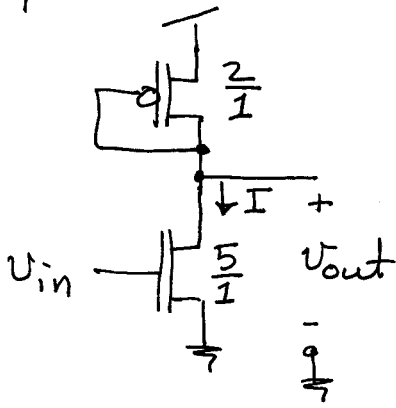


5.1-4



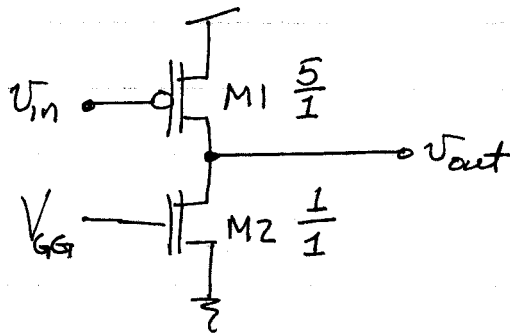
$$A) \quad I = \frac{1}{2} k'_n \left(\frac{5}{I}\right) (V_{in} - V_{T0n})^2$$

$$V_{in} = \sqrt{\frac{2(100\mu A)}{(110 \frac{\mu A}{V^2}) \left(\frac{5}{I}\right)}} + V_{T0n} = \boxed{1.3 \text{ V}}$$

$$B) \quad A_v = \frac{-g_{m1}}{g_{m3}} = \frac{-\sqrt{2\beta_1 I_D}}{\sqrt{2\beta_2 I_D}} = -\sqrt{\frac{k'_n \frac{5}{I}}{k'_p \frac{2}{I}}} = \boxed{-2.34}$$

$$C) \quad r_{out} = \frac{1}{g_{m3}} = \frac{1}{\sqrt{2\beta_2 I_D}} = \frac{1}{\sqrt{2(50 \frac{\mu A}{V^2})(100\mu A)}} = \boxed{10 \text{ k}\Omega}$$

5.1-9



$$(a) \quad V_{GG} = \sqrt{\frac{2(100 \mu A)}{K'_n \frac{1}{1}}} + V_{TN} = 2.04 \text{ V}$$

$$(b) \quad V_{IN} = \sqrt{\frac{200 \mu A}{K'_p \frac{5}{1}}} + |V_{TP}| = (V_{DD} - 1.59) \text{ V}$$

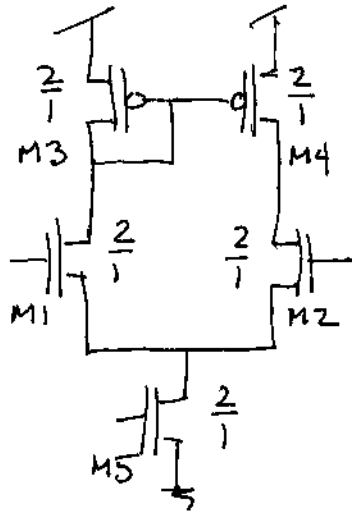
$$(c) \quad A_v = \frac{V_{out}}{V_{in}} = \frac{-g_{m1}}{g_{ds1} + g_{ds2}} = \frac{-\sqrt{2K'_p \frac{5}{1} I_D}}{I_D (\lambda_1 + \lambda_2)} = -24$$

$$(d) \quad \omega_{-3dB} = \frac{g_{ds1} + g_{ds2}}{C_{gd1} + C_{gd2} + C_{bd1} + C_{bd2} + C_L} =$$

$$= \frac{\sqrt{2 I_D} (\sqrt{\beta_p} + \sqrt{\beta_n})}{10 \text{ fF} + 60 \text{ fF} + 500 \text{ fF}} = 652 \times 10^6 \frac{\text{rad}}{\text{s}}$$

$$f_{-3dB} = \frac{\omega_{-3dB}}{2\pi} = \boxed{103 \text{ MHz}}$$

5.2-6



$$(a) A_{vd} = \frac{g_{m1}}{g_{ds2} + g_{ds4}} = \frac{2}{(\lambda_2 + \lambda_4)} \sqrt{\frac{K'_p \frac{2}{1}}{I_{SS}}}$$

$$\boxed{= 104}$$

$$(b) R_{out} = \frac{1}{g_{ds1} + g_{ds2}} = \frac{2}{I_{SS}(\lambda_2 + \lambda_4)} = 2.22 \text{ M}\Omega$$

$$(c) V_{ICMAX} = V_{DD} - V_{SG3} + V_{TN} = \boxed{V_{DD} - 0.316 \text{ V}}$$

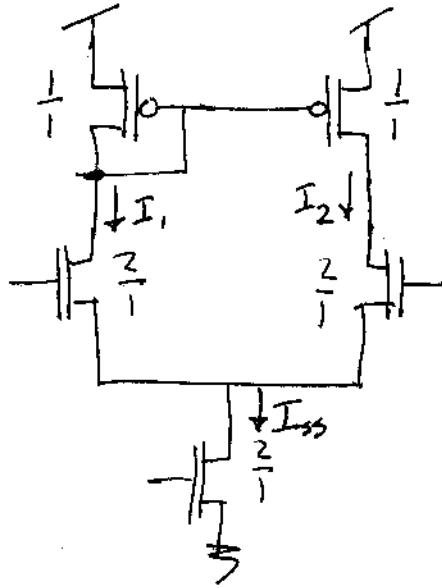
$$V_{SG3} = \sqrt{\frac{I_{SS}}{K'_p \frac{2}{1}}} + |V_{TP}| = 1.016 \text{ V}$$

$$V_{ICMIN} = V_{GS2} + V_{GS5} - V_{TN} = \boxed{1.91 \text{ V} + V_{SS}}$$

$$V_{GS2} = \sqrt{\frac{I_{SS}}{K'_n \frac{2}{1}}} + V_{TN} = 0.91 \text{ V}$$

$$V_{GS5} = \sqrt{\frac{2I_{SS}}{K'_n \frac{2}{1}}} + V_{TN} = 1.00 \text{ V}$$

5.2-9



$$I_2 = 1.05 I_1$$

$$I_1 + I_2 = 100 \mu\text{A}$$

$$I_1 = 100 \mu\text{A} - I_2$$

$$I_2 = 1.05 (100 \mu\text{A} - I_2)$$

$$2.05 I_2 = 100 \mu\text{A}$$

$$I_2 = 51.21 \mu\text{A}$$

$$I_1 = 48.78 \mu\text{A}$$

$$A_{vc} = \frac{-g_{dss}}{2g_{m4}} = \frac{-\frac{1}{2} I_{SS} \lambda_5}{2 \sqrt{2 K'_p \left(\frac{1}{1}\right) (51.21 \mu\text{A})}} = \boxed{-0.028}$$