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EE255 Exam 2 October 12th, 2000

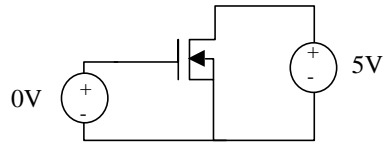
Instructor (circle one) Bashir Furgason

The exam consists of 16 multiple choice questions and 4 workout problems. Record the answers to the multiple choice on this page. Return the entire exam. There will be no partial credit for the multiple choice portion. There may be partial credit for the workout problems and hence show all your work.

DO NOT BEGIN UNTIL INSTRUCTED TO DO SO

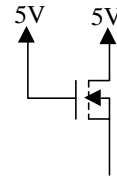
- | | | | | | |
|-----|---|---|---|---|---|
| 1) | a | b | c | d | e |
| 2) | a | b | c | d | e |
| 3) | a | b | c | d | e |
| 4) | a | b | c | d | e |
| 5) | a | b | c | d | e |
| 6) | a | b | c | d | e |
| 7) | a | b | c | d | e |
| 8) | a | b | c | d | e |
| 9) | a | b | c | d | e |
| 10) | a | b | c | d | e |
| 11) | a | b | c | d | e |
| 12) | a | b | c | d | e |
| 13) | a | b | c | d | e |
| 14) | a | b | c | d | e |
| 15) | a | b | c | d | e |
| 16) | a | b | c | d | e |

1. Given the MOSFET biased as shown below, in which region will the device operate ?
 $V_T = 1\text{V}$



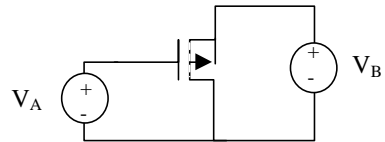
- (a) Saturation (b) Linear (c) Cut-off (d) active (e) inverse active
-

2. Given the MOSFET biased as shown below, in which region will the device operate ?
 $V_T = 1\text{V}$



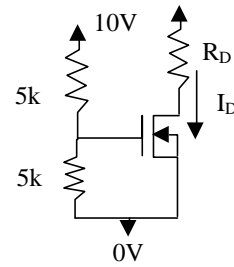
- (a) Saturation (b) Linear (c) Cut-off (d) active (e) inverse active
-

3. The transistor below has $K_p = 2\text{mA/V}^2$, $V_{TH} = 3\text{V}$, $V_A = 6\text{V}$, and $V_B = 10\text{V}$.
 What is the value of I_D ?



- (a) 0mA (b) 2mA (c) 6mA (d) 16mA (e) 18mA
-

4. For the transistor biased as shown in the circuit below, find the value of I_D ? Assume that R_D is such that the device is in saturation.
 $K_N = 0.2 \text{ mA/V}^2$, $V_{TH} = |3|$

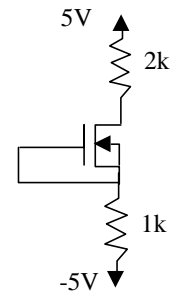


- (a) 3.2mA (b) 6.4mA (c) 12.8mA (d) 25.6mA (e) 51.2mA
-

5. For the circuit shown above in problem 4, Find R_D such that the transistor is in saturation ?

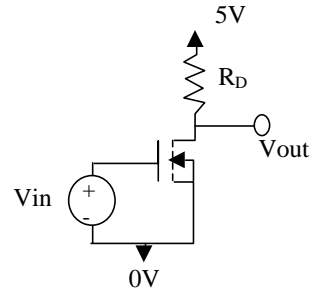
- (a) 90Ω (b) 180Ω (c) 220Ω (d) 360Ω (e) 450Ω
-

