ID # _____

NAME _____

EE-255 **EXAM 1** **October 10, 2001**

Instructor (circle one) Talavage Gray

This exam consists of 16 multiple choice questions (80 points) and one workout problem (20 points). Record all answers to the multiple choice questions on this page. You must turn in the entire exam. There will be no partial credit for the multiple choice questions, but there will be partial credit for the workout problems. You MUST show your work on the workout problems.

Circle the one best answer for each question. Five points per question.

Do not open and begin until you are 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

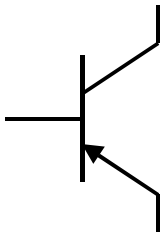
13) a b c d e

14) a b c d e

15) a b c d e

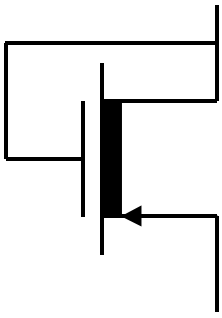
16) a b c d e

1. Identify the device below:



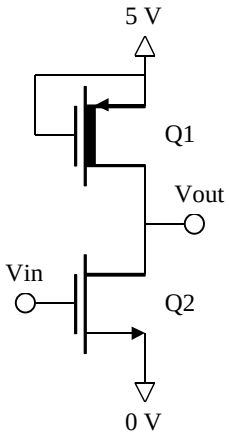
a) p-channel bipolar junction transistor
b) n-channel bipolar junction transistor
c) pn-junction transistor
d) pnp bipolar junction transistor
e) npn bipolar junction transistor

2. The device below may operate in which regions?



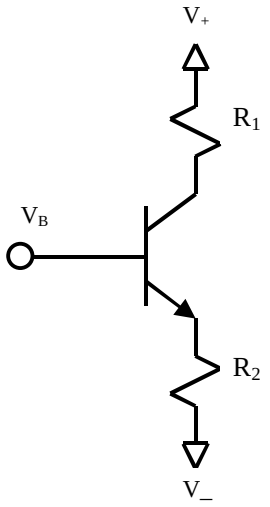
a) cutoff and saturation only
b) saturation only
c) forward active and saturation only
d) cutoff and ohmic only
e) cutoff and forward active only

3. If V_{in} = 5 V, what are the likely states of operation for Q_1 and Q_2, respectively?



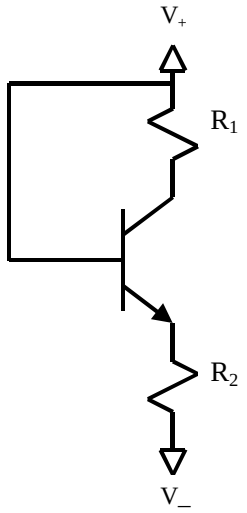
a) ohmic, cutoff
b) saturation, ohmic
c) cutoff, ohmic
d) forward active, saturation
e) cutoff, cutoff

4. In the following circuit, V_+ = 0 V, V_- = -5 V, R_1 = 7.7 kΩ and R_2 = 2.3 kΩ. It is observed that V_B = -2 V when the base current is +100μA. If it is known that β > 10, indicate either the most likely value of β OR the best explanation as to why β cannot be determined.



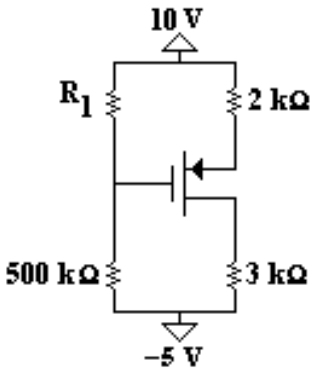
a) 10
b) 50
c) Transistor is in the ohmic region
d) Transistor is in the saturation region
e) Cannot compute I_C to compute β

5. The transistor in the circuit below is characterized with $\beta = 100$, $|V_{BE}(on)| = 0.6$ V, $|V_{CE}(sat)| = 0.2$ V. If $V_+ = 5$ V, $V_- = 2$ V and $R_2 = 1.2$ kΩ, what is the maximum value of R_1 such that the transistor remains in the Forward Active region of operation?



