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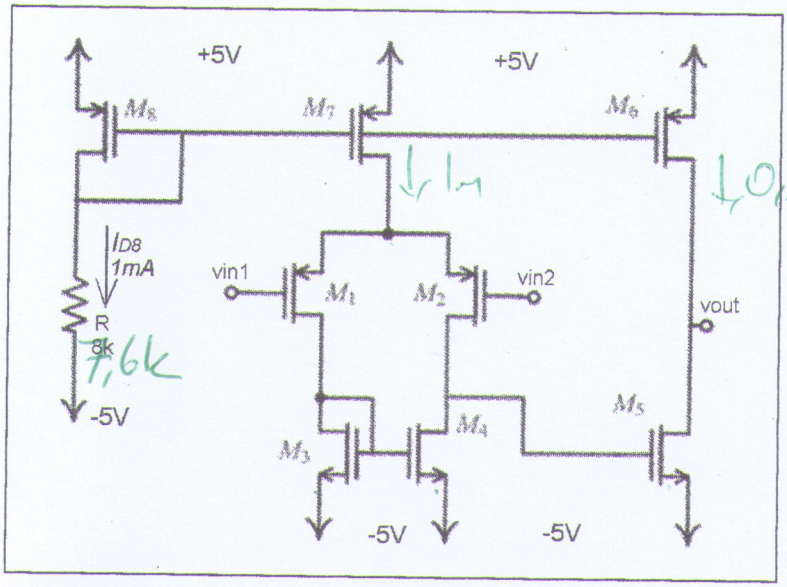
P1 For the transistors in the figure, $k_p'=\mu_p C_{ox}=40\mu A/V^2$, $k_n'=\mu_n C_{ox}=100\mu A/V^2$, $V_{An}=60V$, $V_{Ap}=40V$, $V_{Th,p}=-0.8V$, $V_{Th,n}=0.6V$ are given.
Vin1=Vin2=0 for DC case

	L(um)	W(um)
M1	0.7	17.5
M2	0.7	17.5
M3	0.7	7
M4	0.7	7
M5	0.7	7
M6	0.7	8.75
M7	0.7	17.5
M8	0.7	17.5



a) Find the differential gain of the circuit (vout/(vin1-vin2)).

$g_{m1}=g_{m2}=I_{m1}=g_{m3}=g_{m4}=g_{m5}$

$g_{m7}=g_{m8}=I_{m1}$ $g_{m6}=0,5mS$ $80k=r_{ds2}\neq r_{ds4}=120k$

$r_{ds6}=80k$

$r_{ds5}=120k$

$g_{m1}=\sqrt{2K_n I_{D5}}$

$\downarrow$

$\cong 1mS$

$\frac{v_{d4}}{v_{in1}-v_{in2}} = \underbrace{g_{m1}(r_{ds2}//r_{ds4})}_{48}.$

$\frac{v_{out}}{v_{gs5}} = -\underbrace{g_{m5}}\cdot\underbrace{(r_{ds6}//r_{ds5})}_{48}$

$g_{m5}=\sqrt{2K_p I_{D5}}$

$\downarrow$

$\cong 1mS$

$\frac{v_{out}}{v_{in1}-v_{in2}} = 1m\cdot 48k\cdot(1m\cdot 48k)$

$\downarrow$

$\cong -2300$

$g_{m3}=\sqrt{2K_n I_{D3}}$

$\downarrow$

$\cong 1mS$

b) Find the CMMR value.

$$CMRR = \left(\frac{g_m}{I_m}\left(\underbrace{r_{ds2}//r_{ds4}}_{48k}\right)\right)\left(\underbrace{2g_{m3}}_{2.1m}\cdot R_{ss}\right)$$

