ECE-255
Exam 2
March 12, 2015

Name: _____
(Please print clearly)

Student ID: _____

INSTRUCTIONS

1) This is a closed book, closed notes exam.

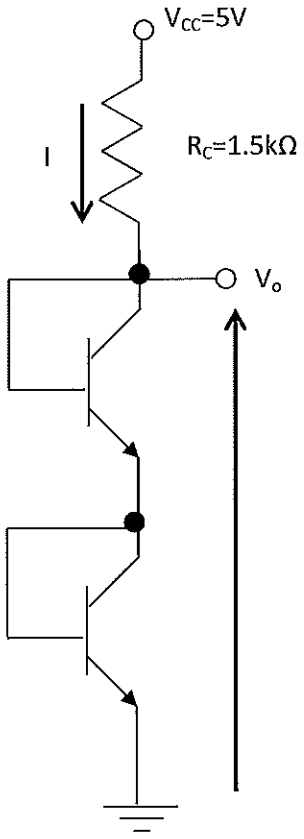
2) Clearly mark your multiple choice answers in the test booklet.

3) 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.

4) 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.

5) 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) For the circuit shown below what are the values of I and V_o? Assume $V_{BE(on)}=0.7\ V$ and $\beta=\infty$



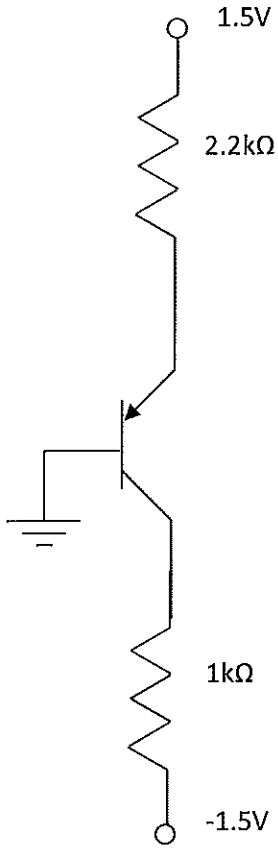
1) Vo=5V, I=2.4mA
2) **Vo=1.4V, I=2.4mA**
3) Vo=1.4V, I=2.87mA
4) Vo=0.7V, I=2.4mA
5) Vo=1.4V, I=3.3mA
6) None of the above

$V_o = 2V_{BE(ON)} = 1.4\ V$

$I = \frac{5-1.4}{1.5} = 2.4\ mA$

2) For the bipolar circuit shown below, what is the value of V_{EC}? Assume $\beta=50$ and $V_{EB}(on)=0.7$

1) V_{EC}=3V
2) V_{EC}=0.2V
3) **V_{EC}=1.8V**
4) V_{EC}=0.7V
5) V_{EC}=2.2V
6) None of the above



$$I_E = \frac{1.5 - 0.7}{2.2} = 0.364 \text{ mA}$$

$$I_C = \alpha I_E = \frac{50}{51} \times 0.364$$

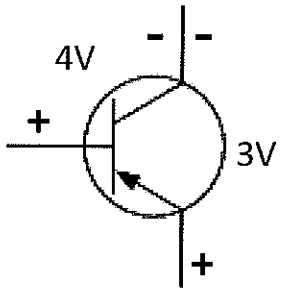
$$I_C \approx 0.357$$

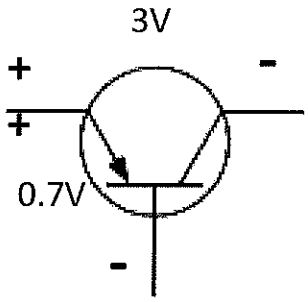
$$V_{EC} = 3 - 2.2 I_E - 1 I_C$$

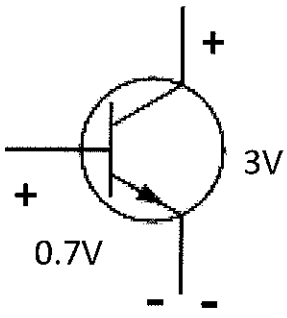
$$V_{EC} = 3 - 2.2(0.364) - 1(0.357)$$

$$V_{EC} = 1.8 \text{ V}$$

3) For each of the three transistors shown below, identify the region of operation from the list of possible answers given below.

