American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics

Quiz 2 – December 19, 2008

Closed Book – *No Programmable Calculators*

90 minutes

Penalty is 5 to 1

(1 to 4 wrong answers do not result in a penalty; 5 to 9 wrong answers cancel one correct answer; 10 to 14 wrong answers cancel two correct answers; and so on)

Name: _____ANSWERS_____ ID number: _____

An N-channel MOSFET with $k' = 1$ mA/V^2 is biased such that it is operating in the saturation region. The Early voltage for this MOSFET is $V_A = 5$ V.
When the MOSFET is biased at $V_{OV} = 1$ V, with $V_{DS} = V_X$ Volts, the drain current is 1 mA. When the overdrive voltage increases to 1.2 V, V_{DS} decreases by 20% to $0.8 \times V_X$ while the drain current increases to 1.2 mA.

1. Find the initial value of V_{DS} (V_X in V).
a) 35 b) 32.5 c) 27.5 d) 25 e) 30

2. Find the value of (W/L) for this MOSFET.
a) 1/6 b) 1/7 c) 1/4 d) 1/3 e) 1/5

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3. If a P-channel MOSFET is biased at $V_{GS} = -9$ V and $V_{DS} = -1$ V, and has a threshold voltage $V_t = -3$ V, find its region of operation.

a) Triode (Linear) b) Saturation c) Cutoff d) Pinch-Off e) Unknown

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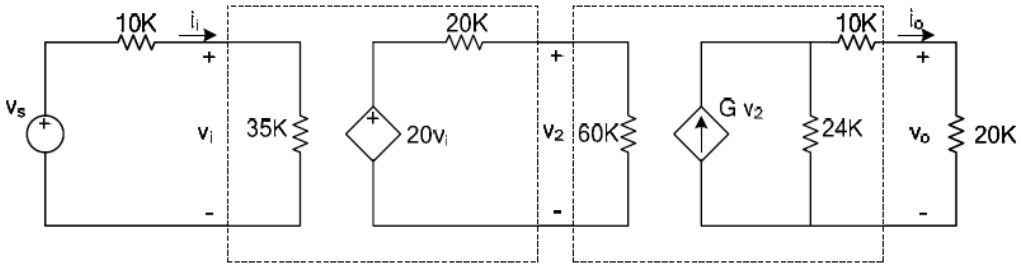
4. Consider the two-stage amplifier shown below. What should be the value of G (in mA/V) to achieve a voltage gain v_o/v_i of 700?



a) 7.5 b) 4.5 c) 5.25 d) 6 e) 6.75

5. Find the output resistance (in KΩ) of the amplifier (set the input to zero, and use the definition of output resistance).
a) 94 b) 34 c) 7.06 d) 10 e) 24

6. If $G = 3$ mA/V, what is the short-circuit transconductance i_o / v_i (in mA/V), when the 20K load resistance connected across the output is set to zero (replaced by a short circuit)?
a) 21.2 b) 31.8 c) 42.4 d) 52.9 e) 63.5

The drain current of an enhancement N-channel MOSFET is measured at several values of V_{GS}, V_{DS}, and V_{SB}, as shown in the table below.
For this MOSFET, $|2\phi_f| = 0.6$ V.

V_{GS} (V)	V_{DS} (V)	V_{SB} (V)	I_D (mA)
3	3	0	3.6
3	4	0	4.2
4	1	0	I_X
4	4	0	9.45
4	4	4	6.6703

7. Find the value of V_{t0} (in V).
a) 0.9 b) 0.8 c) 0.6 d) 0.7 e) 1.0

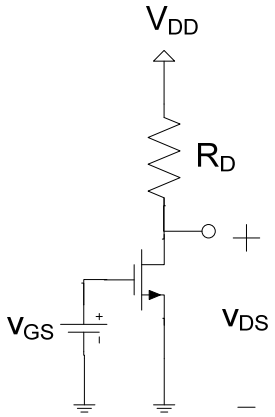
8. Find the value of $k'(W/L)$ (in mA/V^2).
a) 0.9 b) 1.4 c) 1.1 d) 1.2 e) 1.3

9. Find I_X (in mA).
a) 3.77 b) 3.92 c) 2.25 d) 3.24 e) 2.86

10. Find the value of V_A (in V).
a) 4 b) 3 c) 5 d) 10 e) 7

11. Find the value of γ (in V$^{1/2}$).
a) 0.35 b) 0.4 c) 0.5 d) 0.3 e) 0.45

The MOSFET in the circuit below has the $i_D - v_{DS}$ characteristics shown in Figure A. The curves correspond to the following values of V_{GS}: 1, 2, 3, 4, and 5 V. Assume that V_{DD} = 5 V and R_D = 2.2 KΩ.



