IMPORTANT: Besides your calculator (cell phones are not allowed, any attempt to use cell phones will be strictly penalized) and the sheets you use for calculations you are only allowed to have an A4 sized "copy sheet" during this exam. Notes, problems and alike are not permitted. Please submit your "copy sheet" along with your solutions. You may get your "copy sheet" back after your solutions have been graded. *Do not forget to write down units and convert units carefully!*

ELE222E INTRODUCTION TO ELECTRONICS

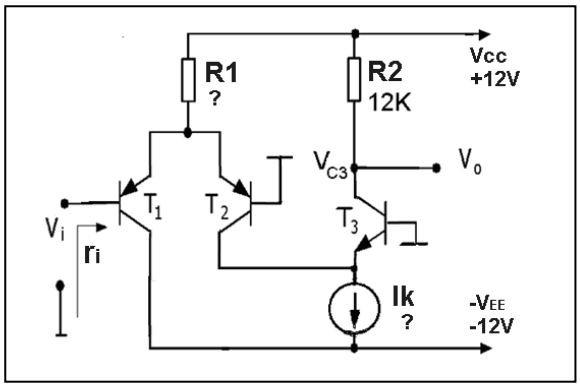
Final Exam 25 May 2011 9.00-11.00

Zümray DOKUR ÖLMEZ, Metin YAZGI, Bülent YAĞCI, Rıza Can TARCAN, Türker KÜYEL, İnci ÇİLESİZ

Student number and name:_____

Mandatory Problem (30 points):

The two BJTs T_1 and T_2 shown in the figure are identical. Their parameters are $h_{FE}= \beta_F = 250$, $|V_{BE}| = 0{,}6$ V, $V_{CEsat}=0{,}2$ V, $V_T = 25$ mV and $V_A = \infty$.



a) The design requires $V_{C3}=6$ V for $V_i = 0$V, and $v_o/v_i = 100$. Find the resistor value for R_1 and the current I_k.(15 points) Note: R_1 is much larger than r_{e1} and r_{e2}.

b) Taking into account the saturation and cutoff conditions for T_3 , find the variance of output voltage (V_o) and the corresponding variance of the input voltage (V_i) (15 points)

GOOD LUCK!

Mandatory Problem (40 points):

(A) For the transistors shown below $h_{fe} = h_{FE} = 200$, $V_{BE} = 0{,}6V$, $V_{CESAT} = 0{,}2V$ and $V_T = 25mV$. You can assume $h_{re} \cong 0$ and $h_{oe} \cong 0$. All capacitors are ideal.

a) Find R_3, R_4 and R_5 for $I_C = 1mA$, $V_{CE} = 4V$ and $r_i = 10k\Omega$ (10 points)

b) Calculate v_o/v_i. (10 points).

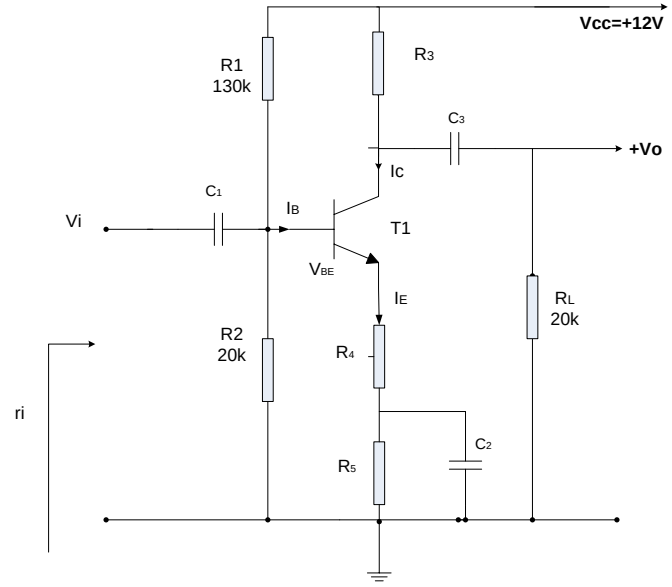


Figure-1

(a) R_3 =_____ R_4 =_____ R_5 =_____

(b) v_o/v_i =_____

(B) For the MOS shown below $V_T = 1V$, $V_A = 100V$ $0{,}5\mu_n C_{ox}(W/L) = 2mA/V^2$, and all capacitors are ideal.

a) Calculate biasing currents and voltages. (10 points)

b) Calculate input resistance r_i and v_o/v_i. (10 points)

