7.1

$$\frac{V_o}{V_i} = \frac{\alpha \times Total\ resistance\ in\ collectors}{Total\ resistance\ in\ emitters} = \frac{0.99 \times 25}{2r_e + 2 \times 0.25}$$

$$r_e = \frac{V_T}{I_E} = \frac{25\ mV}{0.1\ mA} = 250\ \Omega$$

$$\rightarrow \frac{V_o}{V_i} = \frac{0.99 \times 25}{2 \times 0.25 + 2 \times 0.25} = 25\ V/V$$

$$R_{in} = (\beta + 1)(2r_e + 2R_e) = 2 \times 101 \times (0.25 + 0.25) = 101\ k\Omega$$

7.2

a) Assuming $v_{id} = 0$ and the two sides of the differential amplifier are matched. Thus,

$$I_{D1} = I_{D2} = 0.5\ mA$$

$$I_{D1,2} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)V_{OV}^2 \quad \rightarrow \quad 0.5 = \frac{1}{2} \times 2.5 \times V_{OV}^2 \rightarrow V_{OV} = 0.632\ V$$

$$V_{CM} = V_{GS} + 1\ mA \times Rss = V_t + V_{OV} + 1 \times Rss = 0.7 + 0.632 + 1 = 2.332\ V$$

b) $g_m = \frac{2I_D}{V_{OV}} = \frac{2 \times 0.5}{0.632} = 1.58\ mA/V$

$$A_d = g_m R_D \quad \rightarrow \quad 8 = 1.38 \times R_D \rightarrow \quad R_D = 5.06\ k\Omega$$

c) $V_{D1} = V_{D2} = V_{DD} - I_D R_D = 5 - 0.5 \times 5.06 = 2.47\ V$