

Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

*Do NOT begin until told to do so*  
*Make sure that you have all pages before starting*  
*You may not leave the room during the exam*  
*No calculators, open book, open notes*

## ACADEMIC INTEGRITY:

Students have the responsibility to know and observe the requirements of The UNCC Code of Student Academic Integrity (1997-99 Catalog page 336). This code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials, and complicity in academic dishonesty.

Useful constants, etc:

$$\begin{array}{cccc}
 e \approx 2.72 & \pi \approx 3.14 & 1/e \approx 0.37 & \sqrt{2} \approx 1.41 \\
 \sqrt{3} \approx 1.73 & \sqrt{5} \approx 2.22 & \sqrt{7} \approx 2.64 & \sqrt{10} \approx 3.16 \\
 \ln[2] \approx 0.69 & \ln[4] \approx 1.38 & \ln[55] \approx 4.0 & \ln[256] \approx 5.6 \\
 \log_{10}[2] \approx 0.30 & \log_{10}[3] \approx 0.48 & \log_{10}[55] \approx 4.0 & \log_{10}[10] \approx 1.0 \\
 \log_{10}[0.1] \approx -1.0 & \log_{10}[0.5] \approx -0.3 & \log_{10}[e] \approx 0.43 & \cos(\pi/4) \approx 0.79
 \end{array} \tag{1}$$

$$\cos(A)\cos(B) = \frac{1}{2}\cos(A - B) + \frac{1}{2}\cos(A + B)$$

$$e^{j\theta} = \cos(\theta) + j\sin(\theta)$$

$$\cos^2(A) = \frac{1}{2} + \frac{1}{2}\cos(2A)$$

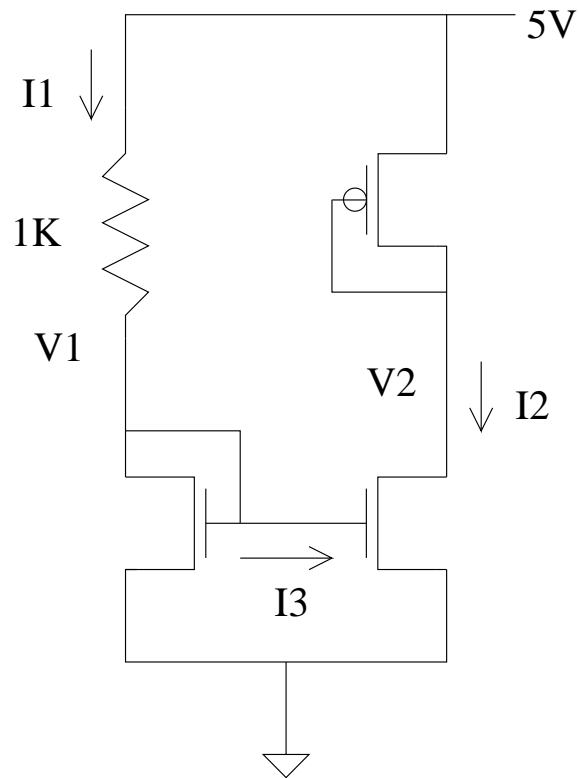
1. 25 points

For the following circuit, find the voltages  $V_1$ ,  $V_2$  and currents  $I_1$ ,  $I_2$ ,  $I_3$ .

Label the values directly on the schematic.

