3.27

a.) $V_{gs_1} = V_{in} - V_{out} = 1V$ $\qquad \gamma = 0, \quad V_{th} = 0.7V$

$V_{gs_2} = V_{gs_1} + 0.5 = 1.5V$

$$g_m = \frac{2I_D}{V_{gs} - V_{th}} \rightarrow V_{gs} = \sqrt{\frac{2I_D}{\mu_n C_{ox}(W/L)}} + V_{th}$$

$$V_{gs_1} = 1V = \sqrt{\frac{2(0.5E\text{-}3)}{1.34E\text{-}4\left(\frac{W}{L}\right)}} + 0.7$$

$$(0.3)^2 = \frac{2(0.5E\text{-}3)}{1.34E\text{-}4\left(\frac{W}{L}\right)}$$

$$\left(\frac{W}{L}\right)_1 = \frac{2(0.5E\text{-}3)}{1.34E\text{-}4\,(0.3)^2} = 82.92$$

$$V_{gs_2} = 1.5V = \sqrt{\frac{2(0.5E\text{-}3)}{1.34E\text{-}4\left(\frac{W}{L}\right)}} + 0.7$$

$$\left(\frac{W}{L}\right)_2 = \frac{2(0.5E\text{-}3)}{1.34E\text{-}4\,(0.8)^2} = 11.66$$

b.) $V_{in} - V_{out} = 1V\,|_{V_{in} = 2.5V} \rightarrow V_{out} = 1.5V, \quad \gamma = 0.45, \quad 2\phi_F = 0.9$

$$V_{th} = V_{th0} + \gamma\left(\sqrt{2\phi_F + V_{SB}} - \sqrt{2\phi_F}\right)$$

$$V_{th_1}\,|_{V_{SB} = V_{out}} = 0.7 + 0.45\left(\sqrt{0.9 + 1.5} - \sqrt{0.9}\right)$$

$$V_{th_1} = 0.97V$$

$$V_{sg_1} = 1V = \sqrt{\frac{2(0.5E\text{-}3)}{1.34E\text{-}4\left(\frac{W}{L}\right)}} + 0.97$$

$$\left(\frac{W}{L}\right)_1 = \frac{2(0.5E\text{-}3)}{1.34E\text{-}4\,(0.03)^2} = 8291.87$$