6. For the circuit show below, find the value of V_{DS} ?
 $K_N = 2 \text{ mA/V}^2$, $V_{TH} = |1|$



- (a) 0.5 (b) 1 (c) 4 (d) 5 (e) 7
-

7. For the circuit shown below, when $V_{in}=5V$ and $V_{out}=0.2V$, find the I_D ?
 $K_N=0.1mA/V^2$, $V_{TH}=|2|$

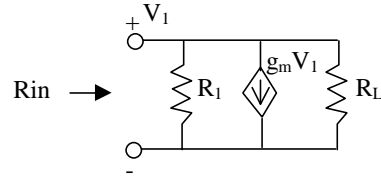


- (a) 0.11mA (b) 0.22mA (c) 0.33mA (d) 0.44mA (e) 0.55mA

8. Given the circuit shown in the figure below and the output characteristics of the transistor shown in the adjacent figure, what is the value of I_D and V_{DS} for the transistor ?

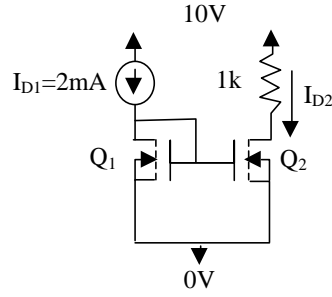
- (a) $I_D = 8mA$, $V_{DS}=8V$, (b) $I_D = 16mA$, $V_{DS}=6V$, (c) $I_D = 6mA$, $V_{DS}=8V$, (d) $I_D = 24mA$, $V_{DS}=4V$, (e) $I_D = 8mA$, $V_{DS}=6V$

9. What is the input impedance of the circuit shown below;



- (a) R_1 (b) $R_1 || R_L$ (c) $1/g_m$ (d) $R_1 || R_L || 1/g_m$

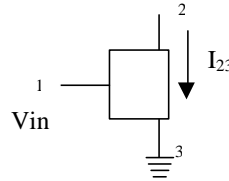
10. For the MOS circuit shown below, determine the value of I_{D2} and V_{DS2} ? Assume that $K_{N1}=K_{N2}$.



- (a) $I_{D2}=2\text{mA}$, $V_{DS2}=5\text{V}$ (b) $I_{D2}=2\text{mA}$, $V_{DS2}=8\text{V}$ (c) $I_{D2}=1\text{mA}$, $V_{DS2}=4\text{V}$
 (d) $I_{D2}=1\text{mA}$, $V_{DS2}=8\text{V}$ (e) $I_{D2}=3\text{mA}$, $V_{DS2}=8\text{V}$

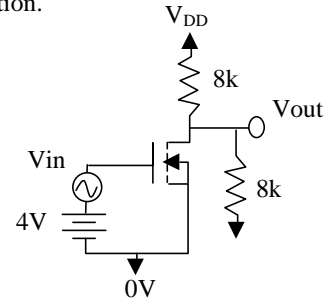
11. Given a hypothetical 3 terminal device, the current voltage relationships are shown below. Determine the transconductance for this device. Input is taken at node 1 and output is taken at node 2.

$$I_{23} = AV_{13} + BV_{13}^2 + CV_{23}$$



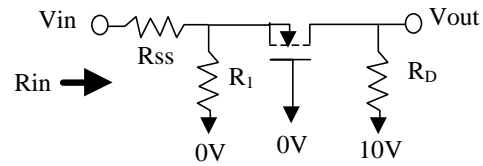
- (a) $2A + BV_{13}$ (b) $AV_{13} + B$ (c) $A + 2BV_{13}$ (d) $BV_{13} + C$ (e) $2BV_{13} + C$

12. The numerical value of the small signal voltage gain of the amplifier shown below is; $K_N=1\text{mA/V}^2$, $V_{TH}=|2|$, $\lambda_n=0$. Assume the device is in saturation.



