Student Name: **Instructor: Mustafa Altun**

Student ID:

Date: 11/01/2013

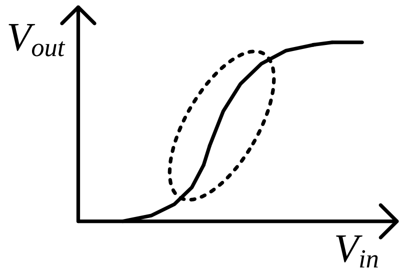
EHB262E Electronics II, Fall 2012
FINAL

Duration: 120 Minutes
Grading: 1) 30% (6% each), 2) %30, 3) 40% (25%+15%)
Exam is in closed-notes and closed-books format
For your answers please use the space provided in the exam sheet
GOOD LUCK!

1) Please circle TRUE if you think that the statement is true; FALSE otherwise.

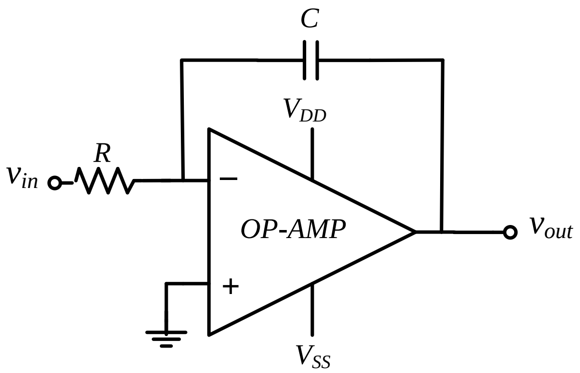
a. The characteristic curve of an **analog** amplifier is shown below. The region circled by the dashed line is where the amplifier operates properly.

TRUE / FALSE



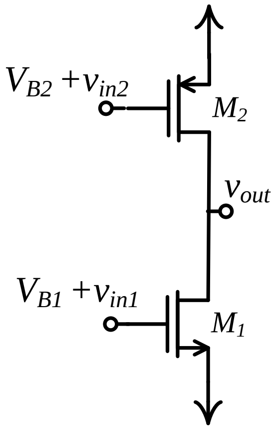
b. For the circuit shown below, $v_{out} = -RC\frac{dv_{in}}{dt}$.

TRUE / FALSE



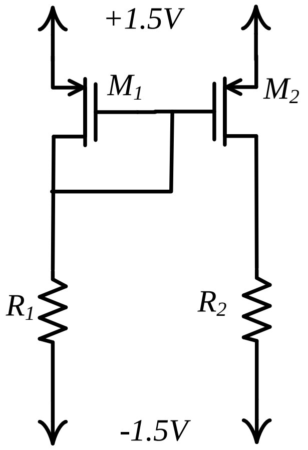
c. For the amplifier shown below, $\frac{v_{out}}{v_{in1}+v_{in2}} = -\frac{r_{o1} // r_{o2}}{g_{m1} \cdot g_{m2}}$ (Suppose that the transistors are in **saturation**).

TRUE / FALSE



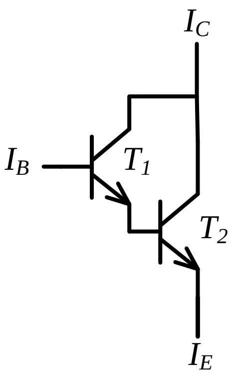
d. Consider a circuit shown below where I_{D1} = *1mA* and R_1=*2k*Ω. Suppose that M_1 and M_2 are identical transistors. If R_2 is *3k*Ω then M_2 operates in **triode** (linear) region.

TRUE / FALSE



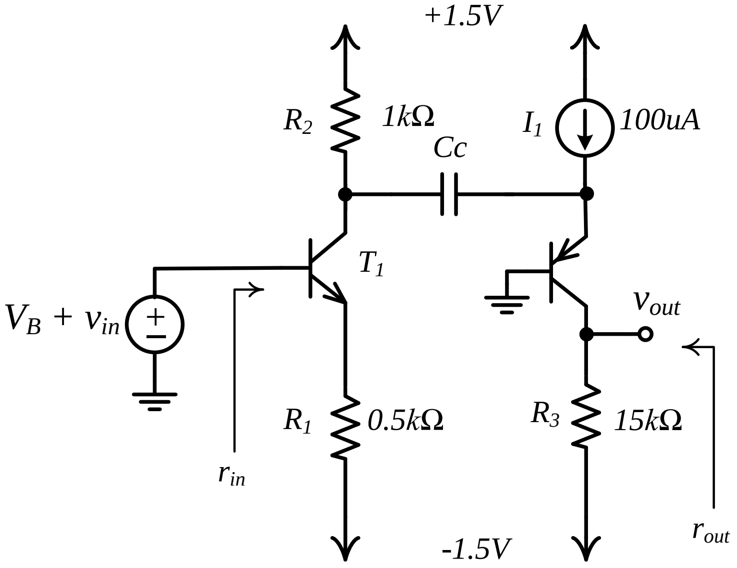
e. For the Darlington pair shown below, $\frac{I_C}{I_B} = \beta_1 + \beta_2$.