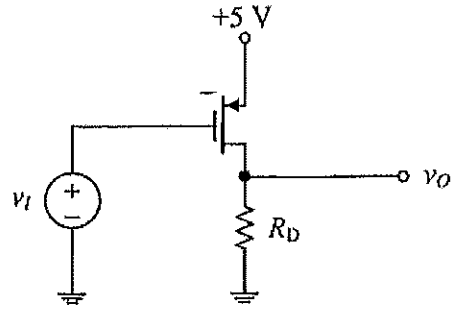






1) Forward Active;	Saturation;	Reverse Active
2) **Cut-off;**	**Forward Active;**	**Forward Active**
3) Cut-off;	Reverse Active;	Forward Active
4) Saturation;	Forward Active;	Saturation
5) Saturation;	Reverse Active;	Reverse Active
6) None of the above		

4) For the MOSFET shown below, if the input voltage is v_I =0V and R_D =125Ω, find the output voltage, v_o.



MOSFET Parameters:

$K_p = 0.25\ \text{mA/V}^2$
$V_{TP} = -1\ \text{V}$
$\lambda = 0\ \text{V}^{-1}$

(1) 0V **(2) 0.25V** (3) 0.50V
(4) 1V (5) 5V (6) None of the above

$V_{SG} = 5 - 0 = 5$ $|V_{SG}| > |V_{tp}|$ Transistor is on

$I_D = \frac{K_p}{2}(V_{SG} - |V_{tp}|)^2$

$I_D = \frac{0.25}{2}(5-1)^2 = 2\ \text{mA}$

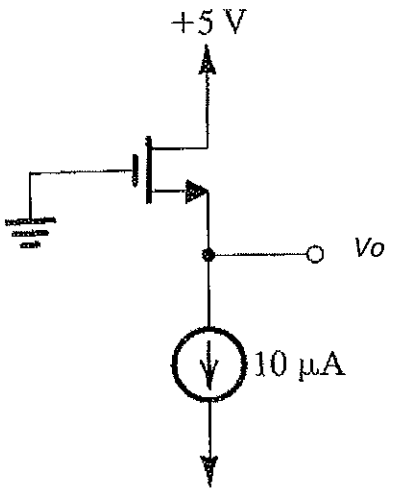
$V_o = R_D I_D = 125 \times 2 \times 10^{-3} = 0.25\ \text{V}$

$V_{SD} > V_{SG} - |V_{tp}|$

$5 - 0.25 > 5 - 1$

$4.75 > 4$ ✓

5) For the MOS circuit shown below what is the value of V_o? Assume V_{tn}=0.8 V, k_n=0.5 mA/V^2, and λ=0



(1) V_o=0.6V (2) V_o=5V (3) V_o=-0.6V

(4) V_o=1V **(5) V_o=-1V** (6) None of the above

$I_D = 10\ \mu A$

$I_D = \frac{k_n}{2}(V_{GS} - V_t)^2$

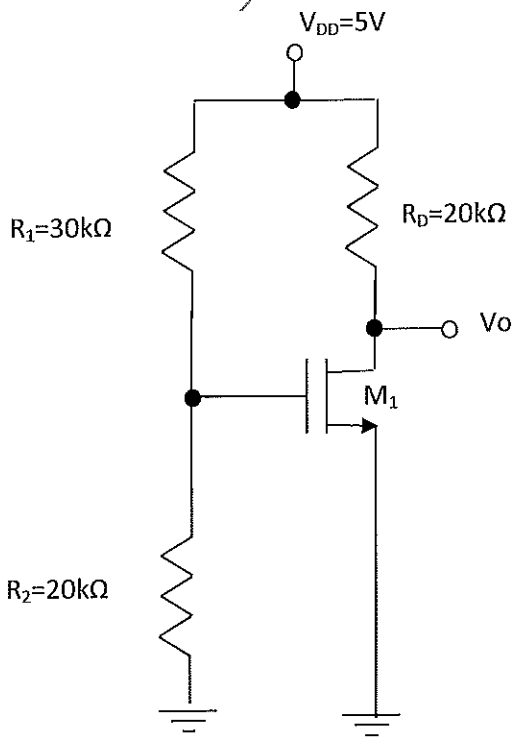
$10 \times 10^{-6} = \frac{0.5 \times 10^{-3}}{2}(V_{GS} - 0.8)^2$

