ECE-255
Exam II
March/3/2010

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(Please print clearly)

Student ID: —

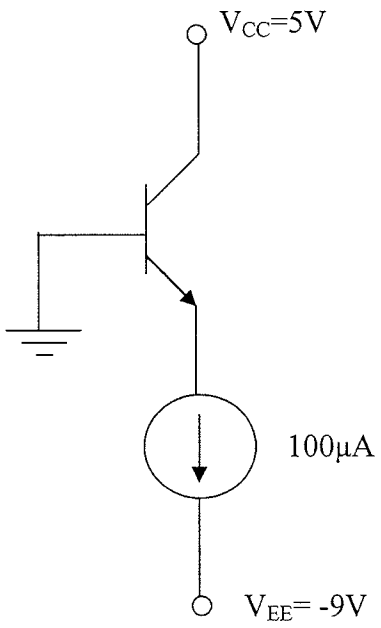
INSTRUCTIONS

- This is a closed book, closed notes exam.
- Carefully mark your multiple choice answers on the scantron form. Work on multiple choice problems and marked answers in the test booklet will not be graded. Nothing is to be on the seat beside you.
- When the exam ends, all writing is to stop. This is not negotiable. No writing while turning in the exam/scantron or risk an F in the exam.
- All students are expected to abide by the customary ethical standards of the university, i.e., your answers must reflect only your own knowledge and reasoning ability. As a reminder, at the very minimum, cheating will result in a zero on the exam and possibly an F in the course.
- Communicating with any of your classmates, in any language, by any means, for any reason, at any time between the official start of the exam and the official end of the exam is grounds for immediate ejection from the exam site and loss of all credit for this exercise.

1) In a bipolar transistor operating in the forward active region,

(1) BE and BC junctions are both forward biased
(2) BE and BC junctions are both reverse biased
(3) BE junction is forward biased and BC junction is reverse biased
(4) BE junction is reverse biased and BC junction is forward biased
(5) BE junction is forward biased and CE junction is forward biased
(6) BE junction is reverse biased and CE junction is forward biased

2) For the bipolar circuit shown below, V_{CE}=?
β=100, $I_s=10^{-14}$A, and V_T=25mV



(1) 14V (2) 5.575V (3) 0.7V (4) 5V
(5) 4.425 (6) None of the above

$I_E = 100\,\mu A \qquad I_C = \alpha I_E = \frac{\beta}{\beta+1} I_E$

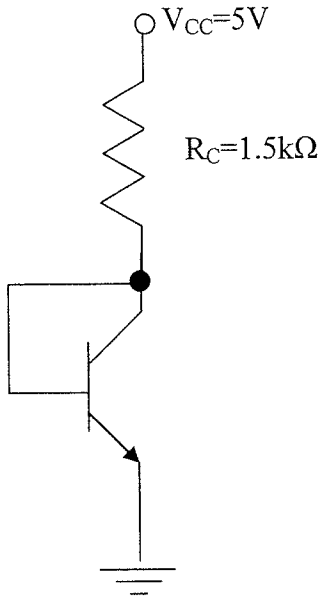
$I_C = 100 \times \frac{100}{101} = 99\,\mu A$

$V_{BE} = V_t \ln \frac{I_C}{I_S} = 0.025 \ln \frac{99 \times 10^{-6}}{10^{-14}} = 0.575$

$V_B = 0 \Rightarrow V_E = -0.575$

$V_{CE} = V_C - V_E = 5 - (-0.575) = 5.575$

3) For the bipolar circuit shown below, I_C?
β=100, V_{BE}(on)=0.7

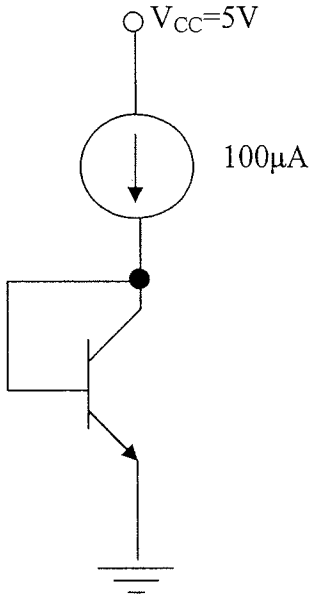


(1) 3.13mA (2) 2.84mA (3) 3.8mA (4) 3.33mA
(5) 1.43mA (6) None of the above

$$I_E = \frac{5 - 0.7}{1.5\,k\Omega} = 2.8667\ mA$$

$$I_C = I_E \cdot \beta/\beta+1 = 2.84\ mA$$

4) For the diode connected bipolar transistor shown below, V_{BE}=?
β=100, $I_s=10^{-14}$A, and V_T=25mV

