ECE 3040 Quiz 4 – June 15, 2005

Professor Leach Name_____

Instructions. Print your name in the space above. The quiz is closed-book and closed-notes. The quiz consists of 2 problems. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

1. (a) Why is a MOSFET that is fabricated on a p-type semiconductor substrate called an "n-channel MOSFET?" `Because the n channel is induced by the gate-to-body voltage.`
   (b) Where do the electrons come from that form the inversion layer in the n-channel MOSFET? `From the` n^+ `regions under the source and drain.`
   (c) How does the fabrication of the depletion mode MOSFET differ from the fabrication of the enhancement mode MOSFET? `Ion implantation is used to induce the channel.`
   (d) What is the major difference in the current versus voltage characteristics of the enhancement and depletion mode MOSFETs? $V_{TH} > 0$ `for the enhancement and` $V_{TH} < 0$ `for the depletion.`
   (e) What name is associated with the voltage $1/\lambda$ on the MOSFET output characteristics? `Early voltage.` Use a simple sketch to show how this voltage affects the graph of the output characteristics. `It causes the` i_D `versus` v_{DS} `lines to have a slope and they all converge at the point` $v_{DS} = -1/\lambda$.
   (f) How does the body effect change the MOSFET characteristics? `It causes` V_{TH} `to change.`

2. The figure shows a MOSFET circuit. It is given that $V^+ = 18\,\text{V}$, $R_1 = 7.5\,\text{k}\Omega$, $R_2 = 500\,\Omega$, $K = 0.001\,\text{A}/\text{V}^2$, and $V_{TH} = 1.5\,\text{V}$.
   (a) Calculate the value of V_1 required to obtain a drain-to-source voltage of 10 V.

$$I_D = \frac{V^+ - V_{DS}}{R_D + R_S} = \frac{18 - 10}{7.5\,\text{k}\Omega + 500\,\Omega} = 1\,\text{mA}$$

$$I_D = K\left(V_{GS} - V_{TH}\right)^2 \Longrightarrow V_{GS} = \sqrt{\frac{0.001}{0.001}} + 1.5 = 2.5\,\text{V}$$

$$V_1 = V_S + V_{GS} = I_D R_S + V_{GS} = 0.5\,\text{V} + 2.5\,\text{V} = 3\,\text{V}$$

   (b) Calculate the power dissipation in the MOSFET.

$$P = V_{DS} I_D = 10\,\text{V} \times 0.001\,\text{A} = 0.01\,\text{W}$$