TRUE / FALSE



2) Consider a two-stage amplifier shown below where $\boldsymbol{V_B = -0.4V}$. Suppose that the value of *Cc* is high enough, so it can be considered shorted in small signal analysis. Find the small signal values of $\boldsymbol{r_{in}}$, $\boldsymbol{r_{out}}$, and $\boldsymbol{v_{out}/v_{in}}$.

NPN Transistor parameters: $V_{BE} = 0.7$, $\beta = 100$, $V_A = 100V$, $V_T = 25\ mV$.
PNP Transistor parameters: $|V_{BE}| = 0.7$, $\beta = 50$, $|V_A| = 10V$, $V_T = 25\ mV$.

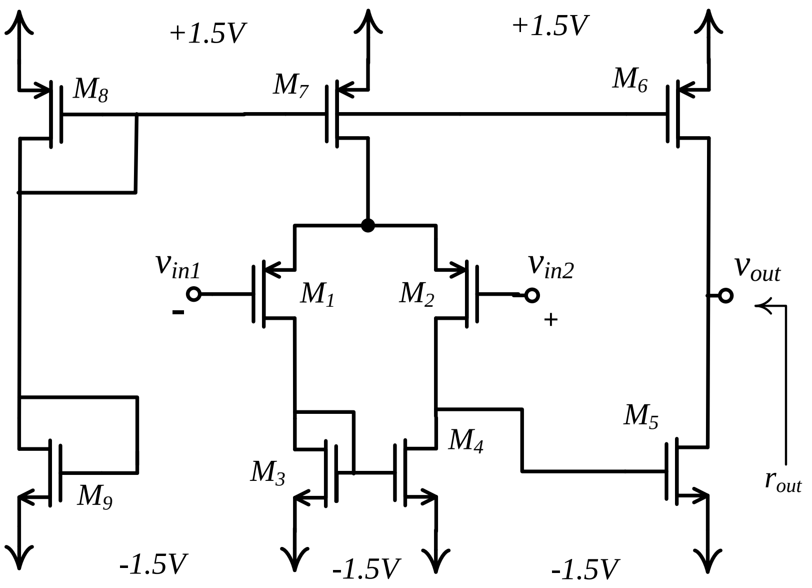


Two-stage Amplifier.

3) Consider an operational amplifier shown below. Suppose that input and output DC values are all zero. In DC analysis, use the following equation:

$$I_D = \frac{1}{2} k'_{p,n} \frac{W}{L} (V_{GS} - V_{T0\,p,n})^2 .$$

Transistor parameters: $k_n' = \mu_n c_{ox}$=100uA/V^2, $k_p' = \mu_p c_{ox}$=50uA/V^2, V_{An}= 25V, $|V_{Ap}|$=25V, $V_{T0,n}$=1V, $|V_{T0,p}|$=0.5V.

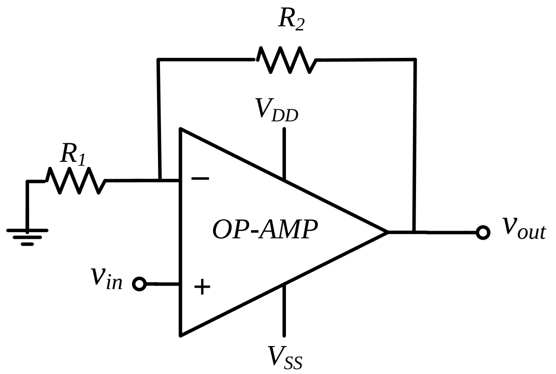


Transistor	L (μm)	W (μm)
M_1	1	32
M_2	1	32
M_3	1	16
M_4	1	16
M_5	1	16
M_6	1	8
M_7	1	16
M_8	1	16
M_9	1	2

Operational Amplifier (OP-AMP).

a. Find the small signal values of the differential gain $\boldsymbol{v_{out}/(v_{in2}-v_{in1})}$, the common-mode gain $\boldsymbol{v_{out}/v_{in}}$ (where $v_{in}= v_{in2} = v_{in1}$), and the output resistance $\boldsymbol{r_{out}}$ of the amplifier. Also determine the **CMRR.**

b. Consider a non-inverting amplifier shown below where R_1=R_2=50Ω. If you use an **ideal** OP-AMP then what is $\boldsymbol{v_{out}/v_{in}}$? If you use the OP-AMP shown above (use the results in **a.**) then what is $\boldsymbol{v_{out}/v_{in}}$? Justify your answer.



Non-inverting Amplifier