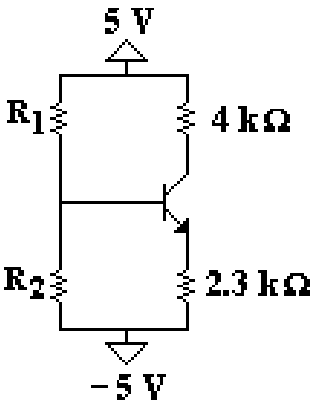
a) 110 Ω
b) 220 Ω
c) 260 Ω
d) 150 Ω
e) 200 Ω

6. In the following circuit, the transistor has $k = 2$ mA/V^2 and $|V_{th}| = 2$V. If the drain current is 2 mA, what is the approximate value of R_1?



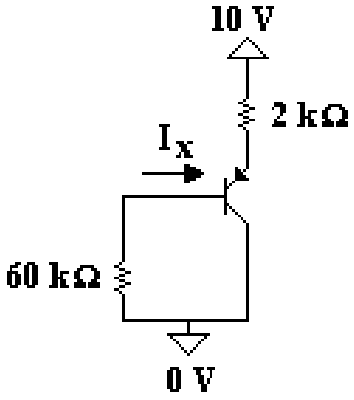
a) 1200 kΩ
b) 440 kΩ
c) 330 kΩ
d) 125 kΩ
e) 250 kΩ

7. The transistor below has $\beta = 50$. If we desire a collector current of 1 mA, what are appropriate values for R_1 and R_2?



a) $(R_1,R_2) = (70\ k\Omega, 30\ k\Omega)$
b) $(R_1,R_2) = (35\ k\Omega, 17\ k\Omega)$
c) $(R_1,R_2) = (350\ k\Omega, 170\ k\Omega)$
d) $(R_1,R_2) = (39\ k\Omega, 15\ k\Omega)$
e) $(R_1,R_2) = (15\ k\Omega, 39\ k\Omega)$

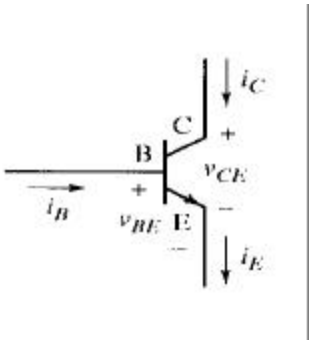
8. The transistor below has $\beta = 100$. What is the value of I_X?



a) 50 μA
b) 12 μA
c) -12 μA
d) 35 μA
e) -35 μA

9. You are given a circuit containing a silicon npn bipolar power transistor. You are told that $\beta_F = 100$, plus or minus 10%.. You measure $I_B = 10$ mA and $I_C = 0.432$ A. What is the region of operation?

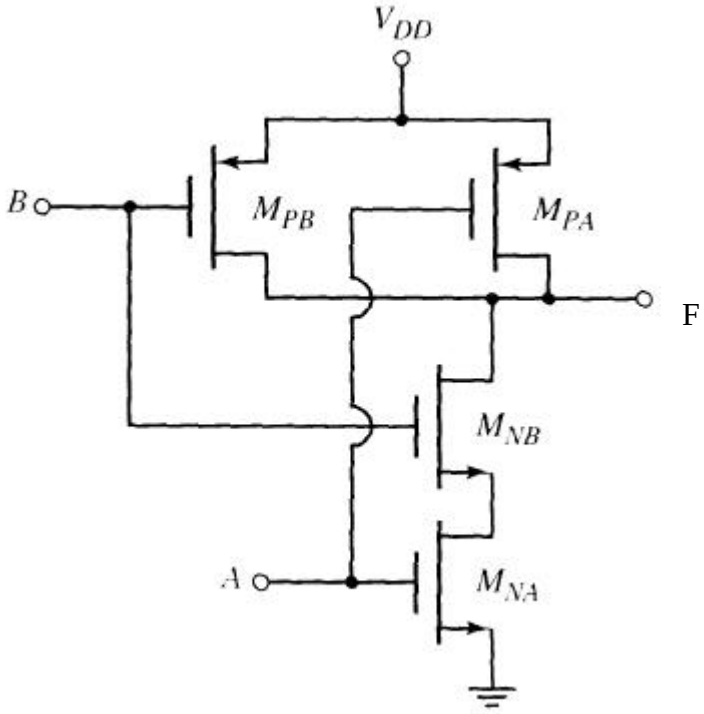
a) forward active
b) cut-off
c) triode
d) saturation
e) inverse active



