1.

a) $\beta R_E > 10 R_2$

$= 100 \times 1.2 > 10 \times 4.7$

$= 120 > 47$ (satisfied)

now,

$$V_B = \frac{R_2}{R_1 + R_2} V_{CC} = \frac{4.7\,k\Omega}{39\,k\Omega + 4.7\,k\Omega} \times 16\,V$$

$$= 1.721\,V$$

$$V_E = V_B - V_{BE} = 1.721 - 0.7\,V$$

$$= 1.021\,V$$

$$I_E = \frac{V_E}{R_E} = \frac{1.021\,V}{1.2\,k\Omega} = 0.851\,mA$$

$$r_e = \frac{26\,mV}{I_E} = \frac{26\,mV}{0.851\,mA} = 30.55\,\Omega$$

b) Calculation of Z_i:

now, $R' = R_1 \| R_L$

$= \frac{R_1 \times R_L}{R_1 + R_L}$

$= \frac{39 \times 4.7}{39 + 4.7}$

$= 4.195 \, k\Omega$

$Z_i = R' \| \beta r_e$

$= \frac{R' \times \beta r_e}{R' + \beta r_e}$

$= \frac{4.195 k\Omega \times 100 \times 30.55\Omega}{4.195 k\Omega + 100}$

$= 1.77 \, k\Omega$

Z_o Now, $r_o > 10 R_e$

$50 \, k\Omega > 10 \times 3.9 \, k\Omega$

$\therefore Z_o = R_e = \cancel{k\Omega} \; 3.9 \, k\Omega$

c) $A_v = -\frac{R_e}{r_e}$

$= -\frac{3.9\,k\Omega}{30.55\,\Omega}$

$= -127.65$

$A_i =$

now, $R' \geq 10\beta r_e$

$4.195\,k\Omega \geq 10\,(100 \times 30.55)$

[not satisfied]

$A_i = \frac{\beta R'}{R' + \beta r_e}$

$= \frac{100 \times 4.195\,k\Omega}{4.195\,k\Omega + 100 \times 30.55\,\Omega}$

$= 57.862$

d) ~~r_o~~

$r_o = 25\,k\Omega$

$r_o > 10 R_C$

$25\,k\Omega > 10 \times 3.9\,k\Omega$ (not satisfied)

So, ~~$Z_i =$~~

$Z_i = 1.77\,k\Omega$

$Z_o = R_C \parallel r_o$

$= \dfrac{R_C \times r_o}{R_C + r_o}$

$= \dfrac{3.9\,k\Omega \times 25\,k\Omega}{3.9 + 25}$

$= 3.37\,k\Omega$

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$$A_v = -\frac{R_e \,||\, r_o}{r_e}$$

now, $-R_e \,||\, r_o$

$$= -\frac{R_e \times r_o}{R_e + r_o}$$

$$= -\frac{3.9\,k\Omega \times 25\,k\Omega}{3.9\,k\Omega + 25\,k\Omega}$$

$$= 3.37\,k\Omega$$

$$A_v = -\frac{3.37\,k\Omega}{30.55\,\Omega}$$

$$= -110.311$$

$$A_i = \cancel{\frac{\beta R' r_o}{R' + \beta R_e}} \quad \frac{\beta R' r_o}{(r_o + R_e)(R' + \beta r_e)}$$

$$= \frac{100 \times 4.195\,k\Omega \times 25\,k\Omega}{(25 + 3.9)\,k\Omega\,(4.195 + 100 \times 30.55\,\Omega)}$$

$$= 118.622$$

2. a)

$$I_B = \frac{16 - 0.7}{270}$$

$$= 26.86 \mu A$$

$$I_E = (\beta + 1) I_B$$

$$= (110 + 1)(26.86 \mu A)$$

$$= 2.98 mA$$

$$r_e = \frac{26 mV}{I_E} = \frac{26 mV}{2.98} = 8.725 \Omega$$

$$\beta r_e = 110 \times 8.725 = 959.75 \Omega$$

b) $Z_i = R_B \parallel \beta r_e$

$$= \frac{270 k\Omega \times 959.75 \Omega}{270 k\Omega + 959.75 \Omega}$$

$$=$$

$$Z_o = R_E \parallel r_e$$

$$= \frac{R_E \times r_e}{R_E + r_e}$$

$$= \frac{2.7 \times 8.725}{2.7 + 8.725}$$

$$= 8.69\,\Omega$$

c) $$A_V = \frac{R_E}{R_E + r_e} = \frac{2.7\,k\Omega}{2.7\,k\Omega + 8.69\,\Omega}$$

$$= 0.997$$

$A_i =$ $R_B \geq 10\beta r_e$

$270 \geq 10(110 \times 8.725\,\Omega)$

$270\,k\Omega \geq 9.59\,k\Omega$

$\therefore A_i \cong \beta = 110$