$V_{GS} - 0.8 = \pm 0.2$

$V_{GS} = 1$

$V_G = 0 \Rightarrow V_o = V_S = -1\ V$

6) For the MOS circuit shown below, V_o=? λ=0, V_{TN}=1V, K_N=0.2 mA/V^2



(1) 4V (2) 2.5V (3) 2V

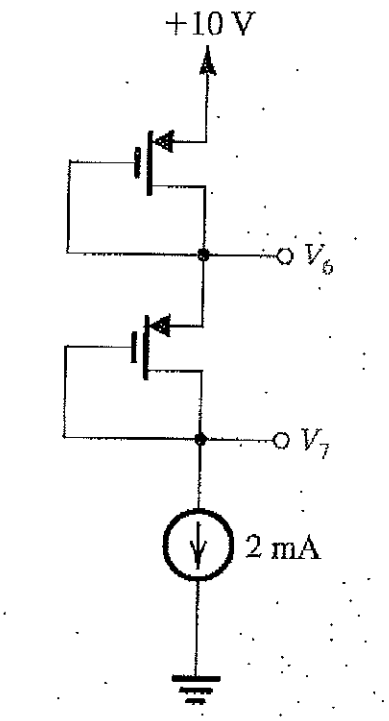
(4) 3.5V **(5) 3V** (6) None of the above

$$V_G = 5\ \frac{20}{20+30} = 5\ \frac{2}{5} = 2\ V$$

$$V_{GS} = 2\ V \qquad I_D = \frac{0.2}{2}(2-1)^2 = 0.1\ mA$$

$$V_o = 5 - 20(0.1) = 3\ V$$

7) For the circuit shown below what is the value of V_6? $|V_{Tp}|=2\ V$, $k_p=1\ mA/V^2$, and $\lambda=0$.



(1) V_6=4V (2) V_6=10V (3) V_6=0V

(4) **V_6=6V** (5) V_6=2V (6) None of the above

$I_D = 2\ mA$ $\quad V_{SG6} = ?$

$$I_D = \frac{k_p}{2}(V_{SG6} - |V_{tp}|)^2$$

$$2 = \frac{1}{2}(V_{SG6} - 2)^2$$

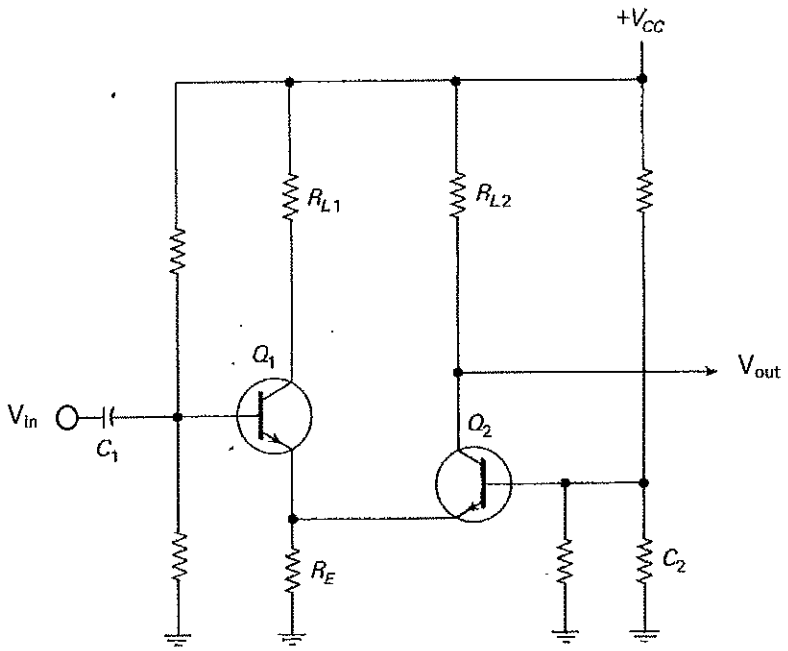
$$(V_{SG} - 2)^2 = 4 \Rightarrow V_{SG} - 2 = \pm 2$$