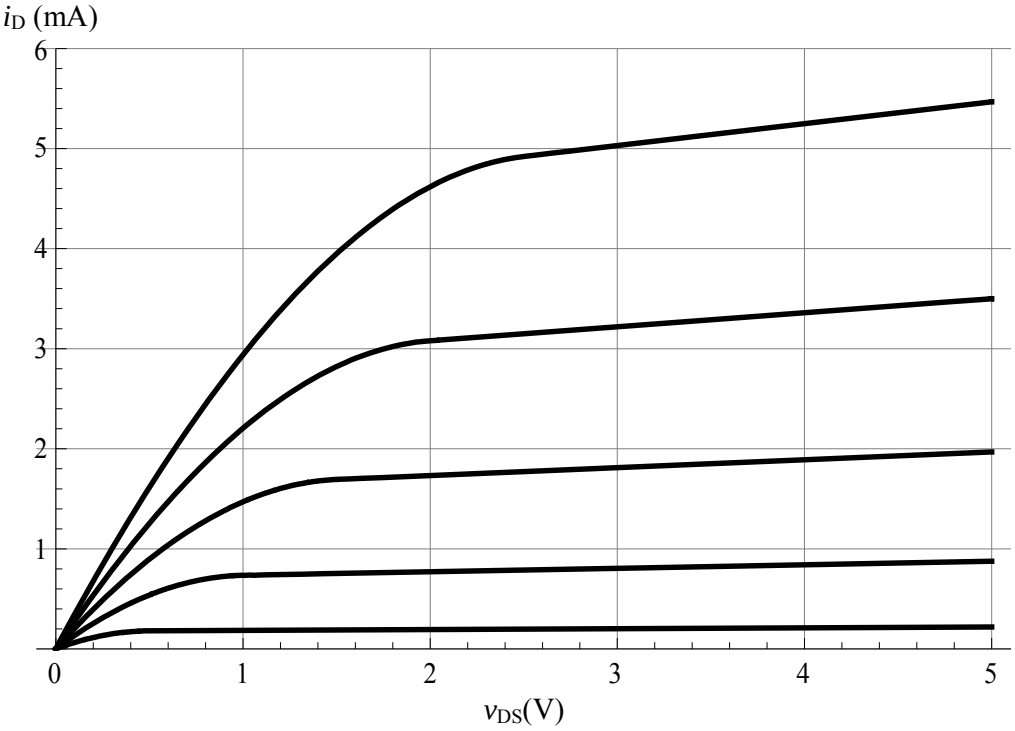


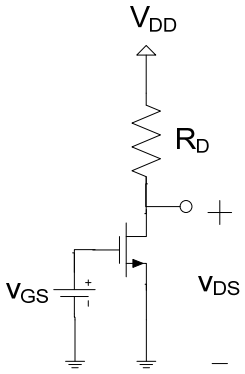
Figure A

12. Find the *y*–axis intercept of the load line.
a) 2.27 b) 5 c) 4.17 d) 3.33 e) 2.78

13. Find V_{DS} (in V) at the bias (Q) point of the MOSFET when V_{GS} = 4 V.
a) 2.4 b) 1.8 c) 0.8 d) 3.2 e) 1.2

14. Find the drain current (in mA) for the MOSFET in the circuit below. The MOSFET parameters are $V_{t0} = 1$ V, $k'(W/L) = 1$ mA/V^2, and $V_A = 4$ V. Assume $V_{GS} = 3$ V, $V_{DD} = 9$ V and $R_D = 1$ KΩ.

a) 0.39 b) 1.44 c) 2.85 d) 4.33 e) 5.70



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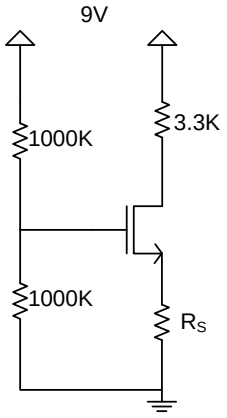
15. Find V_{GS} (in V) for the MOSFET in the circuit below. The MOSFET parameters are $V_{t0} = 0.8$ V and $k'(W/L) = 0.2$ mA/V^2. Assume $R_S = 0.5$ KΩ.

