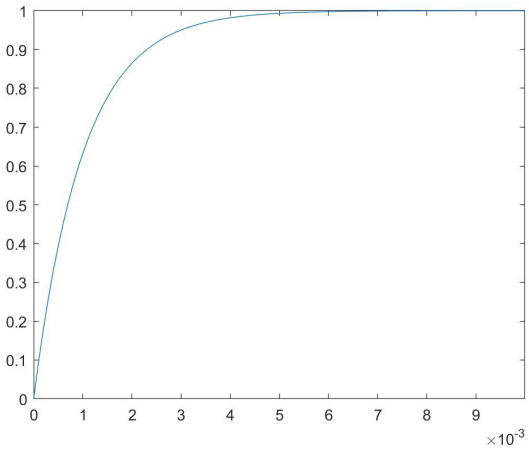
4.1 $RC(V_{out}(t))' + V_{out}(t) = V_{in}(t)$ (b)

$\Rightarrow V_{out} = (1-e^{-\frac{t}{RC}})u(t)$

$\Rightarrow e^{-\frac{t}{RC}}u(t) + (1-e^{-\frac{t}{RC}})u(t) = V_{in}(t)$

$\Rightarrow V_{in}(t) = u(t)$



4.2 $h(t) = \frac{d}{dt} y_{step}(t) = \frac{1}{RC} \cdot e^{-\frac{t}{RC}} u(t)$

4.3 (a) $u(t) \xrightarrow{h(t)} (1-e^{-\frac{t}{RC}})u(t)$

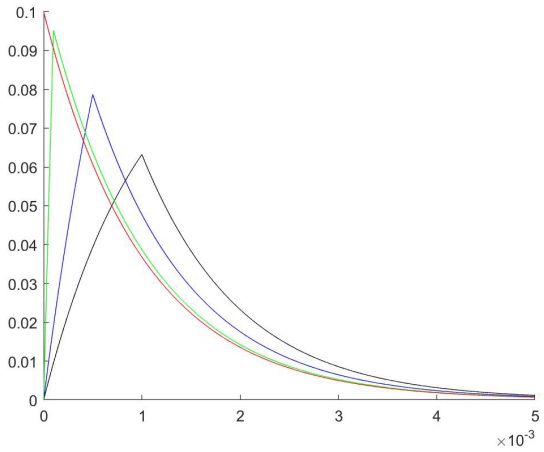
$\Rightarrow u(t-\Delta) \xrightarrow{h(t)} (1-e^{-\frac{t-\Delta}{RC}})u(t-\Delta)$

$\Rightarrow V_{out} \xrightarrow{h(t)} \frac{b}{\Delta}[(1-e^{-\frac{t}{RC}})u(t) - (1-e^{-\frac{t-\Delta}{RC}})u(t-\Delta)]$

(b) $\lim_{\Delta \to 0, b=1} V_{out} = \lim_{\Delta \to 0} \frac{1}{\Delta}[(1-e^{-\frac{t}{RC}})u(t) - (1-e^{-\frac{t-\Delta}{RC}})u(t-\Delta)]$

$= \lim_{\Delta \to 0} \frac{1}{RC} e^{-\frac{\Delta - t}{RC}} u(t-\Delta) = \frac{1}{RC} e^{-\frac{t}{RC}} u(t) =$ 4.2 Answer

(c) Plot



when $\Delta \uparrow$

the plot is more like $10^{-4}h(t)$

4.4 • $u(t) \xrightarrow{T} (1-e^{-1000t})u(t)$ (1)

• $u(t-0.01) \xrightarrow{T} [1-e^{-1000(t-0.01)}]\,u(t-0.01)$ (2)

• $tu(t) \xrightarrow{T} [\frac{1}{1000}\cdot(e^{-1000t}-1)+t]\cdot u(t)$

$(t-0.011)u(t-0.011) \xrightarrow{T} [\frac{1}{1000}\cdot(e^{-1000(t-0.011)}-1)+(t-0.011)]u(t-0.011)$ (3)

• $tu(t-0.005) \xrightarrow{T} [\frac{\frac{1}{1000}-0.05}{e^{-1000\times0.05}}\cdot e^{-1000t}+t-\frac{1}{1000}]\,u(t-0.005)$

$(t-0.011)u(t-0.016) \xrightarrow{T} [\frac{\frac{1}{1000}-0.05}{e^{-1000\times0.05}}e^{-1000(t-0.011)}+(t-0.011)]\,u(t-0.011)$ (4)

$\Rightarrow V_{out} = (1)+(2)+(3)+(4)$

$= (1-e^{-1000t})u(t)+[1-e^{-1000(t-0.01)}]\,u(t-0.01)+[\frac{1}{1000}\cdot(e^{-1000(t-0.01)}-1)+(t-0.011)]u(t-0.011)$

$+[\frac{\frac{1}{1000}-0.05}{e^{-1000\times0.05}}e^{-1000(t-0.011)}+(t-0.011)]\,u(t-0.011)$

4.5

$RC(V_{out})'+V_{out}=V_{in}(t) \Rightarrow$ let $v_{in}=e^{st} \Rightarrow V_{out}=H(s)e^{st}$

$RC\cdot H(s)\cdot s\cdot e^{st}+H(s)\cdot e^{st}=e^{st}$

$\Rightarrow H(s)=\frac{1}{RCs+1} \Rightarrow H(j\omega)=\frac{1}{j\omega RC+1}$

4.6

f_c	$\lvert H(j2\pi f_c)\rvert$	$\angle H(j2\pi f_c)$ deg	T_{dm}
50	0.9540	−17.491	0.9673
200	0.6227	−51.488	0.7151
500	0.3033	−72.343	0.4019
1k	0.1572	−80.957	0.2249
5k	0.0318	−88.177	0.0490