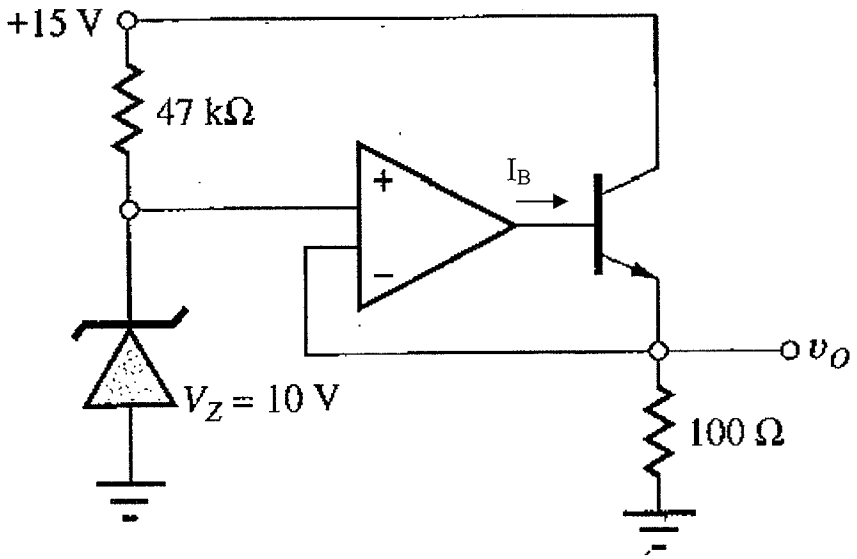


(1) 5V (2) 0.7V (3) 0V (4) -0.575V
(5) 0.575V (6) None of the above

$I_E = 100\ \mu A \qquad I_C = 100 \times \beta/(\beta+1) = 99\ \mu A$

$V_{BE} = 0.025 \ln \frac{I_C}{I_S} = 0.575V$

5) For the circuit shown below, what is I_B?
Assume OpAmp is ideal, $\beta=60$, and $R_Z=0$

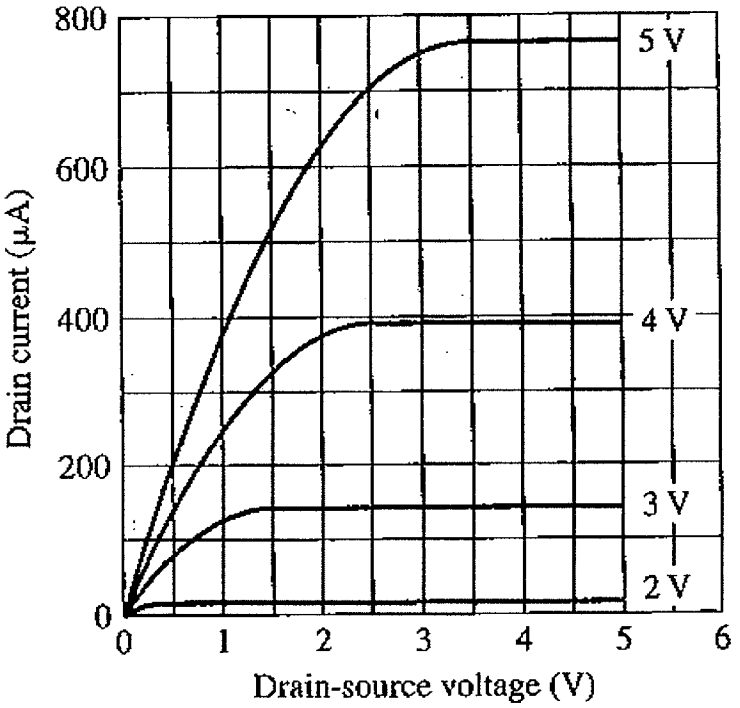


(1) 1.64mA (2) 0 (3) 10mA (4) 0.32mA
(5) 0.1mA (6) None of the above

$V_E = 10\ V \Rightarrow I_E = \frac{10}{100} = 0.1\ A = 100\ mA$

$I_B = \frac{I_E}{\beta+1} = \frac{100}{61} = 1.64\ mA$

6) What is the value of VTN for the transistor whose i_D-v_{DS} characteristic is given below?