NMOS devices:  $K_p = 0.1A/V^2$ ,  $V_t = 1V$ ,  $W/L = 1$ ,  $\lambda = 0$

PMOS devices:  $K_p = 0.1A/V^2$ ,  $V_t = -1V$ ,  $W/L = 1$ ,  $\lambda = 0$



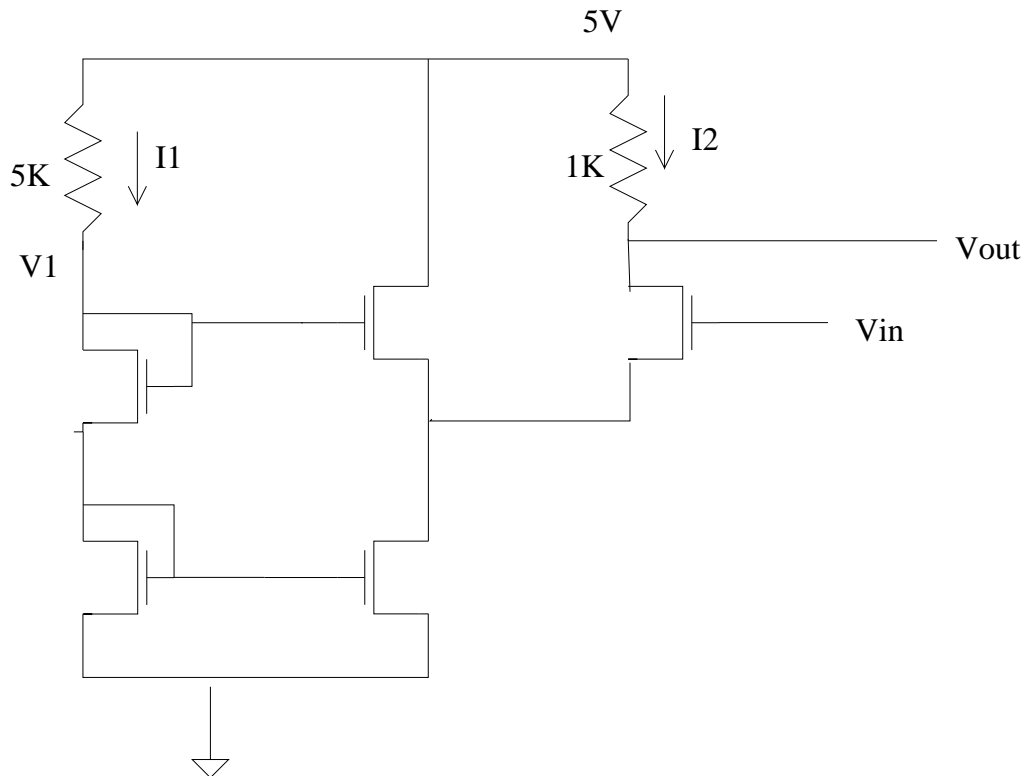
2. 30 points

For the following circuit, (ignore body effect)

- find  $V_1$  and  $I_1$
- Find the DC voltage that must be at  $V_{in}$  for  $I_2=I_1/2$
- If  $I_2=I_1/2$ , find the DC voltage at  $V_{out}$
- If  $I_2=I_1/2$ , find the small-signal voltage gain  $V_{out}/V_{in}$ .

Label the values directly on the schematic.

NMOS devices:  $K_p = 0.1A/V^2$ ,  $V_t = 1V$ ,  $W/L = 1$ ,  $\lambda = 0$   
PMOS devices:  $K_p = 0.1A/V^2$ ,  $V_t = -1V$ ,  $W/L = 1$ ,  $\lambda = 0$



3. 25 points

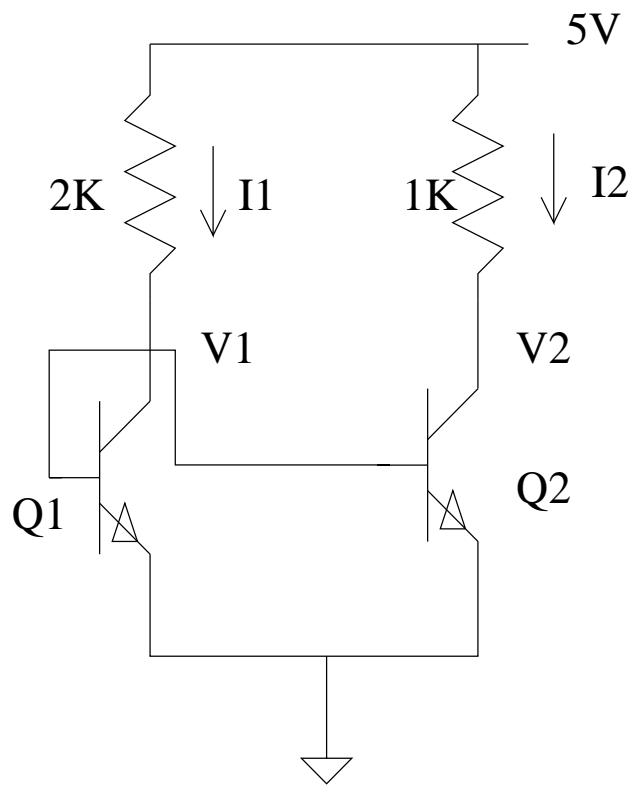
For the following circuit,

a) find  $V_1$ ,  $V_2$  and  $I_1$ ,  $I_2$

b) Is  $Q_2$  in saturation?

Label the values directly on the schematic.

BJT devices:  $\beta = 100$ ,  $I_s = 10^{-15} \text{ A}$ ,  $V_A = \infty$



4. 10 points

An NMOS device is characterized to have a gate-source capacitance  $C_{gs} = 1pF$ , drain-source capacitance  $C_{ds} = 1pF$ , and transconductance  $g_m = 10$ . Find the cutoff frequency  $\omega_T$  in radian/second.

5. 10 points

A BJT device is characterized to have a base-emitter capacitance  $C_\pi = 1pF$  and collector-base capacitance  $C_\mu = 1pF$  at a current of 25 mA. Find the cutoff frequency  $\omega_T$  in radian/second.