Lab 4

Vd vs ln Id

Q1

① $y = 0.0508x + 0.9587$

② $V_d = 0.0508 \ln I_d + 0.9587$

(01) $\ln I_{d1} = 19.654x - 18.851$

(02) $\ln I_{d2} = 19.964x - 18.693$

Arrows

③ Linear from -0.5 to -9

ln (Id values)

$V_T = 0.026\,V$

for diode 1 $\quad 19.654 = \frac{1}{nV_T}$

$$n_1 = \frac{1}{19.654 \times 0.026} = 1.96$$

$\ln(I_S) = -18.851 \quad I_{S1} = e^{-18.851} = 6.50 \times 10^{-9}\,A$

$$n_2 = \frac{1}{19.964 \times 0.026} = 1.926$$

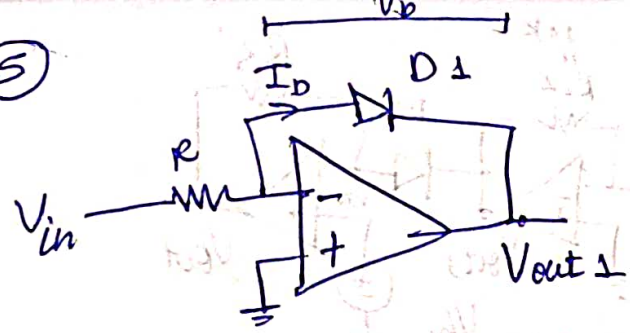
$I_{S2} = e^{-18.693} = 7.616 \times 10^{-9}\,A$

④ $R = \frac{15}{I_{d2}}$

$I_{d2} = 0.001503$

$R = \frac{15}{0.001503} = 9977\,\Omega$

⑤



$$I_D = \frac{V_{in}}{R}$$

$$V_{out_1} = -V_D$$

$$V_{out_1} = nV_T * (\ln(I_S R) - \ln(V_{in}))$$

$$V_{out_1} = -a_1 \ln(V_{in}) + a_2$$

$$a_1 = n_1 V_T$$
$$a_2 = n_1 V_T \ln(I_S R)$$

$$a_1 = 1.96 * 0.026 = 0.05096$$

~~$a_2 = 1.96 * 0.026 \ln(6.5 (-18.851)) = 0.960$~~

$$a_2 = 1.96 * 0.026 \ln(6.5 \times 10^{-9} \cdot 9077) = -0.4914$$

~~$V_{out1} =$~~

$$\boxed{V_{out1} = -0.05096 \ln(V_{in}) - 0.4914}$$

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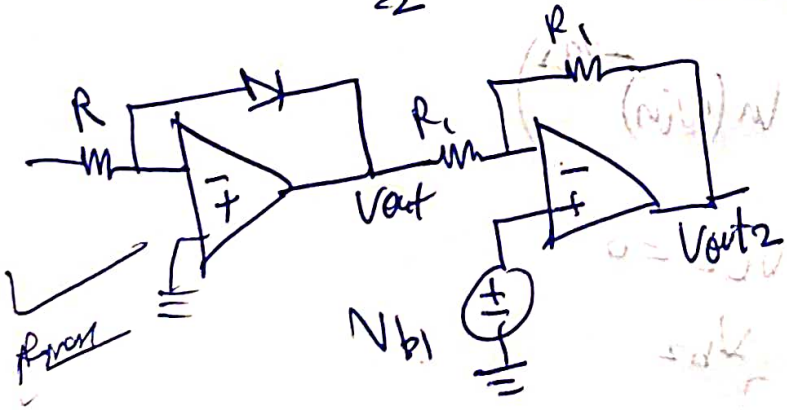
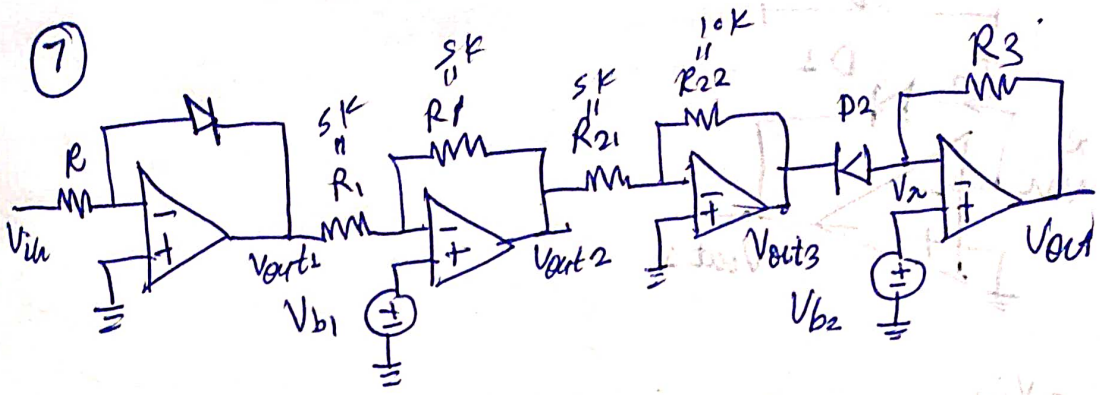
⑥

$$V_{b1} = \frac{a_2}{2} = \frac{-0.4914}{2} = -0.2457\,V$$



(7)



$V_{in} = 1V$

$$V_{R3} = R_3 I_{S2} e^{\frac{V_{b2}}{n_2 V_T}} = 1V$$

$$R_3 I_S e^{\frac{V_{b2}}{n_2 V_T}} = 1 \qquad \beta = \frac{R_{22}}{R_{11}}$$

Variables:

↳ V_{b2} and R_3

⇒ D_2 in linear range

$$R_3 (7.616 \times 10^{-9}) e^{\frac{V_{b2}}{1.92 * 0.026}} = 1$$

$$V_{out1} = -a_1 \ln(V_{in}) + a_2$$

$$V_{out2} = a_1 \ln(V_{in}) - a_2 + a_2$$

$$\left[V_{out3} = -a_1 \beta \ln(V_{in}) = \ln\left((V_{in})^{-a_1 \beta}\right) \right]$$

$$V_{out3} = \ln\left((V_{in})^{-2a_1}\right)$$

for calculating: $V_{out} = R_3 I_{D2} + V_{b2} = 0$

$$-R_3 I_{D2} = V_{b2}$$

$$\boxed{-R_3 I_{D2}}$$

$$I_{b2} = I_{s2} \cdot e^{\frac{V_{b2}}{n_2 V_T}} \cdot V_{ik}^{\frac{n_1}{n_2}\beta}$$

$$\left[I_{b_2} = 7.616 \times 10^{-9} \cdot e^{\frac{V_{b2}}{1.926 * 0.026}} \right]$$

$$0 = 10^4 \left(7.616 \times 10^{-9} \cdot e^{\frac{V_{b2}}{1.926 * 0.026}} \right) + V_b$$

$$0 = 7.616 \times 10^{-5} \, e^{\frac{V_{b2}}{0.0500}} + V_b$$

$$V_{b2} = 0.432\,V$$

$$R_3 = 10\,K\Omega$$

Amar