

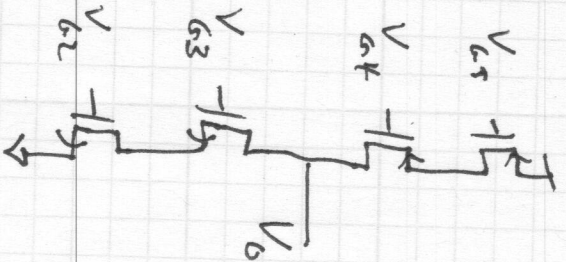
output swing

$$V_{o,min} = V_{G3} - V_{th}$$

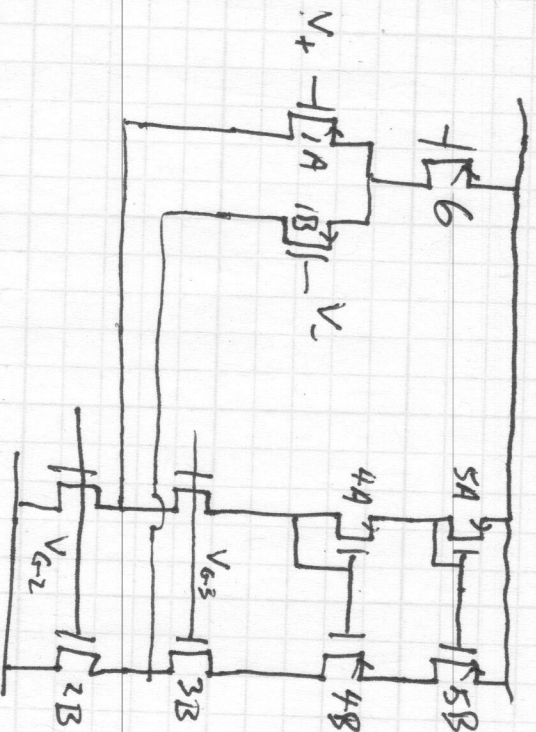
$$V_{G3,min} = V_{th} + V_{ov3} + V_{ov2}$$

$$V_{o,max} = V_{G4} + |V_{tp}|$$

$$V_{G4,max} = V_{DD} - |V_{tp}| - |V_{ov4}| - |V_{ov5}|$$



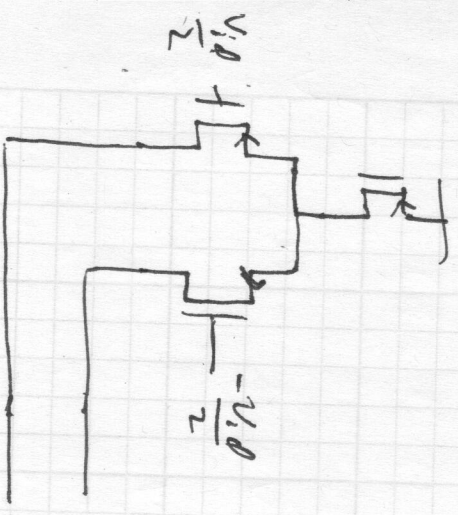
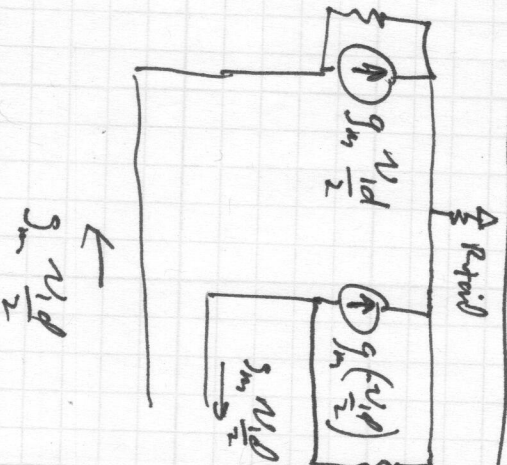
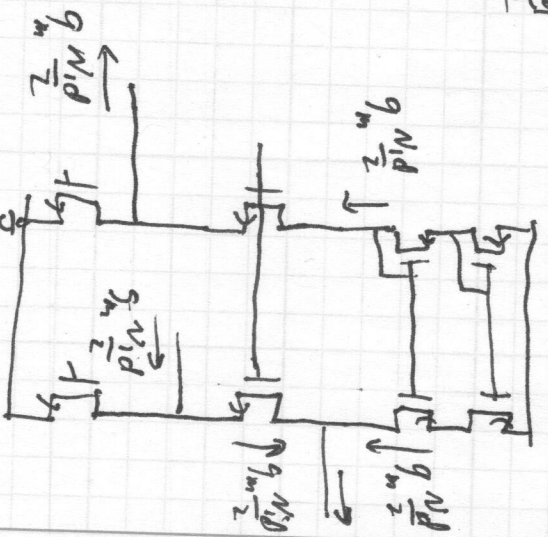
Folded cascode Op-amp (Fig. 6.28)



$$i_o = -g_m \frac{V_{id}}{2} - g_m \frac{V_{id}}{2}$$

$$= -g_m V_{id}$$

$$G_m = \frac{i_o}{V_{id}} = -g_m$$



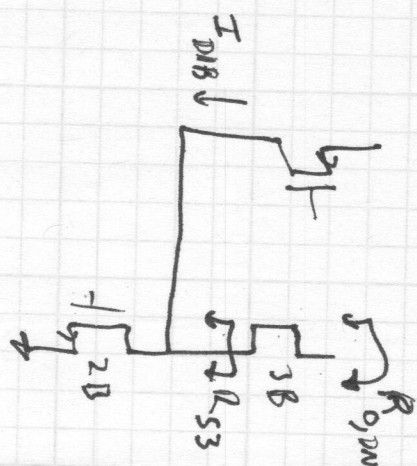
$$R_{OVP} \approx g_{m4} r_{o4} r_{o5B}$$

$$R_{O,IN} = g_{m2B} r_{o3B} R_{S3}$$

$$R_{S3} = r_{o1B} \parallel r_{o2B}$$

$$\frac{1}{R_{S3}} = G_{S3} = g_{o1B} + g_{o2B}$$

$$= \lambda I_{D1B} + \lambda I_{D2B}$$



if $\lambda_n = \lambda_p$ and $I_{D1B} = I_{D5B}$

then $I_{D2B} = 2I_{D1B}$

$$G_{S3} = \lambda(3I_{D1B})$$

$$R_{S3} = \frac{1}{3\lambda I_{D1B}} = \frac{1}{3} r_{o5B}$$

if $V_{OVn} = V_{OVP}$

$$R_O = g_{m4} r_{o4} r_{o5B} \parallel \frac{1}{3} g_{m3} r_{o3} r_{o5B} = \frac{1}{4} g_m r_o^2$$

