Due: 13 November 2019 @8:40 am – **No late homework will be accepted.**

1) Consider the BiCMOS follower circuit shown in Figure 1a. The BJT transistor parameters are $V_{BE,on} = 0.75V$, $V_{CE,sat} = 0.25V$, $V_A = \infty$, and the depletion mode n-MOSFET parameters are $V_{TH} = -1.7V$, $k_n = 15mA/V^2$, $\lambda = 0$ (You can treat depletion mode MOSFETS as regular MOSFETS).

   a. Determine the maximum and minimum values of output voltage and the corresponding input voltages for the circuit to operate in the linear region (i.e. Class-A operation) for (a) $R_L = \infty$ and (b) $R_L = 400\Omega$.

   b. What is the smallest value of R_L possible if a 2.5 V peak sine wave is produced at the output?

   c. What is the corresponding power conversion efficiency?

2) Consider the class-AB output stage in Figure 1b. The diodes and transistors are matched, with parameters $I_S = 7 \times 10^{-12}A$, and $\beta = 50$.

   a. Determine R_1 such that the minimum current in the diodes is 24 mA when $V_O = 25V$. Find i_N and i_P for this condition.

   b. Using the results of part (a), determine the diode and transistor currents when $V_O = 0$.

3) Consider the class-AB MOSFET output stage shown in Figure 2a. The circuit parameters are $I_{Bias} = 0.25mA$, $R_L = 1.2k\Omega$. The transistor parameters are $V_{TH,n} = 0.75V$, $k'_n = 120\mu A/V^2$, $V_{TH,p} = -0.75V$, $k'_p = 50\mu A/V^2$. For the quiescent condition, assume $V_{GS,3} = V_{SG,4}$ and $V_{GS,1} = V_{GS,2}$. Assume $\lambda = 0$ for all transistors.

   a. If $V_i = -1.6V$, $V_O = 0V$, and $i_{D1} = i_{D2} = 0.4mA$, determine the W/L ratio of each transistor.

   b. Assuming a voltage drop across I_{Bias} of 0.25 V and no voltage drop across V_i, find the maximum and minimum limits of V_O.

4) Using SPICE, plot the input/output characteristic of the circuit shown in Figure 2b for $-2.3 V < V_{in} < +2.3$ V. Also, plot the output waveform for an input sinusoid having a peak amplitude of 2.3 V. How are these results changed if the load resistance is raised to 20 Ω? Use 2N2222 npn transistor in LTSpice.
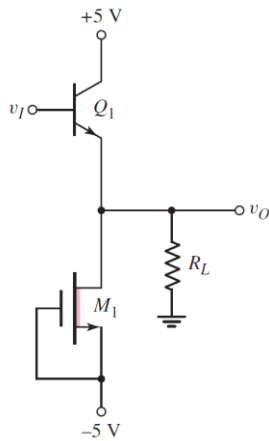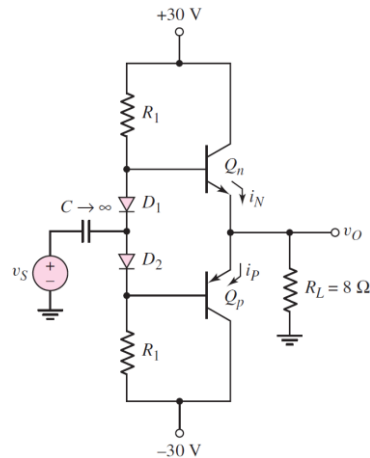

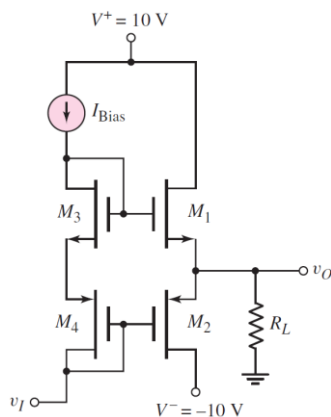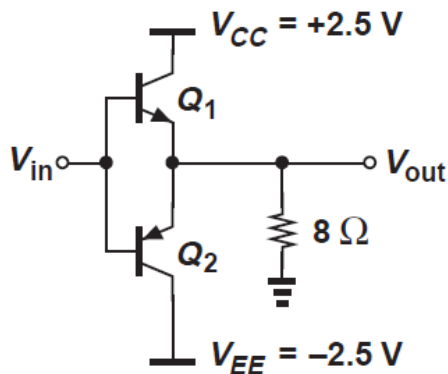Fig 1a. Figure of Question 1

Fig 1b. Figure of Question 2

Fig 2a. Figure of Question 3

Fig 2b. Figure of Question 4