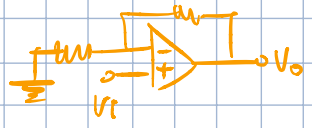
Q1 Op-Amp

gain-bandwidth product = 100 MHz

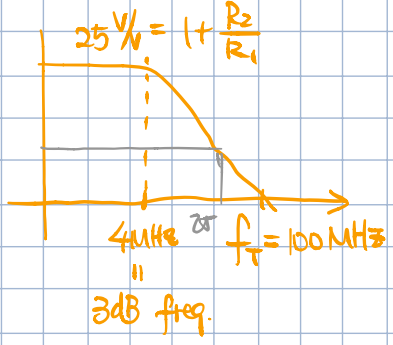
non-inv. amplifier.

closed loop gain $G = 25\ V/V$

What's the gain @ 25MHz?



$$\frac{V_o}{V_i} = 1 + \frac{R_2}{R_1}$$

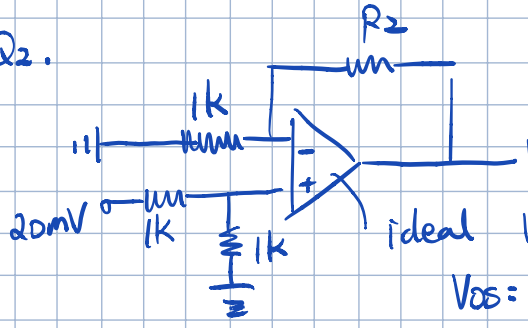


$G \cdot 25MHz = 100MHz$

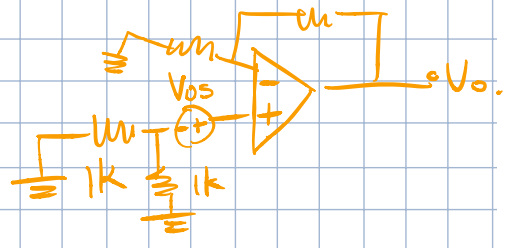
$G = 4\ V/V$

$20\log 4 = 12\ dB$ //

Q2.



What's max R_2 to ensure no saturation at V_o?



$$V_{o1} = \left(20 \times \frac{1}{1+1}\right)\left(1 + \frac{R_2}{R_1}\right) = 10(1+R_2)$$

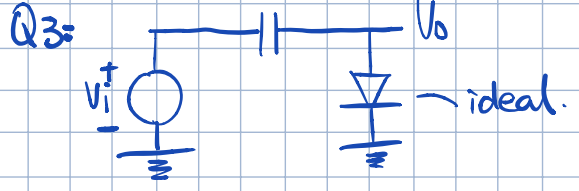
$$V_{o2} = 10\left(1 + \frac{R_2}{R_1}\right) = 10(1+R_2)$$

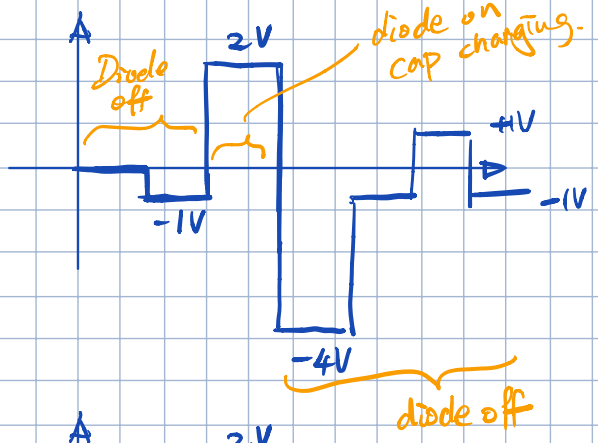
$$V_o = V_{o1} + V_{o2} = 2(10(1+R_2)) = 1000$$

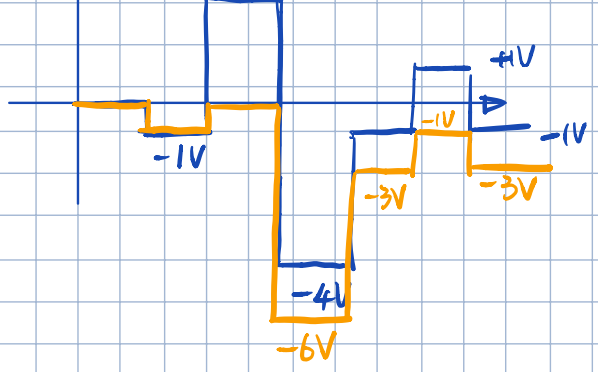
$$10(1+R_2) = 500$$

$$1+R_2 = 50. \quad R_2 = 49\ k\Omega.$$

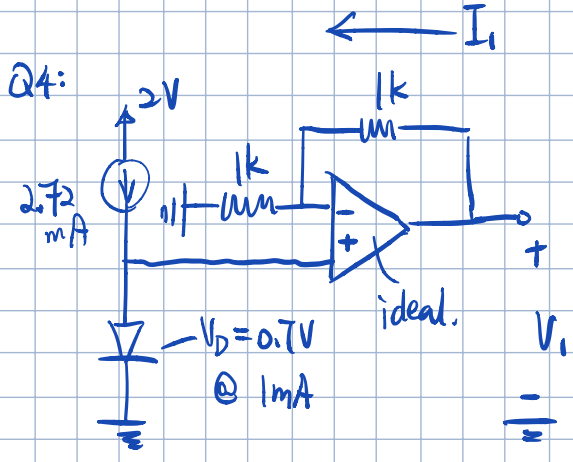
Q3:







