Exercise 4.108

$\boxed{\text{L}}$ **Answer (d).**

We are given a LTI system with impulse response

$$h(t) = e^{-t}\sin(t)u(t). \quad ①$$

We have

substitute ①

$$\begin{aligned}
\int_{-\infty}^{\infty} |h(t)|\,dt &= \int_{-\infty}^{\infty} \left|e^{-t}\sin(t)u(t)\right| dt && u(t)=0 \text{ for all } t<0\\
&= \int_{0}^{\infty} \left|e^{-t}\sin(t)\right| dt && |ab| = |a||b|\\
&= \int_{0}^{\infty} \left|e^{-t}\right| |\sin(t)|\,dt && e^{-t} > 0 \text{ for all } t \in \mathbb{R}\\
&= \int_{0}^{\infty} e^{-t}\,|\sin(t)|\,dt.
\end{aligned}$$

Now, we use the fact that $|\sin(t)| \le 1$ in order to replace $|\sin(t)|$ by its upper bound of 1, yielding an inequality. In particular, we have

$$\begin{aligned}
\int_{-\infty}^{\infty} |h(t)|\,dt &\le \int_{0}^{\infty} e^{-t}\,|1|\,dt && \text{replace } |\sin(t)| \text{ by its upper bound of } 1\\
&= \int_{0}^{\infty} e^{-t} dt && \text{drop } 1\\
&= \left[-e^{-t}\right]\Big|_{0}^{\infty} && \text{integrate}\\
&= [0-(-1)] && \text{simplify}\\
&= 1.
\end{aligned}$$

Thus, we have that

conclusion from above

$$\int_{-\infty}^{\infty} |h(t)|\,dt \le 1.$$

Since $\int_{-\infty}^{\infty} |h(t)|\,dt < \infty$, the system is BIBO stable.