May 20, 2009

INTRODUCTION TO ELECTRONICS

FINAL EXAM

1. In figure 1, T_1-T_2 are identical and $\beta_F=h_{FE}=h_{fe}=250$, $|V_{BE}|=0.6$ V, $V_T=26$ mV is given.

a) Calculate $R_1=R_2$ and R_6 so that $R_i=125$ kΩ and $V_I=0$ when $V_O=0$ (Assume $R_6>>r_{e2}$). **(12.5 p)**
b) Calculate the gain $K_V=v_o/v_i$ and the CMRR for the differential amplifier. **(12.5 p)**

2. In figure 2, for the BJT; $\beta_F=h_{FE}=h_{fe}=100$, $V_{BE}=0.6$ V, $V_A\rightarrow\infty$, $V_T=26$ mV, for the MOSFET; $\beta_n=k_n=\mu_nC_{ox}\cdot(W/L)=4$ mA/V², $V_{TH}=1$ V, $\lambda=0$ is assumed.

a) Calculate R_C, R_E, R_S so that the operation point of the BJT is $I_C=2$ mA, $V_C=6$ V, and $I_D=2$ mA for the MOSFET. **(12.5 p)**
b) Calculate the input resistance R_i and the voltage gain v_o/v_g. **(12.5 p)**

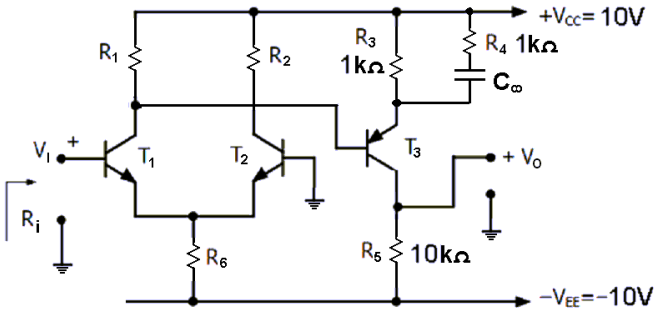

Figure 1

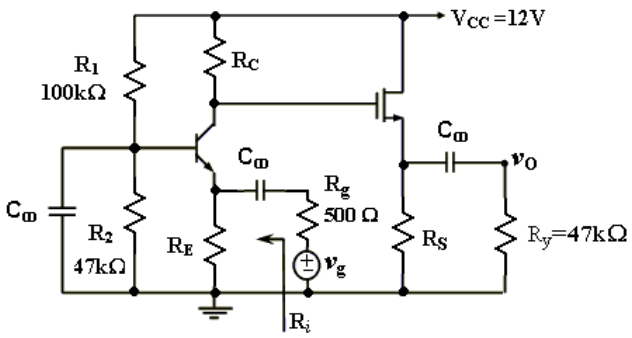

Figure 2

3. In figure 3, the operational amplifier is assumed ideal and the operational amplifier output voltage saturates at $V_O^+=5$ V and $V_O^-=-5$ V. $V_{TH}=1$ V, $\beta_n=k_n=\mu_nC_{ox}\cdot(W/L)=500$ μA/V² and $\lambda=0$ is given for the MOSFET.

a) Express the voltage v_o in terms of v_{I1}, v_{I2}, i_D and the resistors. **(12.5 p)**
b) Assuming $R_1=R_2=R_F=1$ kΩ, find the voltage v_O for the following conditions: **(12.5 p)**
i) $v_{I1}=1.5$ V, $v_{I2}=1$ V, $v_{I3}=0.5$ V
ii) $v_{I1}=0.5$ V, $v_{I2}=3.5$ V, $v_{I3}=2$ V
iii) $v_{I1}=-1$ V, $v_{I2}=1.5$ V, $v_{I3}=2.5$ V

4. In figure 4, assume the constant voltage drop model ($V_D=0.7$ V) for the diodes.

a) Calculate I_{D1} and V_O for $R_1=5$ kΩ, $R_2=10$ kΩ. **(12.5 p)**
b) Calculate I_{D1} and V_O for $R_1=10$ kΩ, $R_2=5$ kΩ. **(12.5 p)**

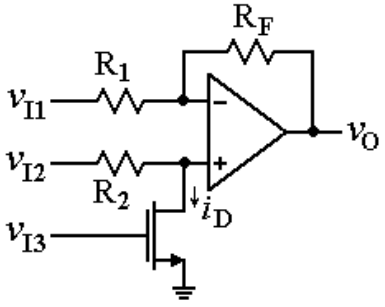

Figure 3

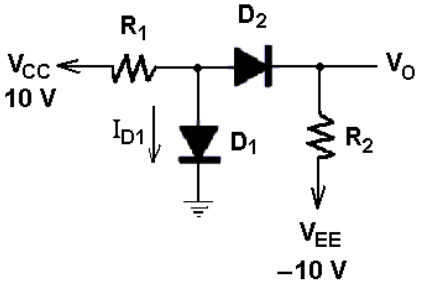

Figure 4