1. Derive $G_m$ and $R_n$ for the following circuits.

(a) ![Circuit Image]

(b) ![Circuit Image]

(c) ![Circuit Image]

(d) ![Circuit Image]

2. For the circuit below, assume $\beta = 100$ and $V_T = 25\, \text{mV}$.

(a) Find the DC collector currents of all transistors. Verify all your assumptions.

(b) Find the maximum unclipped output signal amplitude.

(c) Find the AC small-signal gain ($v_o/v_i$), the input resistance ($R_i$), and the output resistance ($R_o$) for $V_{A,npn} = V_{A,pnp} = \infty$.

(d) Repeat part (c) for $V_{A,npn} = 75\, \text{V}$ and $V_{A,pnp} = 20\, \text{V}$.

3. For the circuits below, assume $\beta = 100$, $V_T = 25\, \text{mV}$, and $V_A = \infty$.

(a) Find $R_C$ and $R_E$ to obtain the maximum symmetrical swing at the output ($v_o$) for $I_C = 1\, \text{mA}$. Calculate the maximum 0-to-peak voltage swing at $v_o$ and the corresponding gain $v_o/v_i$.

(b) Repeat part (a) for $I_C = 2\, \text{mA}$.