1) $I_c = I_E - I_B = 4mA - 20\mu A = 3.98\ mA$

$V_{cc} = V_{CE} + I_c R_c = 7.2V + (3.98mA) \cdot (2.2k\Omega) = 15.96V$

$\beta = \frac{I_c}{I_B} = \frac{3.98mA}{20\mu A} = 199$

$R_B = \frac{V_{RB}}{I_B} = \frac{V_{cc} - V_{BE}}{I_B} = \frac{15.96V - 0.7V}{20\mu A} = 765k\Omega$

2) $R_c = \frac{V_{cc} - V_c}{I_c} = \frac{12V - 7.6V}{2mA} = 2.2k\Omega$

$R_E = \frac{V_E}{I_E} = \frac{2.4V}{2mA} = 1.2k\Omega$

$R_B = \frac{V_{RB}}{I_B} = \frac{V_{cc} - V_{BE} - V_E}{\left(\frac{I_c}{\beta}\right)} = \frac{12V - 0.7V - 2.4V}{\left(\frac{2mA}{80}\right)} = 356k\Omega$

$V_{CE} = V_c - V_E = 7.6V - 2.4V = \underline{5.2V}$

$V_B = V_{BE} + V_E = 0.7V + 2.4V = \underline{3.1V}$

3) $I_c = \beta I_B = 100 \cdot 20\mu A = 2 \cdot 10^{-3} \cdot 10^{6} \cong \underline{2mA}$

$I_E = I_c + I_B = 2mA + 20\mu A = \underline{2.02\ mA}$

$V_E = 1.2 \cdot I_E = 1.2 \times 2.02 = \underline{2.424V}$

$V_{cc} - 2.7k \cdot I_c = \underline{10.6V}$

$V_{cc} = 2.7k \cdot 2mA + 10.6V \Rightarrow 5.4 + 10.6 = \underline{16V}$

$V_{CE} = V_c - V_E = 10.6 - 2.42 = \underline{8.176V}$

$V_B = -8.2k \cdot I_E = -8.2 \times (2.02mA) = -16.564V$

$I' = I_E - I_B = I_c = \underline{2mA}$

4) $V_{BE} = 0.7\,V$

$$-16 + 3.6(I_C + I_B) + 270 I_B + 1.2(I_C + I_B) = 0$$

$$I_C = \beta I_B = 120 I_B$$

$$-16 + 3.6(121 I_B) + 270 I_B + 1.2(121 I_B) = 0$$

$$850.8 I_B = 16 \qquad I_B = 18.8\,\mu A$$

$$I_C = 120 I_B = 2.256\,mA$$

5) $$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)} = \frac{30V - 0.7V}{(550\,k\Omega) + 180(8.2k\Omega + 1.8k\Omega)} = \frac{29.3}{(550\times10^3\,\Omega) + (10\times10^3\,\Omega)}$$

$$I_C = \beta I_B = 180 \cdot (12.47) = 2.24\ mA$$

$$V_C = V_{CC} - I_C R_C = 30V - (2.24mA)(8.2k\Omega)$$

$$\Rightarrow 11.63\ V$$

$$V_E = I_E R_E = 2.24\ mA \times 1.8\ k\Omega$$

$$= 4.03\ V$$

$$V_{CE} = V_{CC} - I_C(R_E + R_C) = 30V - (2.24mA)(8.2\times10^3\,\Omega + 1.8\times10^3\,\Omega)$$

$$= \underline{7.6\,V}$$

b) $I_E = \frac{V_{EE} - V_{BE}}{R_E} = \frac{8V - 0.7V}{2.2k\Omega} = 3.32\,mA$

$V_C = V_{CC} - I_E R_C = 10V - (3.32\,mA).(1.8k\Omega)$

$= \underline{4.02\,V}$

$V_{CE} = V_{CC} + V_{EE} - I_E (R_E + R_C)$

$= 10V + 8V - (3.32\,mA)(2.2k\Omega + 1.8k\Omega)$

$= 18V - 13.28V = \underline{4.72V}$