

Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Circuits & Electronics
Spring 2007

Final Exam

21 May 2007

Name: _____

- There are 31 pages in this final, including this cover page. Please check that you have them all.
- Please write your name in the space provided above, and circle the name of your recitation instructor along with the time of your recitation.
- **IMPORTANT:** The problems in this exam vary in difficulty; moreover, questions of different levels of difficulty are distributed throughout the exam. If you find yourself spending a long time on a question, consider moving on to later problems in the exam, and then working on the challenging problems after you have finished all of the easier ones.
- Do your work for each question within the boundaries of that question, or on the back of the preceding page. When finished, enter your answer to each question in the corresponding answer box that follows the question.
- Remember to include the sign and units for all numerical answers.
- This is a closed-book exam, but you may use a calculator and three double-sided pages of notes.
- You have 3 hours to complete this final.
- Good luck!

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|--------------|------|------|------|------|--|
| 1A. | 1B. | 2. | 3. | 4. | |
| 5. | 6. | 7. | 8. | 9. | |
| 10. | 11. | 12A. | 12B. | 13. | |
| 14. | 15. | 16. | 17. | 18. | |
| | 19A. | 19B. | 19C. | 19D. | |
| Final Score: | | | | | |

Problem 1: 8 points

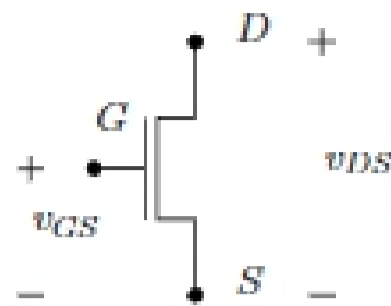


Figure 1.

A MOSFET (shown in Figure 1) operating in the triode region has a characteristic i_{DS} relationship which depends on both v_{DS} and v_{GS} :

$$i_{DS} = K [(v_{GS} - V_T) v_{DS} - v_{DS}^2/2]$$

where $v_{GS} > V_T$ and $v_{DS} \leq v_{GS} - V_T$. The small-signal relationship between i_{ds} , v_{gs} , and v_{ds} can be expressed by an equation of the form

$$i_{ds} = Av_{gs} + Bv_{ds}$$

where A and B are constants. Assume that the device is biased at an operating point (V_{GS}, V_{DS}) .

- (1A) (4 points) Draw the 2-element small-signal model for the device which is operating in the triode region. Express the element values in terms of A and B .

Small-signal equivalent circuit:

- (1B) (4 points) Find the values of the constants A and B in the two-element small signal model for the MOSFET operating in the triode region,

$$i_{ds} = Av_{gs} + Bv_{ds}$$

Formulate your answers in terms of the variables K , V_{GS} , V_T , and V_{DS} .

$A =$

$B =$