$V_{SG} =$ 0 → Not acceptable; 4

$V_S - V_G = 4 \Rightarrow 10 - V_G = 4$

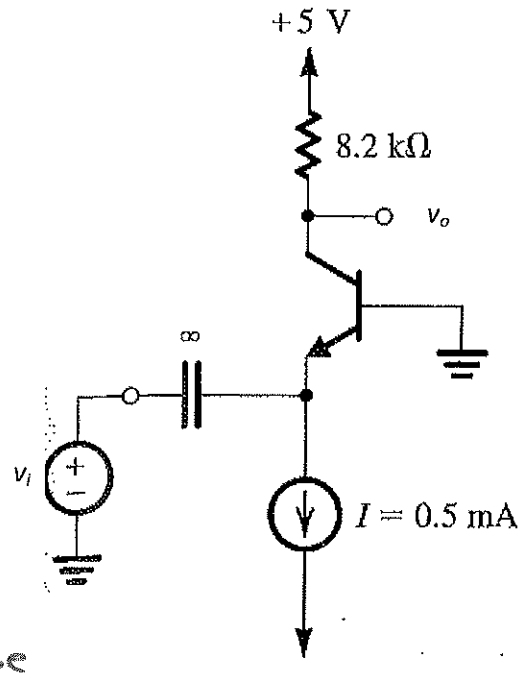
$V_G = V_6 = 6$

8) What is the configuration of the two stage BJT amplifier shown below?



1) CB-CB
2) **CC-CB**
3) CC-CE
4) CE-CC
5) None of the above

9) For the BJT amplifier shown below what is the small signal voltage gain v_o/v_i? Assume $\beta=\infty$, $V_A=\infty$, and $V_T=25mV$



Common Base

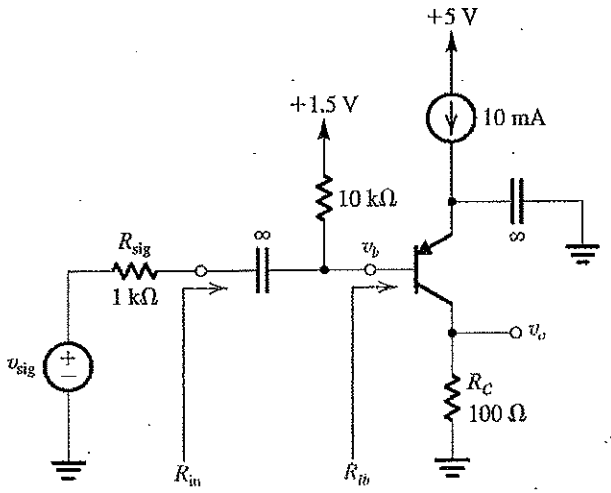
$$A_v = \frac{v_o}{v_i} = g_m R_L$$

(1) **Av=164**
(2) A_V=1
(3) Av=82
(4) A_V=328
(5) A_V=0.5
(6) None of the above

$I_C = I_E = 0.5$ mA $\quad g_m = \frac{I_C}{V_T} = \frac{0.5}{25} = 0.02 \frac{A}{V}$

$A_v = g_m R_L = 0.02 \times 8.2 \times 10^3 = 164$

10) For the amplifier shown below what is the input impedance looking into the base (R_{ib})? Assume β=200 and V_T=25mV.



(1) R_{ib}=100Ω (2) R_{ib}=∞ **(3) R_{ib}=500Ω**

(4) R_{ib}=20kΩ (5) R_{ib}=2.5Ω (6) None of the above

Common emitter

$R_{ib} = r_\pi$

$I_E = 10\ mA$

$I_C = \frac{\beta}{\beta+1} I_E = \frac{200}{201} I_E \simeq 10\ mA$

$g_m = \frac{I_C}{V_t} = \frac{10}{25} = 0.4\ \frac{A}{V}$

$r_\pi = \beta / g_m = \frac{200}{0.4} = 500\ \Omega$