a) 3.67 b) 4.37 c) 3.99 d) 3.27 e) 3.02



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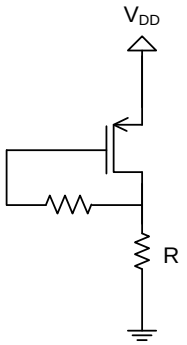
16. The drain current for the MOSFET in the circuit shown is given by $V_{DD}/2R$. The MOSFET threshold voltage is $-V_{DD}/8$. Find the product $k'(W/L) \times V_{DD} \times R$.
a) 6.6 b) 11.1 c) 9.0 d) 7.84 e) 7.1



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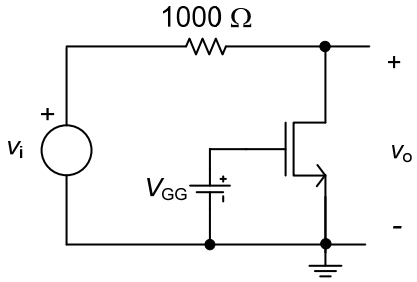
17. Assume in the circuit below that v_i is a small voltage, not exceeding a few milliVolts. Find the value of (W/L) for the MOSFET, if it is required to have $v_o/v_i = 0.5$ when $V_{GG} = 1.8$ V.
The MOSFET parameters are $V_{t0} = 0.6$ V and $k' = 0.1$ mA/V^2.
a) 4.76 b) 3.70 c) 11.1 d) 8.33 e) 6.25



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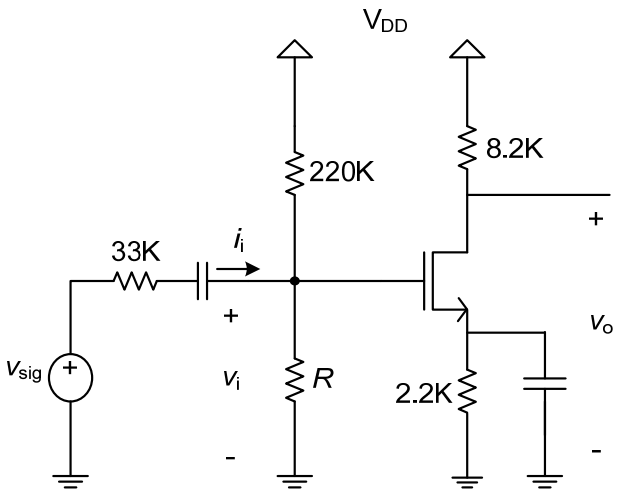
18. A MOSFET amplifier is biased at $V_{OV} = 0.1 \times V_{DD}$, $V_{DS} = 0.5 \times V_{DD}$. Find the product $g_m \times r_o$ for this MOSFET, if $V_A = 4 \times V_{DD}$.
a) 150 b) 170 c) 90 d) 110 e) 130

In the circuit shown below, the MOSFET is biased such that g_m = 1 mA/V and r_o = 50 KΩ. Assume that all capacitors are very large, and that R = 220 KΩ.



19. Find the overall small-signal voltage gain v_o/v_{sig}.
a) –3.28 b) –3.89 c) –4.76 d) –5.14 e) –5.42

20. Find the input resistance v_i/i_i in KΩ.
a) 28.7 b) 110 c) 89.2 d) 40.7 e) 68.8

21. Assume that the gain from gate to drain v_o/v_i is –8. What is the maximum signal swing (in V) at the drain that keeps the MOSFET in saturation?
The transistor is biased at V_{OV} = 0.8 V, V_{DS} = 3 V. Neglect signal distortion.
a) +/–2.13 b) +/–1.42 c) +/–1.6 d) +/–1.78 e) +/–1.96

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22. The process transconductance parameter k' is 0.2 mA/V^2 for a certain process. If the dielectric thickness t_{ox} is *reduced* by a factor of 2, find the new value of k' (in mA/V^2).
a) 0.5 b) 0.4 c) 0.3 d) 0.2 e) 0.1

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23. A MOSFET is biased at V_{OV} = 1 V, V_{DS} = 3 V, with I_D = 0.2 mA. Find the resistance value (in KΩ) that appears between gate and source in the small-signal T-model.
a) 1.67 b) 2.0 c) 5.0 d) 3.33 e) 2.5