using the definitions in (6), (5) can be written as

(5)

$$
\begin{aligned}
y(t) &= y^I(t) + j y^Q(t) \\
&= \frac{1}{2} \int \Big\{ \big(h^I(\tau)\, x^I(t-\tau) - h^Q(\tau)\, x^Q(t-\tau)\big) \\
&\qquad + j\,\big(h^I(\tau)\, x^Q(t-\tau) + h^Q(\tau)\, x^I(t-\tau)\big) \Big\}\, d\tau \\
&= \frac{1}{2} \int \big(h^I(\tau) + j\, h^Q(\tau)\big)\big(x^I(t-\tau) + j\, x^Q(t-\tau)\big)\, d\tau.
\end{aligned}
$$

i.e.,

$$y(t) = \frac{1}{2} \int h(\tau)\, x(t-\tau)\, d\tau. \qquad \text{— (7)}$$

From (7) it is clear that filtering in passband is equivalent to filtering in baseband.

Using the sampling theorem we will now show that filtering in continuous time baseband is further equivalent to filtering in discrete-time baseband.

Sampling theorem:

let $s(t)$ be a bandlimited signal, i.e., $|S(f)| = 0$ for $|f| > W$.

Define $s[n] \triangleq s\left(t = \frac{n}{2W}\right)$.

The theorem states that it is possible to reconstruct $s(t)$ from only the knowledge of the discrete-time sequence $\{s[n]\}$.