Q4:

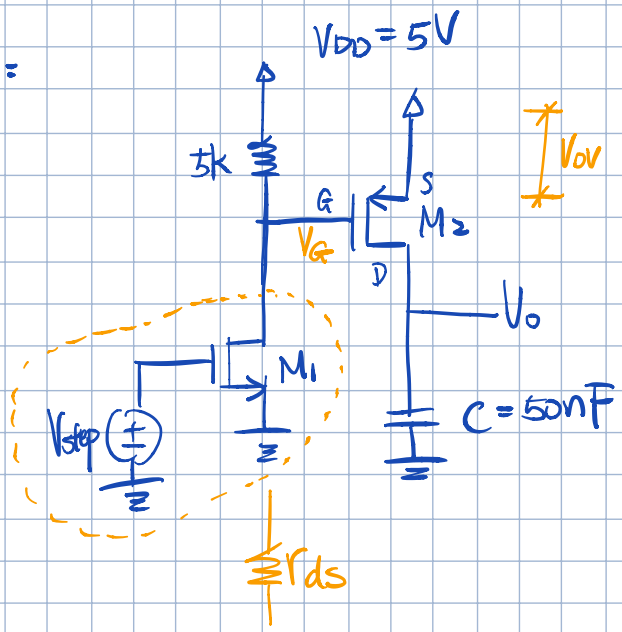


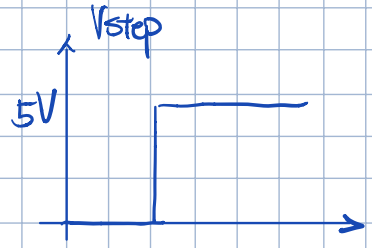
$$V_x = 0.7 + V_T \ln \frac{2.72mA}{1mA} = 0.725V$$

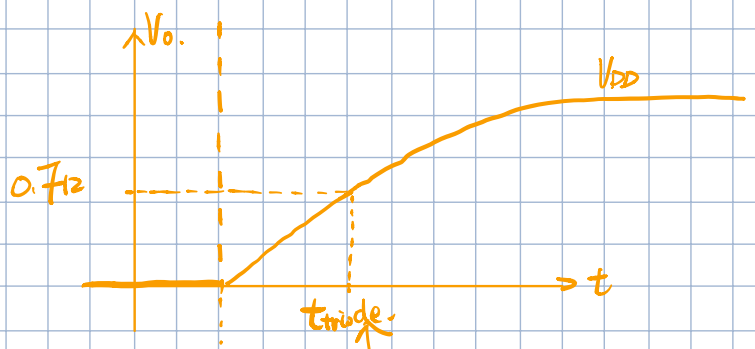
$$V_1 = V_x \left(1 + \frac{R_2}{R_1}\right) = 1.45V$$

$$I_1 = V_1 / (1k + 1k) = 0.725\ mA$$

Q5:







$$r_{ds} = \frac{1}{k_n'(V_{GS} - V_t)} = 222\Omega$$

$$V_G = \frac{222}{5k + 222} \times 5V = 0.212V$$

M2: $V_{S2} - V_o < V_{S2} - V_{G2} - |V_t|$ (0.5V given)

V_{SD} $\quad$ V_{OV}

$$V_o > 0.712V$$

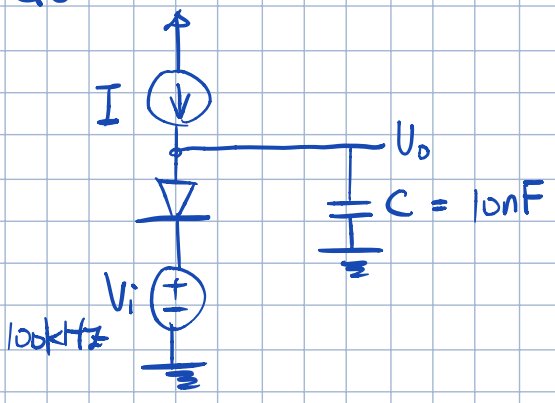
M2 in saturation capacitor is being charged.

$$I_2 = \tfrac{1}{2} k_p (V_{SG_2} - |V_t|)^2 = 9.19\,mA$$

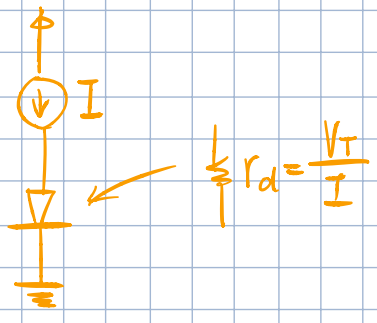
$$Q = CV$$

$$I_2 \cdot t_{triode} = CV_0 \Rightarrow t_{triode} = \approx 87\,\mu s$$

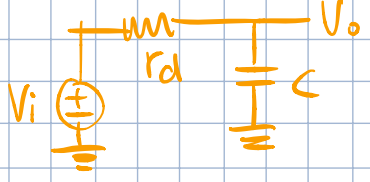
Q6:



DC



AC



$$\frac{V_o}{V_i} = \frac{\frac{1}{sC}}{\frac{1}{sC} + r_d} = \frac{1}{1 + j\omega r_d C}$$

$$\angle \frac{V_o}{V_i} = 0 - \tan^{-1}(r_d \omega C) = -30^\circ$$

$$r_d = 91.8\,\Omega$$

$$I = V_T / r_d = 272\,\mu A$$