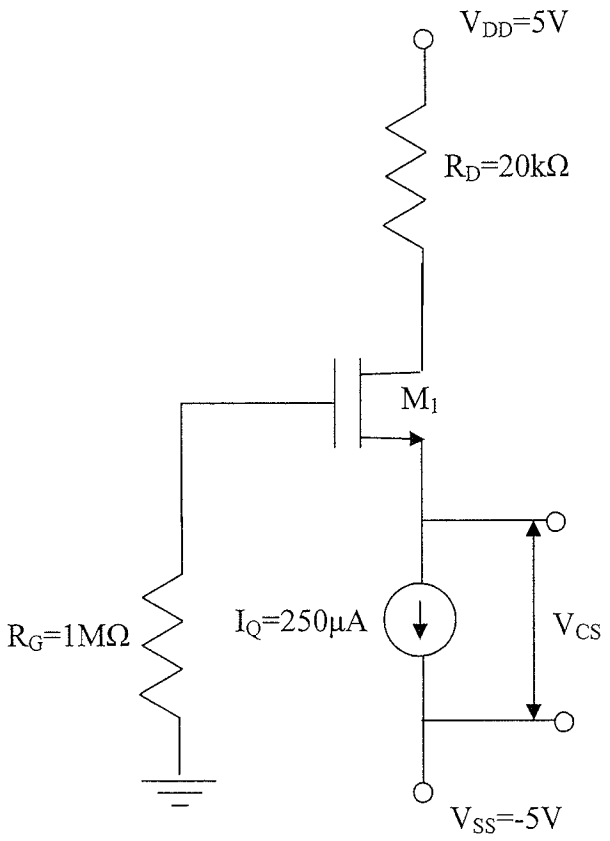


(1) 0V (2) ~1.5V (3) -2V (4) ~1V
(5) One cannot estimate V_T from these graphs alone
(6) None of the above

See problem set for HW #5

7) For the MOS circuit shown below, what is the voltage drop across the current source, V_{CS}=?

V_{TN}=1V, K'_N=80 μA/V^2, (W/L)=3



(1) 7.44V (2) 0V (3) 2V (4) 2.56V
(5) 5V (6) None of the above

$I_D = 250\ \mu A$ $\quad I_D = \frac{K_n}{2}(V_{GS} - V_t)^2$

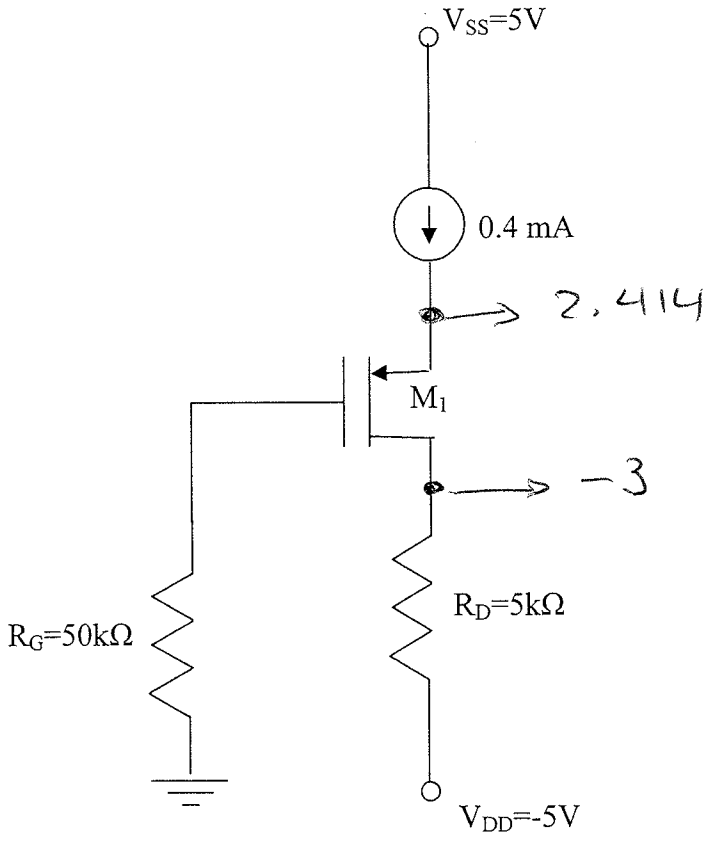
$250 = \frac{80 \times 3}{2}(V_{GS} - 1)^2 \Rightarrow V_{GS} = 2.44$

$V_G = 0 \Rightarrow V_S = -2.44$

$V_{CS} = -2.44 - (-5) = 2.56\ V$

8) For the MOS circuit shown below, V_{DS}=?

