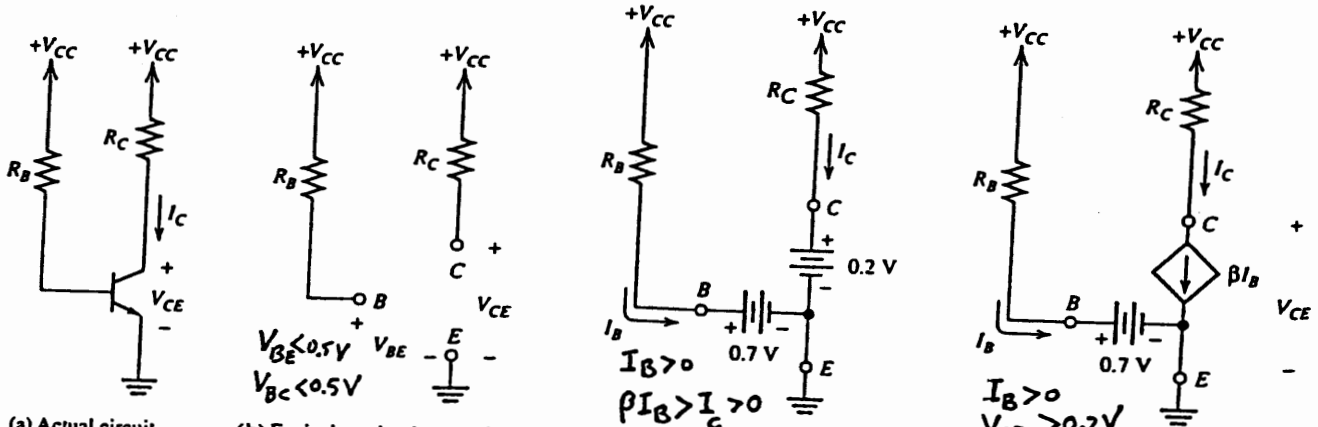
PROBLEM 2

BJT dc Large Signal Model--Fixed Biasing

The dc bias circuit shown has $V_{CC} = 15$ V $R_B = 200$ kΩ, $R_C = 1$ kΩ,
For the following two cases determine whether the transistor is in active region or in saturation, and solve for I_C ,and V_{CE}
CASE A) $\beta = 100$
CASE B) $\beta = 300$.



(a) Actual circuit (b) Equivalent circuit assuming operation in cutoff (c) Equivalent circuit assuming operation in saturation (d) Equivalent circuit assuming operation in the active region

In both cases, the transistor cannot be in cutoff or Reverse Active (since $V_{CC} > 0$) So we must examine two possibilities in each case : Saturation or Forward Active.

1) Assume Saturation then use circuit(c). Find I_B and I_C

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} \Rightarrow I_B = \frac{15 - 0.7\ V}{200\ k\Omega} = 71.5\mu A$$

$$I_C = \frac{V_{CC} - V_{CE}}{R_C} \Rightarrow I_C = \frac{15 - 0.2\ V}{1\ k\Omega} = 14.8\ mA$$

Now Test $\frac{I_C}{I_B} = \frac{14.8\ (mA)}{71.5\ (\mu A)} \cong 270 \quad \therefore 100 < \frac{I_C}{I_B} < 300$

CONCLUSION : For $\beta = 100$ $\frac{I_C}{I_B} > \beta \Rightarrow$ assumption of Saturation is wrong

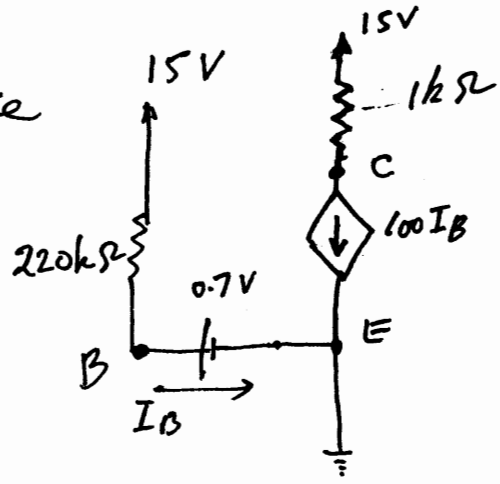
For $\beta = 300$ $\frac{I_C}{I_B} < \beta \Rightarrow$ Saturation is INDEED CORRECT

$\therefore$ For $\beta = 300$ Transistor is Saturated with $I_B = 71.5\mu A$, $I_C = 14.8\ mA$, $V_{CE} = 0.2V$

For $\beta = 150$ Transistor is NOT saturated then it must be in forward Active Region. To solve we must use circuit(d)

P.T.O. →

PROBLEM 2 continued



$\beta = 100 \Rightarrow$ Forward Active

$I_B = \frac{15 - 0.7}{220} \frac{V}{k\Omega} = 71.5\,\mu A$ As before

$I_C = 100\, I_B = 7.15\ mA$

$V_{CE} = 15 - 7.15 \times 1\ (mA \times k\Omega)$

$V_{CE} = 7.85\ V$

OBSERVATION

It was less time consuming to:

1) Treat the problem as 1
2) It's easier to assume saturation first

Don't forget here the test criteria is simple: If $\frac{I_C}{I_B} < \beta$ Then assumption is correct If $\frac{I_C}{I_B} > \beta$ " "

is wrong & → Forward Active