Pulse problem 0:

\[ V_{out}(t) = V(1 - e^{-t/\tau}) \]

where \( \tau = RC \) \( (BW = \frac{1}{2\pi f_c} = \frac{1}{2\pi \tau}) \)

\( t_1: \) \( V_{out}(t_1) = 0.1V \Rightarrow 0.1V = V(1 - e^{-t_1/\tau}) \)

\( 0.1 = (1 - e^{-t_1/\tau}) \)

\( e^{-t_1/\tau} = 0.9 \)

\( t_1 = -\tau \ln 0.9 = +\tau \ln 10/9 \)

\( = \tau (\ln 10 - \ln 9) \).

\( t_2: \) \( V_{out}(t_2) = 0.9 \Rightarrow 0.9V = V(1 - e^{-t_2/\tau}) \)

(similar algebra to above)

\( t_2 = \tau \ln 10 \).

\[ RT = t_2 - t_1 = \tau \ln 9 \]

\[ \frac{\ln 9}{2\pi BW} = \frac{0.35}{BW} \]

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Pulse Problem 1:

Note: terminology of problem is a bit unclear.

0.9V = threshold for Schmitt trigger low to high transition. 1.7V = threshold for high to low.

Neglect Schmitt trigger propagation delay and assume the output is a step funx. (Actual device will have delay, pulse rise time).

width of output pulse:

Consider \( V_b \). At \( t = 10\mu s \), the positive-going edge of \( V_b \) leads to \( (t \geq 10\mu s) \):

\[ V_b(t') = 3.1V(e^{-t'/\tau})u(t') \]

where \( t' = t - 10\mu s \), and

\[ \tau = RC = 1000\mu s \times 100 \times 10^{-12} = 0.10 \mu s \]

The positive transition causes \( V_{out} \) to go to 3.3V at \( t = 10\mu s \).

It falls to 0.2V when \( V_b = 0.9V \),

\[ 0.9V = 3.1V(e^{-t'/0.10\mu s}) \]

\( t' = 0.10 \mu s \ln(3.1/0.9) = 0.12 \mu s \)

(width of "notch" in output pulse.)

⇒ circuit produces negative-going pulse synchronized with trailing edge of input pulse.
Pulse problem 2:

\[ RT = \frac{0.35}{BW} \]

\[ BW = f_c > \frac{1}{2\pi RC} = \frac{1}{2\pi \times 1000 \times 2 \times 50 \times 10^{-12}} = 3.2 \text{ MHz} \]

\[ RT = \frac{0.35}{3.2 \text{ MHz}} = 110 \text{ ns} \]