

Problem 1:

Do Problems 7.30, 7.31 from the textbook.

Problem 2:

Estimate the largest sampling interval T_s to allow perfect reconstruction of the signals ($x*y$ denotes convolution)

1. $\frac{\sin^2 2t}{t^2} \sin 3t$
2. $\frac{\sin 2t}{t^2} * \sin 3t$
3. $\frac{\sin 3t}{2t} \frac{\sin 2t}{2t}$.
4. $\frac{\sin 3t}{t} * \sin 2t$.

Note: For (2), the Fourier of $1/t$ is $F\left\{\frac{1}{t}\right\} = \frac{\pi}{j} \text{sign}(w)$. This is a consequence of Duality, which can be briefly stated as $FF = 2\pi R$, where, R denotes the reflection operation. Duality allows us to compute Fourier transforms for time functions that appear in the frequency column, e.g., $1/jw$. (Verify!) Then, for example, $F\left\{\frac{1}{t} \frac{\sin t}{t}\right\} = \frac{1}{2\pi} \frac{\pi}{j} \text{sign}(w) * \text{pulse}(w, 1)$ which is not bandlimited. A similar computation appears in pp.311 of the textbook, but with a typo in Eqn. 4.42 (the integrant should be $X(n)$).

Problem 3:

Suppose that a continuous time signal $x(t)$ is bandlimited to 1kHz and it is pre-processed by DT system with ideal sampling and reconstruction. The output of the discrete system is then processed by a CT system with transfer function $H(s) = \frac{1}{s+1}$. Select a suitable sampling time T_s and find the discrete-time filter transfer function $H_d(z)$ so that $y(t) = x(t)$.