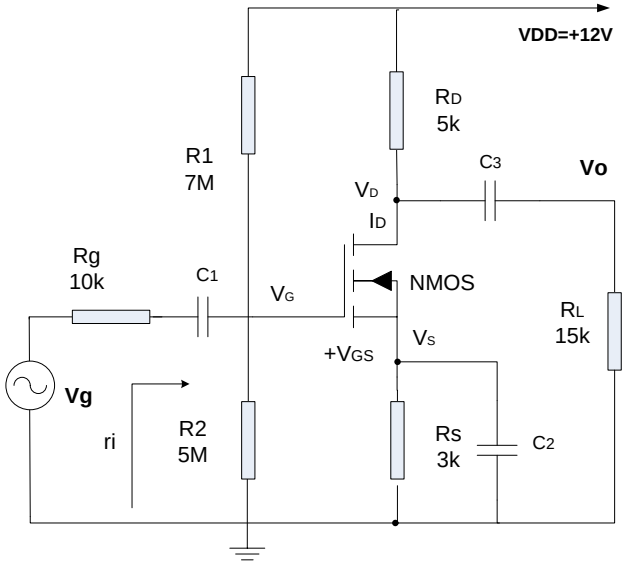


Figure-2

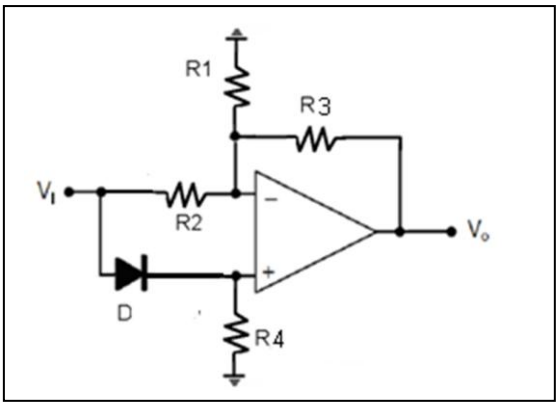
(a) V_G,=_____ V V_D,=_____ V
V_S,=_____ V V_{GS},=_____ V

I_D,=_____ mA

(b) r_i,=_____ v_o/v_i =_____

GOOD LUCK!

Elective Problem (30 points): The OPAMP and the diode shown in the figure have ideal properties. The OPAMP saturation voltages at the output are V_O^+=5 V and V_O^-= −5 V.

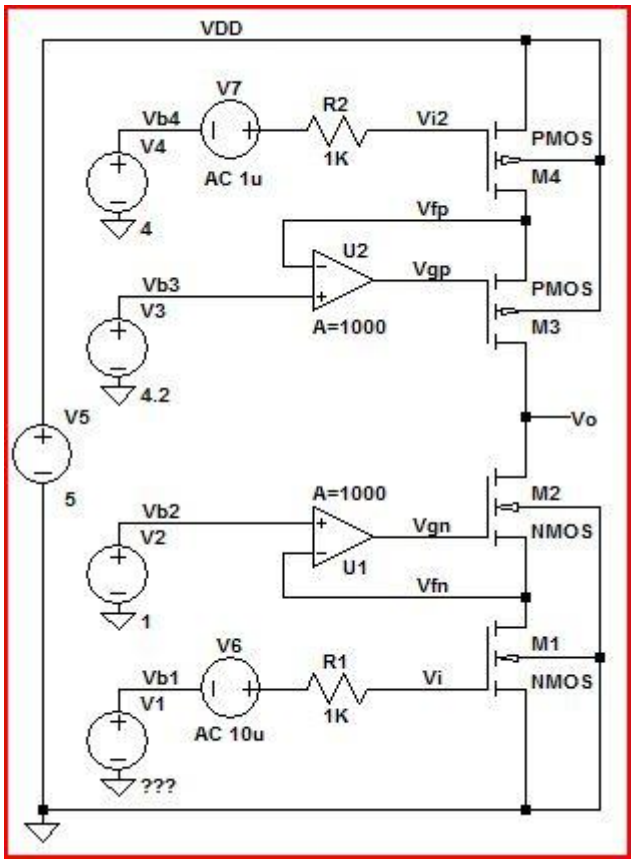


a) Find the gain of the circuit for both V_i>0 and V_i<0 .
(15 points)

b) Find R_2 and R_3 for V_O = 2|V_i| (R_1=R_4=10k). For which values of V_i is V_O= 2|V_i| valid?(15 points)

GOOD LUCK!

Elective Problem (30 points): The circuit below is used for high gain.



Transistors are all enhancement mode MOS transistors,

all MOS transistors operate in **SAT**,

V_{tp} = -0,8V for PMOS, V_{tn} = 0,7V for NMOS,

all transistors have $0.5\mu C_{ox}W/L = 500e-6$ Amp/V^2,

and channel length modulation parameter $\lambda = \frac{1}{V_A}$ is 5 V^{-1}.

a) Notice that V4 sets the Id. Find I_D's for (4 points)
M1, M2, M3, and M4. (Ignore λ for this part)
I_D M1 =_____ , I_D M2=_____, I_D M3=_____,
I_D M4 =_____

b) Compute DC values for V_{i2}, V_{fp}, V_{gp}, (12 points)
V_{gn}, V_{fn}. Make reasonable assumptions. What
should V1 be to match the bias current set by M4?
V_{i2} =_____, V_{fp}=_____, V_{gp}=_____, V_{gn}=_____
V_{fn}=_____ V1=_____

c) V_o = 2,5V is given. Show that all transistors
operate in SAT. What happens to M2 if Vo were 1V? (8 points)

d) Compute the gm and the output resistance (r_{ds}) of M1.
g_m =_____ r_{ds}=_____ (6 points)

Your answers must be accurate within 1-2%.

GOOD LUCK!