9. An germanium npn power transistor has $I_B = 20$ mA, $I_C = 2$ A, $V_{BE} = 0.25$ V, and $V_{CE} = 5$ V. The thermal resistance, $\theta_{device\text{-}ambient}$, between the heat-sinked device and the ambient is 2°C/W . If the ambient temperature is 20 degrees Celsius, what, to the nearest degree, is the device temperature?

a) 40°C
b) 21°C
c) 25°C
d) 10°C
e) insufficient information provided to determine

11. For A = logic "1" and B = logic "1", what is F?



a) logic "0"

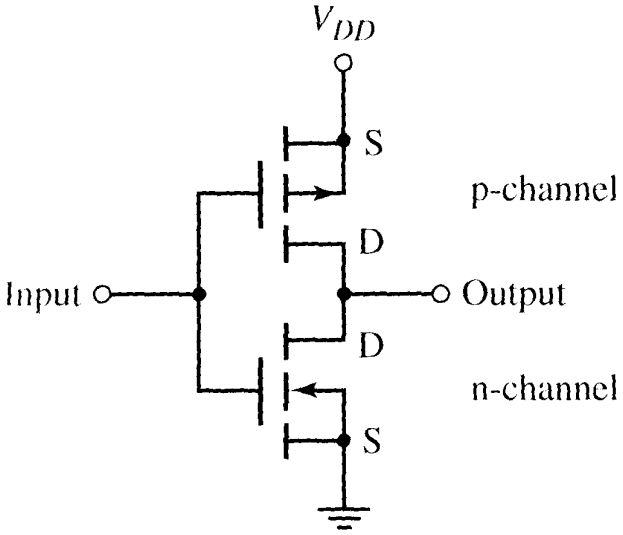
b) logic "1"

c) logic "-1"

d) logic "2"

e) it will be random

12. The channel length, oxide thickness, and $|V_T|$ of the p-channel and n-channel MOSFETs at right are equal. For a symmetric VTC, the width of the p-channel MOSFET must be about 3 times that of the n-channel MOSFET. This is because



a) the electron mobility is about a factor of 3 smaller than the hole mobility.

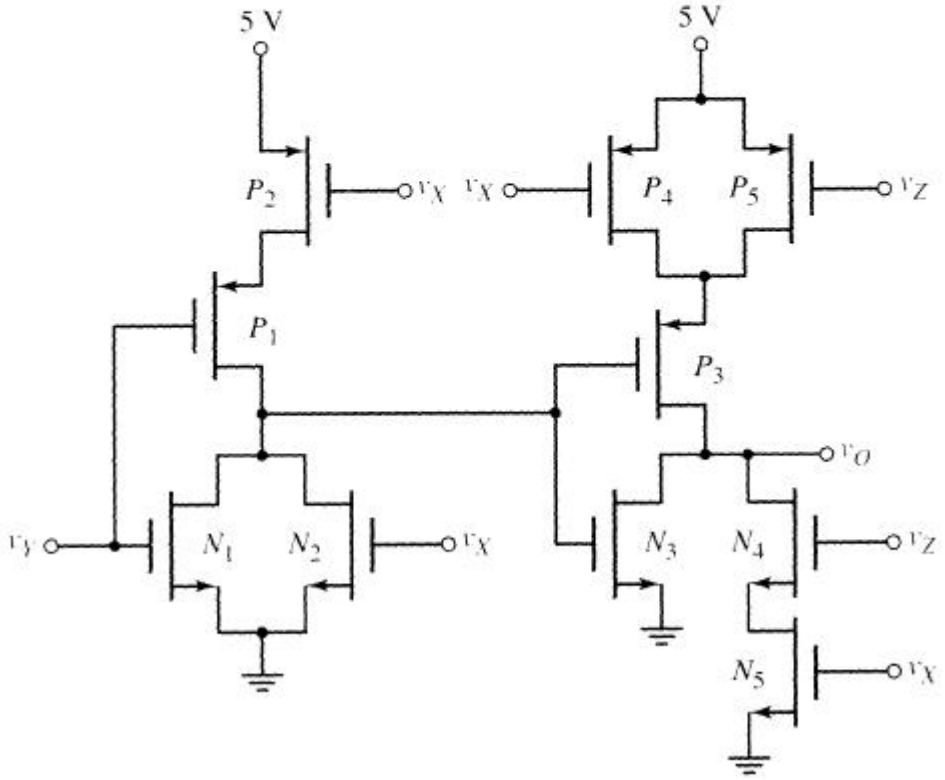
b) the electron charge is a factor of 3 smaller than the hole charge.

