

Due: 14 November 2018 @9:00 am – **No late homework will be accepted.**

- 1) Consider the BiCMOS follower circuit shown in Figure 1a. The BJT transistor parameters are $V_{BE,on} = 0.7V$, $V_{CE,sat} = 0.2V$, $V_A = \infty$, and the depletion mode n-MOSFET parameters are $V_{TH} = -1.8V$, $k_n = 12mA/V^2$, $\lambda = 0$ (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) $R_L = 500\Omega$.
 - b. What is the smallest value of R_L possible if a 2 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 $I_S = 6 \times 10^{-12}A$, and $\beta = 40$.
 - a. Determine R_1 such that the minimum current in the diodes is 25 mA when $V_O = 24V$. 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 $I_{Bias} = 0.2mA$, $R_L = 1k\Omega$. The transistor parameters are $V_{TH,n} = 0.8V$, $k_n = 100\mu A/V^2$, $V_{TH,p} = -0.8V$, $k_p = 40\mu A/V^2$. 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 $V_i = -1.5V$, $V_O = 0V$, and $i_{D1} = i_{D2} = 0.5mA$, determine the W/L ratio of each transistor.
 - b. Assuming a voltage drop across I_{Bias} of 0.2 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 $-2V < V_{in} < +2V$. Also, plot the output waveform for an input sinusoid having a peak amplitude of 2 V. How are these results changed if the load resistance is raised to 16Ω ? Use 2N2222 npn transistor in LTSpice.

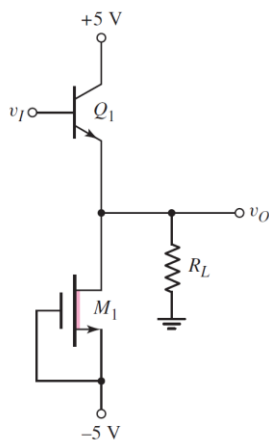


Fig 1a. Figure of Question 1

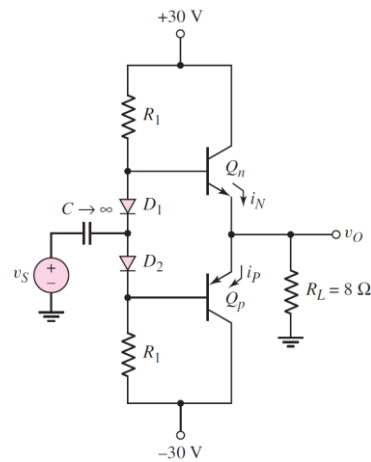


Fig 1b. Figure of Question 2

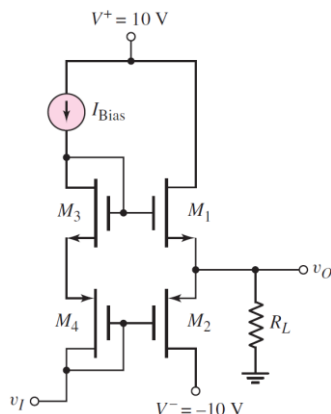


Fig 2a. Figure of Question 3

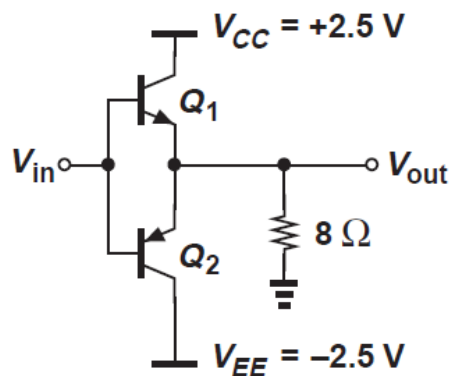


Fig 2b. Figure of Question 4