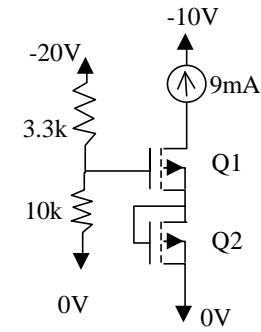
- (a) +16 (b) -16 (c) +8 (d) -8 (e) -32

13. The input impedance for the circuit shown below, assuming that the transistor is biased in saturation, is;



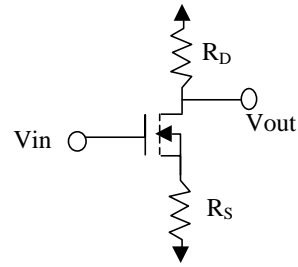
- (a) $R_{ss} \parallel R_1$ (b) $R_{ss} + R_1 \parallel 1/g_m$ (c) $R_{ss} \parallel R_1 \parallel 1/g_m$ (d) $R_s \parallel R_1 \parallel 1/g_m \parallel R_D$
 (e) $1/g_m$

14. Determine the regions for operation for the transistors in the circuit shown below;
 $K_N = 1 \text{ mA/V}^2$, $V_{TH} = 1 \text{ V}$



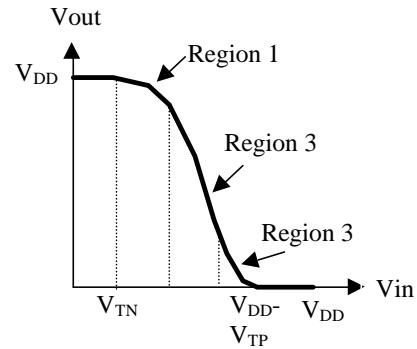
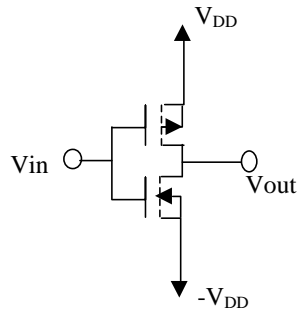
- (a) Q1 linear, Q2 Saturation (b) Q1 Saturation, Q2 Saturation
 (c) Q1 Saturation, Q2 Linear (d) Q1 Cut-off, Q2 Linear
 (e) Q1 linear, Q2 Cut-off

15. If the transistor is biased in saturation, changing R_S from 0 to $1\text{k}\Omega$ in the circuit below does the following;



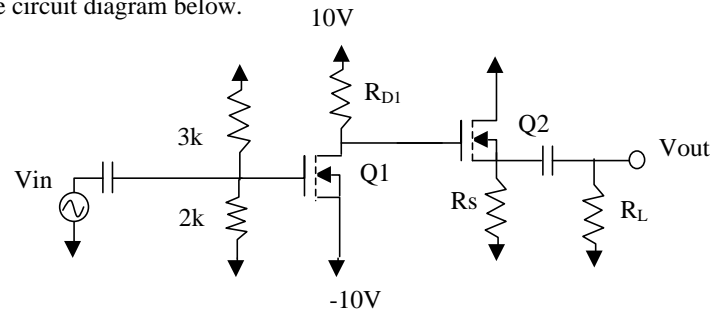
- (a) increases the magnitude of the ac voltage gain and lowers R_{out}
- (b) increases the magnitude of the ac voltage gain and increases circuit stability
- (c) decreases the magnitude of the ac voltage gain and increases circuit stability
- (d) decreases the magnitude of the ac voltage gain and increases R_{in}
- (e) does nothing to the magnitude of the ac voltage gain or R_{in}

16. A CMOS inverter circuit is shown below. In region 1 of the transfer curve, the transistors are in the following regions of operation;



- (a) NMOS Saturation, PMOS Linear
- (b) NMOS linear, PMOS Saturation,
- (c) NMOS Saturation, PMOS Cut-off,
- (d) NMOS Cut-off, PMOS Linear,
- (e) NMOS Active, PMOS Passive

17-20 pertain to the circuit diagram below.



$$K_N = 0.1 \text{ mA/V}^2, V_{TH} = 1, \lambda = 0$$

17. Calculate the maximum value of R_{D1} so that Q1 is in saturation.

18. Calculate R_S so that Q2 is in saturation, and I_{D2} is 0.9mA.

19. Draw the ac small signal equivalent circuit with the transistor models, and the DC transfer curve of the circuit.

20. Calculate the approximate numerical value of the ac small signal voltage gain.
