ECEN4827/5827 Problem DC.1: Operating modes and DC solution

For the CMOS and BiCMOS circuits shown in Figs. a,b,c,d,e,f determine (by hand) operating modes (cut-off, triode or active/saturation for MOSFETs; cut-off, saturation or active for BJTs) for all transistors. Find all labeled DC voltages and currents, verify the assumptions you made, and show all work.

To obtain credit, attach copies of the pages with the circuit diagrams, and label your final answers (device operating modes, currents and voltages) on these pages. No credit will be given for solutions obtained by simulation.

All MOS devices have the same parameters:
- NMOS transistors: $\mu_n C_{ox} = 40 \mu A/V^2$, $V_{th} = 0.7$ V, $\lambda \approx 0$, $\gamma \approx 0$.
- PMOS transistors: $\mu_p C_{ox} = 20 \mu A/V^2$, $V_{th} = -0.7$ V, $\lambda \approx 0$, $\gamma \approx 0$.

Transistor aspect ratios W/L are shown in the diagrams.

All bipolar transistors have the same parameters:
- $\beta >> 1$, $V_{BE} = 0.7$ V (when the base-to-emitter junction is forward biased), and $V_{CEsat} = 0.2$ V. Early effects can be neglected, $V_A \rightarrow \infty$.

The DC voltages $V_{DD}$, $V_{SS}$, and current sources $I$ can be considered ideal.