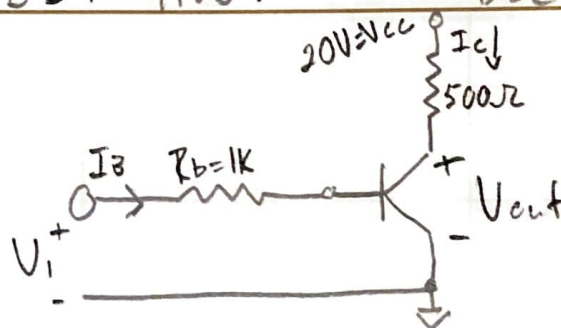1.) a) $V_1 = 0.2V$
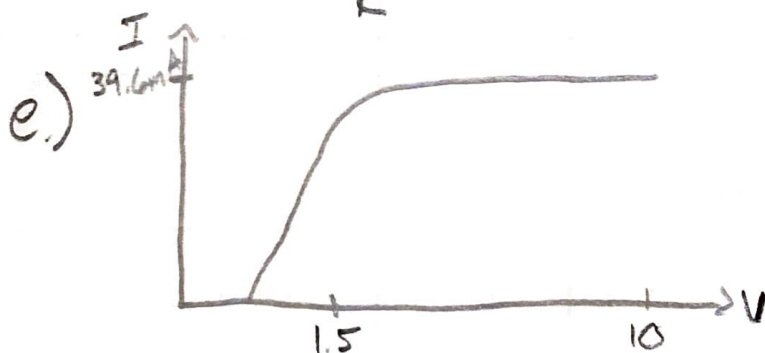
$I_c = 0A$

$V_{out} = 20V$

b.) $V_1 = 3V$ saturated

$V_{out} = V_{CEsat} = 0.2V$

$I_c = \frac{V_{cc} - V_{CEsat}}{R} = \frac{20 - 0.2}{500} = 39.6mA$

c.) $V_1 = 8V$ saturated

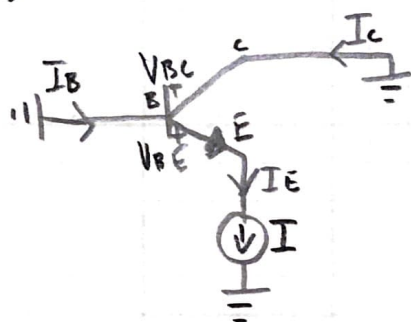$V_{out} = 0.2V$

$I_c = \frac{V_{cc} - V_{CEsat}}{R} = 39.6mA$

e)

2.) a.) Label collector, base, emitter terminals (C, B, E)

b.) Transister type: NPN

c.) Label V_{BE} & V_{BC} and directions for I_E, I_C, I_B

d.) Find $I_E, I_C, I_B, V_{BC}, V_{BE}$ if $I = 175mA$

2)

$I_E = I = \boxed{175\,mA}$

$I_B + I_C = I_E \Rightarrow I_C = \beta_F I_B$

$I_B + \beta_F I_B = I_E \Rightarrow I_B(1 + \beta_F)$

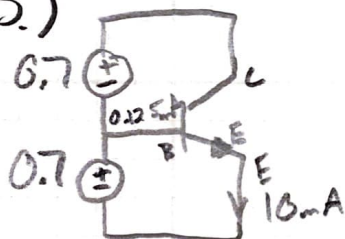$I_B = \frac{175}{101} = \boxed{1.73\,mA}$

$I_C = I_E - I_B$

$= 175 - 1.73 = \boxed{173.27\,mA}$ $\boxed{V_{BC} = 0 \rightarrow GND}$

$V_{BE} = \phi_T \ln\left(\frac{I_C}{I_S}\right) = 0.0258 \ln\left(\frac{173.27}{6\times10^{-16}}\right)$
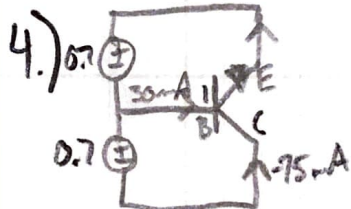
$\Rightarrow V_{BE} = \boxed{0.681\,V}$

3)

$I_C + I_B = I_E \rightarrow I_C = I_E - I_B = I_C = 10mA - 0.125mA$

$= 9.875mA$

$I_C = \beta_F I_B \rightarrow \beta_F = \frac{I_C}{I_B}$

$\boxed{\beta_F = 79}$

$V_{BE} = \phi_T \ln\left(\frac{I_C}{I_S}\right) \Rightarrow e^{\left(\frac{V_{BE}}{\phi_T}\right)} = \frac{I_C}{I_S}$

$I_S = \frac{I_C}{e^{\left(\frac{V_{BE}}{\phi_T}\right)}} = \boxed{1.63\times10^{-14}\,A}$

4)

$I_B + I_C = I_E$
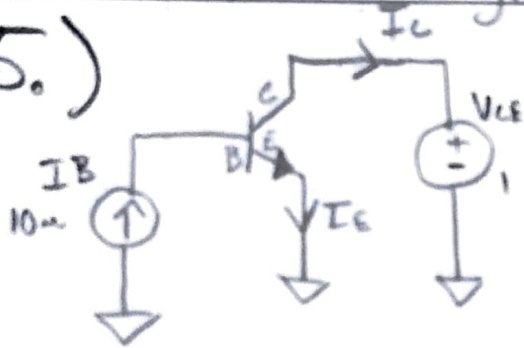
$30 - 75 = I_E \Rightarrow -45mA$

$-\left(\frac{-75}{30}\right) - 1 = \beta_R \Rightarrow \boxed{\beta_R = 1.5}$
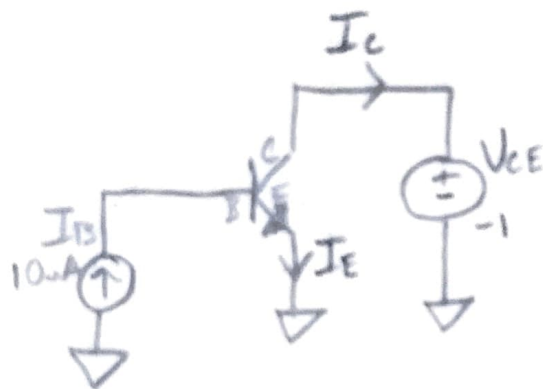
$-I_C = (\beta_R + 1) I_B$

$V_{BC} = \phi_T \ln\left(\frac{I_E}{I_S}\right) \rightarrow \frac{I_E}{e^{\left(\frac{V_{BC}}{\phi_T}\right)}} = I_S = \boxed{7.4136\times10^{-17}\,A}$

5.)

$I_E = -510 mA$

$I_C = 500 mA$

$I_B = 10 mA$

$I_B = 10 mA$

$I_C = 500 mA$

$I_E = -510 mA$

BJT HW1

Gabriel Emerson

Vcc
20

R2
500

R1
1000

Q1
NPN

V1
0

.Model NPN NPN(IS=1e-16 BF=100 BR=2)
.dc V1 0 10 1

BJT_HW1

V(n002)

I(R1)

I(R2)

9.65V   v = 21.75V, 39.50mA