$$LHS = \int_{V_{CE,sat}}^{V_0} \frac{dv_0}{V_{CC} - v_0} = \left[-\ln(V_{CC} - v_0) \right]_{V_{CE,sat}}^{V_0} = RHS$$

$$RHS = \frac{1}{R_C C} t$$

$$LHS = -\ln(V_{CC} - v_0) + \ln(V_{CC} - V_{CE,sat}) = \frac{t}{R_C C} = RHS$$

So $$\ln\left(\frac{V_{CC} - V_{CE,sat}}{V_{CC} - v_0}\right) = \frac{t}{R_C C}$$

$$\ln\left(\frac{V_{CC} - v_0}{V_{CC} - V_{CE,sat}}\right) = \frac{-t}{R_C C}$$

$$\ln\left(\frac{v_0 - V_{CC}}{V_{CE,sat} - V_{CC}}\right) = \frac{-t}{R_C C}$$

$$\rightarrow \quad \frac{v_0 - V_{CC}}{V_{CE,sat} - V_{CC}} = e^{-\frac{t}{R_C C}}$$

$$\rightarrow \quad v_0 - V_{CC} = (V_{CE,sat} - V_{CC}) e^{-\frac{t}{R_C C}}$$

$$\boxed{v_0 = V_{CC}\left(1 - e^{-\frac{t}{R_C C}}\right) + V_{CE,sat}\, e^{-\frac{t}{R_C C}}}$$

(V_{CC}: 5V; $V_{CE,sat}$: 0.2V)