**Massachusetts Institute of Technology**
**Department of Electrical Engineering and Computer Science**

# 6.002 – Electronic Circuits
**Spring 2007**
**Homework #6**
**Handout - S07-030**

**Issued 3/15/2007 – Due 3/23/2007**

**Reading:** Section 7.7, and Sections 8.1-8.2 of A+L. Review Section 4.5

**Exercise 6.1**. Do Exercise 8.1 from A+L Chapter 8 (page 447).

**Exercise 6.2**. Consider a two-terminal device formed by a MOSFET with its gate tied to its drain. The MOSFET is characterized by parameters $V_T$ and $K$, and its drain-to-source voltage and drain current are denoted as $v_R$ and $i_R$, respectively.

**a.** Write the $v_R$ - $i_R$ relation for this device operating under the saturation discipline (i.e. for $v_R \geq V_T$).

**b.** Develop a small-signal model for this device about a dc operating point $v_R = V_R$, describing the relationship between $v_r$ and $i_r$.

**Problem 6.1**. Do Problem 7.5 from A+L Chapter 7 (pages 396-397) with the following changes:

- For part **a.**, show that $v_{OUT}$ is related to $v_{IN}$ according to $v_{OUT}^2 - 2(v_{IN} - V_T + \frac{1}{RK})v_{OUT} + (v_{IN} - V_T)^2 = 0$ instead of the equation listed in the book.
- For part **b.**, only find the range for $v_{IN}$. Do not find the corresponding range for $v_{OUT}$. You should be able to do this without having to solve any quadratic equations.

**Problem 6.2**. Do Problem 7.10 from A+L Chapter 7 (page 399).

*(Problem 6.3 on back)*

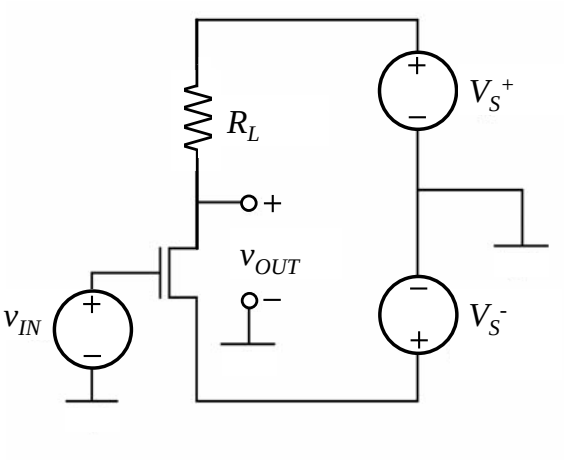


Figure 1: Amplifier Dual power supplies layout.

**Problem 6.3**. In many amplifiers we use dual power supplies so we can obtain a $0$ V offset at the output. An example is shown in Fig. 1.

For this problem, use $V_S^+ = +1.5$ V, $V_S^- = -1.5$ V, and MOSFET parameters $K$ =1 mA/V$^2$ and $V_T = 0.5$ V. Then:

**a.** Find the value of $R_L$ such that $v_{OUT} = 0$ V when $v_{IN} = 0$ V.

**b.** As $v_{IN}$ is increased, the output voltage $v_{OUT}$ decreases. For the value of $R_L$ found in part **a.**, find the minimum output voltage $v_{OUT}$ such that the MOSFET will obey the saturation discipline.