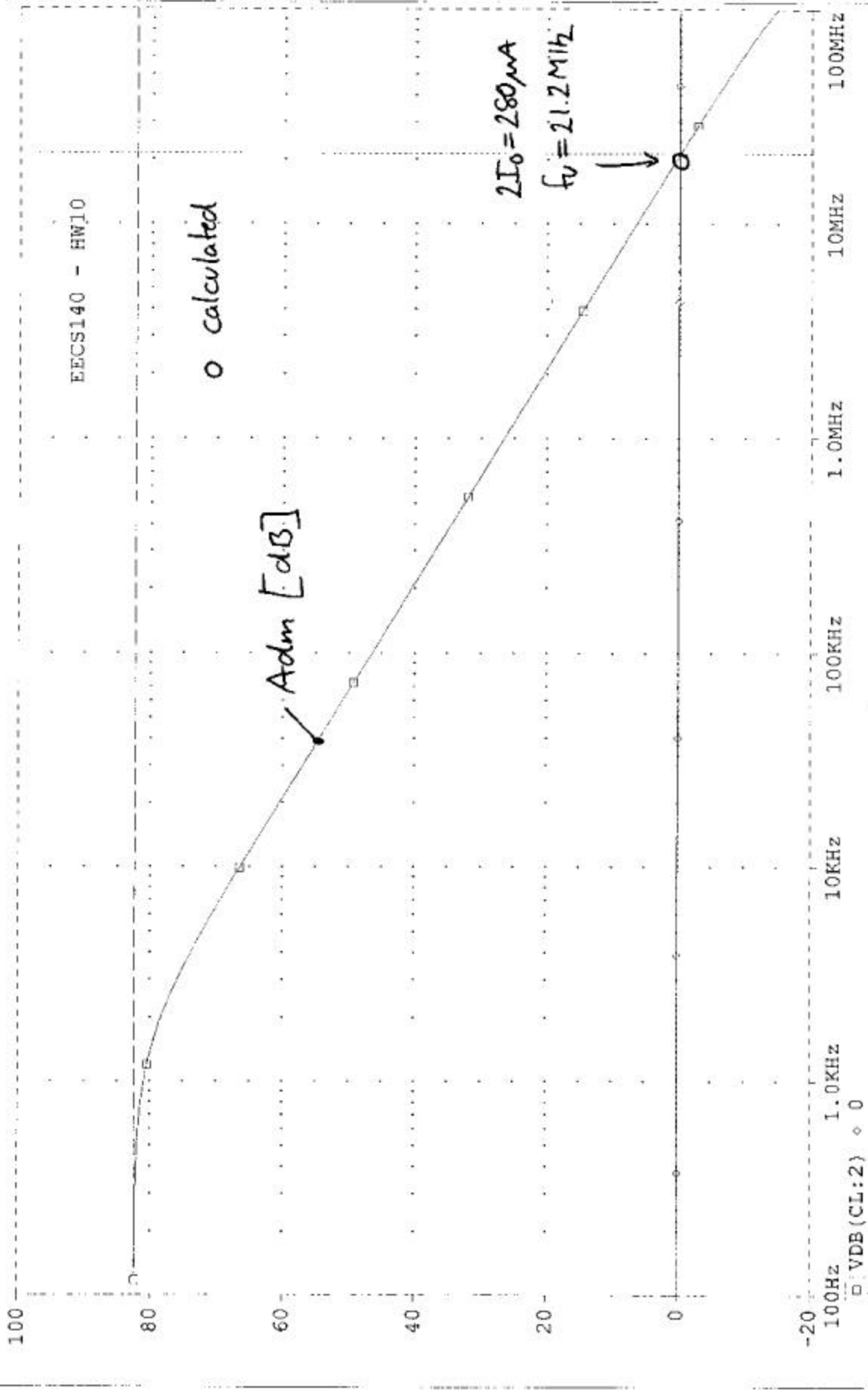


* U:\Eel140\spice\hw10sim.sch

Date/Time run: 10/27/99 18:34:00

Temperature: 27.0

(A) hw10sim



A1:(21.210M,-86.590m) A2:(100.000,82.336) DIFF(A):(21.209M,-82.422)

Date: October 27, 1999

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Time: 18:34:38