R_{ss}: $r_{ds7}\downarrow 40k$

$$= 48.80 \cong 3800$$

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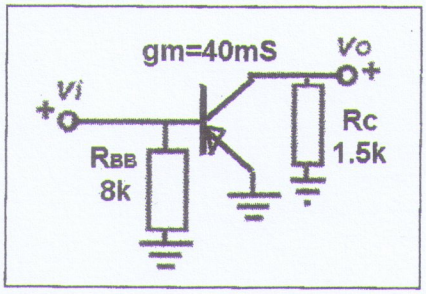
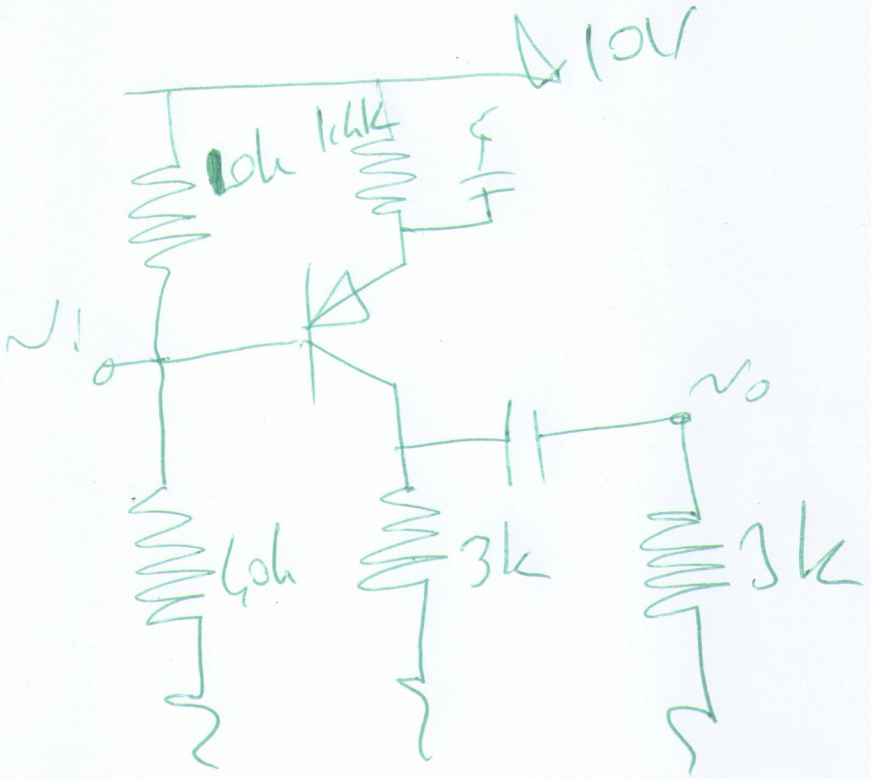
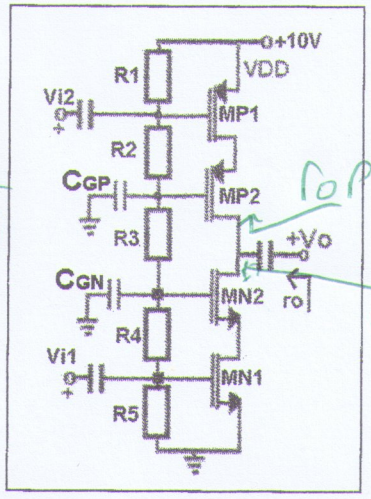
P2 The circuit, ac case of which is given in the figure has a DC source of 10V. β_F=100, $|V_{BE}|$=0.6V and V_A=∞ are given for the PNP transistor. In DC case V_{BQ}≈8V and V_{CQ}≈3V. In ac case, R_{BB}=8k, R_c=1.5kand g_m=40mS (V_T=25mV). The circuit has one PNP transistor, four bias-resistors, two capacitors and one load-resistor. Design and sketch the circuit.





P3 β=2mA/V², $|V_{TH}|$=1V and V_A=50V are given for the all transistors in the Figure. R1=R5=200k, R2=R4=250k, R3=100k.
Find vo in terms of vi1 and vi2.



$r_{op2} = r_{dsp} \cdot (1 + g_{mp2} r_{s2}) + r_{s2} \cong 5M\Omega$ $(r_{ON} = 5M)$

$V_{GS1} = \frac{R_5}{R_1+R_2+R_3+R_4+R_5} 10 = 2V$

$I_{DSAT} = I_{DN2} = I_{DP2} = I_{P1} = \frac{2m}{2}(2-1)^2 = 1mA$

$\frac{v_o}{v_{i2}} = \frac{v_{dp1}}{v_{gp1}} \cdot \frac{v_{dp2}}{v_{sp2}} \cong \frac{-g_{mp1} \cdot \frac{1}{g_{mp2}} \cdot g_{mp2}(r_{op} \| r_{o}}{1}$

$\frac{v_o}{v_{i1}} = \frac{v_{dn1}}{v_{gn1}} \cdot \frac{v_{dn2}}{v_{sn2}} \cong -g_{mn1} \cdot \frac{1}{g_{mn2}} \cdot g_{mn2}(r_{op} \| r_{on}$

$v_o = -5K(v_{i1} + v_{i2})$