c) the electron mobility is about a factor of 3 larger than the hole mobility.

d) the electron charge is a factor of 3 larger than the hole charge.

e) quarks carry a charge 1/3 that of an electron.

v_X	v_Y	v_Z	N_1	N_2	N_3	N_4	N_5	v_O
1	0	1						
0	0	1						
1	1	0						
1	1	1						



13. Which row of inputs from the table above yields the following for N_1, N_2, N_3, N_4, N_5, V_O?

on, on, off, off, on, "1"

a) the top row

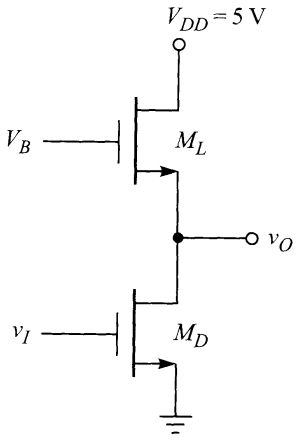
b) the second row from the top

c) the third row from the top

d) the bottom row

e) none of them

14. The threshold voltage for both transistors at right is 1 V.
The minimum value for V_B necessary to yield V_{OH} = 5 V is



a) 1 V

b) 4 V

c) 5 V

d) 0 V

e) 6 V

15. A depletion-mode p-channel MOSFET will have

a) $V_T < 0$ and a p-type source and drain

b) $V_T < 0$ and an n-type source and drain

c) $V_T > 0$ and a p-type source and drain

d) $V_T > 0$ and an n-type source and drain

e) nothing to do on Saturday night

16. The gate current in an MOS transistor is approximately

a) βI_D

b) βI_C

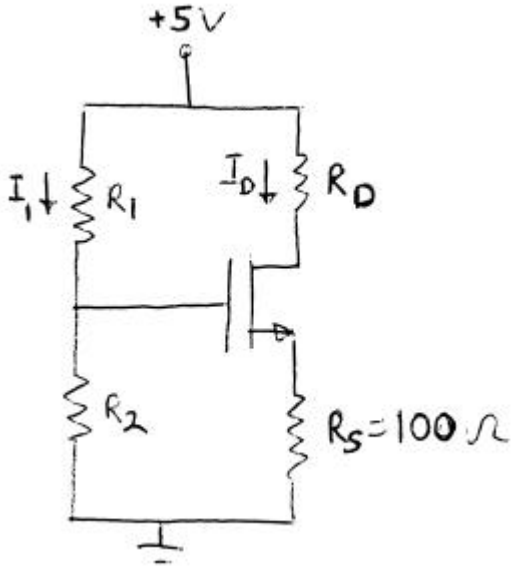
c) zero

d) I_D / β

e) I_B

Workout Problem (20 points)

