

$$3.3 \text{ a)} \quad g_m = \sqrt{2\mu_n C_{ox} \left(\frac{W}{L}\right) I_D} \quad \mu_n C_{ox} = 1.34 \text{E-4}, \quad I_D = 1 \text{mA}$$

$$g_m = \sqrt{2 \cdot 1.34 \text{E-4} \cdot \left(\frac{50}{0.5}\right) \cdot (1 \text{E-3})} \quad R_D = 2000 \Omega$$

$$g_m = 0.00518 = 5.18 \text{E-3}$$

$$A_v = -g_m R_D$$

$$= -(5.18 \text{E-3})(2000) = -10.35 \text{ V/V}$$

$$\text{b.) Edge of triode} \rightarrow V_{gs} - V_{th} = V_{DS}, \quad \lambda = 0$$

$$I_D = 0.5 \mu_n C_{ox} \frac{W}{L} \underbrace{(V_{gs} - V_{th})^2}_{V_{DS}^2} \underbrace{(1 + \lambda V_{DS})}_0 = 0.5 \mu_n C_{ox} \frac{W}{L} V_{DS}^2$$

and

$$I_D = \frac{V_{DD} - V_{DS}}{R_D} = \frac{3 - V_{DS}}{2000}$$

$$\frac{3 - V_{DS}}{2000} = 0.5 \cdot 1.34 \text{E-4} \left(\frac{50}{0.5}\right) V_{DS}^2$$

$$0.0067 V_{DS}^2 + \frac{V_{DS}}{2000} - \frac{3}{2000} = 0$$

$$V_{DS} = 0.437 \text{ V}$$

$$I_D = \frac{3 - 0.437}{2000} = 1.28 \text{ mA}$$

$$g_m = \sqrt{2\mu_n C_{ox} \left(\frac{W}{L}\right) I_D} = \sqrt{2 \cdot 1.34 \text{E-4} \cdot \left(\frac{50}{0.5}\right) \cdot (1.28 \text{E-3})}$$

$$g_m = 0.00586 = 5.86 \text{E-3}$$

$$A_v = -g_m R_D = -(5.86 \text{E-3})(2000) = -11.71 \text{ V/V}$$

$$\text{Input voltage: } V_{gs} - V_{th} = V_{DS} \mid V_{th} = 0.7$$

$$V_{gs} - 0.7 = 0.437 \rightarrow V_{gs} = 1.137 \text{ V}$$