V_{TP}= -0.8V, K_P=400 μA/V^2



(1) -5.2V (2) -0.6V (3) 0V (4) 2.5V
(5) 2.4V (6) None of the above

$I_D = I_S = 0.4\ mA \qquad I_D = \frac{K_p}{2}(V_{GS} - V_{tp})^2$

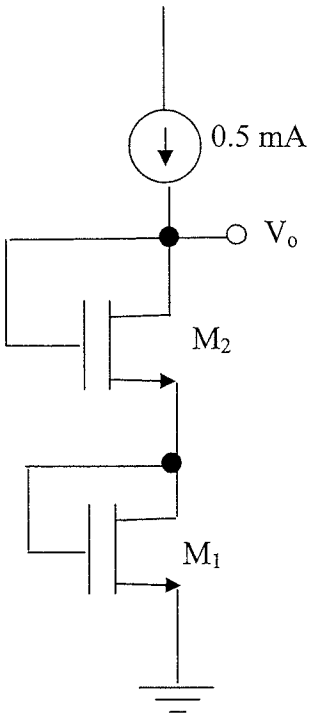
$0.4 = \frac{0.4}{2}(V_{GS} + 0.8)^2 \Rightarrow V_{GS} + 0.8 = \pm 1.414$

$V_{GS} = -1.414 - 0.8 = -2.214 = V_G - V_S$

$V_G = 0 \Rightarrow V_S = 2.214$

$V_D = +0.4\ mA \times 5\ K - 5 = -3\ V$

9) Find the output voltage (V_o) for the circuit shown below,
V_{TN}=0.75V, K'_N=100μA/V^2, $(W/L)_1$=10/1, $(W/L)_2$=20/1



(1) 3.2V (2) 1.5V (3) 0V
(4) 2.5V (5) it is open circuit (6) None of the above

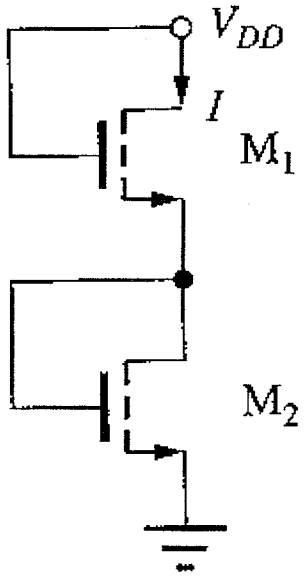
$$V_o = V_{GS1} + V_{GS2}$$

$$= V_t + \sqrt{\frac{2I_D}{K_{n1}}} + V_t + \sqrt{\frac{2I_D}{K_{n2}}}$$

$$= 0.75 + \sqrt{\frac{2 \times 0.5}{0.1 \times 10}} + 0.75 + \sqrt{\frac{2 \times 0.5}{0.1 \times 20}}$$

$$= 1.5 + 1 + \sqrt{\frac{1}{2}} = 3.2\ V$$

10) Find the current I in the circuit below
V_{DD}=10V and both transistors have W/L=10/1, V_{TN}=0.75V, and K'_N=100μA/V^2



(1) 18mA
(2) 0mA since gates are tied to drains (transistors are off)
(3) 9.03mA
(4) 0.9mA
(5) 42mA
(6) None of the above

Same as last years second Exam

$V_{GS1} = V_{GS2} = 5\,V$

$V_{GS} = V_{tn} + \sqrt{\frac{2I_D}{K_n}}$

$5 = 0.75 + \sqrt{\frac{2I_D}{K_n}}$

$I_D = \frac{K_n}{2}(V_{GS} - V_{tn})^2$

$= \frac{0.1 \times 10}{2}(5 - 0.75)^2$

$=$