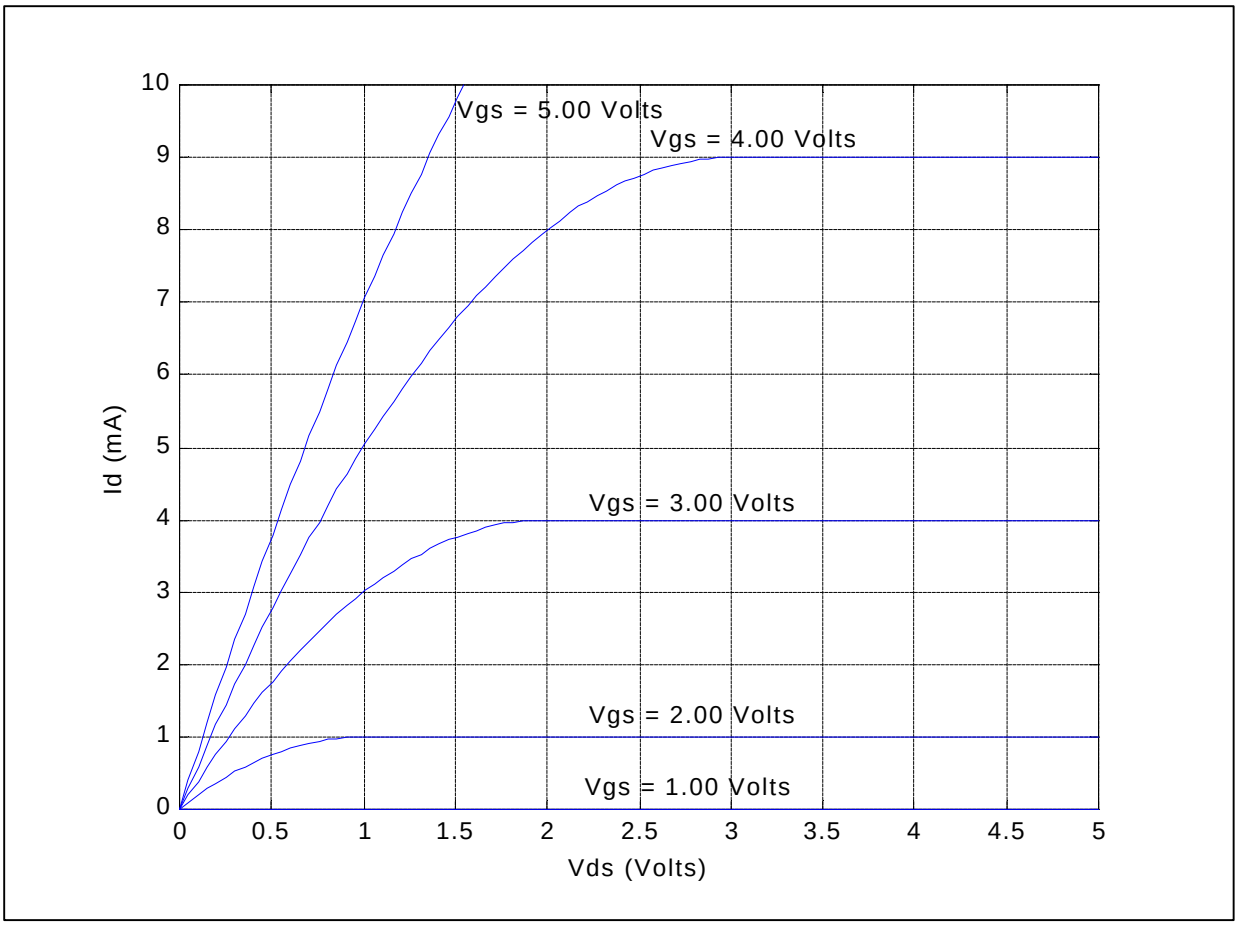
The characteristic of the n-channel MOSFET in the circuit to the right is shown in the figure at the bottom of the page. K_N = 1 mA/V^2, V_{TN} = 1V.



A. (15 pts) Find R_1, R_2, and R_D such that the transistor is in saturation, I_D = 4 mA and $I_1 = 0.01\ I_D$.

   Show all your wok on the following page and clearly identify your answers.

B. (5 pts) Plot the load line for R_D on the graph below and identify the Q-point.



Show your work for Part A here: