1) Verify that $h(t) = \int_{-\infty}^{\infty} H(f) e^{j2\pi f t} df$.

$$\begin{aligned}
h(t) &= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} h(t') e^{-j2\pi f t'} e^{j2\pi f t} dt' df \\
&= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} h(t') e^{j2\pi f(t-t')} dt' df \\
&= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} h(t') e^{jp(t-t')} \left(\frac{1}{2\pi}\right) dp dt' && \text{Let } p = 2\pi f \\
&= \int_{-\infty}^{\infty} h(t') \delta(t-t') dt' && \text{Since } 2\pi\delta(x-a) = \int_{-\infty}^{\infty} e^{ip(x-a)} dp \\
&= h(t)
\end{aligned}$$

2) Verify that if $h(t) = K, H(f) = K\delta(f)$ and that if $h(t) = K\delta(t), H(f) = K$.

$$\begin{aligned}
H(f) &= \int_{-\infty}^{\infty} h(t) e^{-j2\pi f t} dt \\
&= \int_{-\infty}^{\infty} K e^{-j2\pi f t} dt \\
&= K \int_{-\infty}^{\infty} e^{-j2\pi f t} dt \\
&= -K \left(\frac{1}{2\pi}\right) \int_{-\infty}^{\infty} e^{jpf} dp \\
&= -K\delta(f)
\end{aligned}$$

$$\begin{aligned}
h(t) &= \int_{-\infty}^{\infty} H(f) e^{j2\pi f t} df \\
&= \int_{-\infty}^{\infty} K e^{j2\pi f t} df \\
&= K \int_{-\infty}^{\infty} e^{j2\pi f t} df \\
&= K \left(\frac{1}{2\pi}\right) \int_{-\infty}^{\infty} e^{jpt} dp \\
&= K\delta(t)
\end{aligned}$$

There seems to be an issue with the minus sign on the first solution. I am not sure how to avoid having a minus sign for at least one of the solutions because of the structure of the transforms.

3) Verify that if $h(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT), H(f) = \frac{1}{T} \sum_{-\infty}^{\infty} \delta\left(f - \frac{n}{T}\right)$.

4) Verify that, if $h(t) \leftrightarrow H(f), h(t-t_0) \leftrightarrow H(f) e^{-j2\pi f t_0}$.

$$
\begin{aligned}
H(f)e^{-j2\pi f t_0} &= \int_{-\infty}^{\infty} h(t-t_0)e^{-j2\pi f t}dt \\
&= \int_{-\infty}^{\infty} h(t')e^{-j2\pi f(t'+t_0)}dt' \qquad \text{Let } t' = t - t_0 \\
&= \int_{-\infty}^{\infty} h(t')e^{-j2\pi f t'}e^{-j2\pi f t_0}dt' \\
&= \int_{-\infty}^{\infty} h(t')e^{-j2\pi f t'}dt' e^{-j2\pi f t_0} \\
&= H(f)e^{-j2\pi f t_0}
\end{aligned}
$$

$$
\begin{aligned}
h(t-t_0) &= \int_{-\infty}^{\infty} H(f)e^{-j2\pi f t_0}e^{j2\pi f t}df \\
&= \int_{-\infty}^{\infty} H(f)e^{-j2\pi f(t-t_0)}df \\
&= h(t-t_0)
\end{aligned}
$$

5) Verify that, if $h(t)$ is even, then $H(f)$ is real, and that if $h(t)$ is odd, then $H(f)$ is imaginary.

6) Verify that $x(t) * h(t) = \int_{-\infty}^{\infty} h(t)x(t-\tau)d\tau$.