Since we are assuming linear operation we don't have to go to $i_C = I_S e^{V_{BE}/V_T}$ equation.

For $\beta$ open-circuited, $i_E = 0$ and (1) gives

$$i_C = I_S e^{V_{BE}/V_T}$$

Substitute into (2) to get

$$i_C = (\beta + 1) I_S e^{V_{BE}/V_T}$$

For $i_E$ varying from 10 $\mu$A to 40 $\mu$A, $i_C$ varies from 1 mA to 4 mA ($\beta = 100$), and $V_C = V_{CC} - R_C i_C$ varies from 4 to 1 V. Thus the peak-to-peak collector voltage swing is

$$V_C = 3 V \quad \text{p-p}$$

For $V_C = \frac{1}{2} V_{CC} = 2.5 V$

$$I_C = 2.5 \text{mA}$$

And $I_b = 2.5 \times 100 = 250 \mu A$

$$V_{EE} = V_{BE} + I_b R_e$$

$$= 0.7 + 0.025 \times 100$$

$$= 3.2 V$$

On the verge of saturation

$$V_{CE} = 0.3 V$$

For linear operation

$$\frac{V_{CE}}{V_T} = 0.3$$

$$(5 - I_C R_C) = \frac{V_{CC}}{V_T} \times 5 \times 10^{-3} = 0.3$$

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$$|I_C| = 156.67 \text{ mA}$$

Note $I_C$ is negative.

$$I_C = -156.67 \text{ mA}$$

Now we can find the dc collector voltage. Refer to sketch of the output voltage, we see that

$$|\Delta U_0| = |I_C \times 0.005|$$

$$\Rightarrow V_{EE} = 0.3 + 156.67 \times 0.005$$

$$= 10.8 V$$