SYSTEM CLASSIFICATION EXERCISES

(a) Sampling system: The output of the sampler is the value of the input at discrete instants in time. The spacing between samples is \( T \), seconds.

\[
\begin{array}{c}
\text{Continuous-time input} \\
\begin{array}{c}
\text{Sampler} \\
\end{array} \\
\text{Discrete-time output}
\end{array}
\]

\[ f(t) \rightarrow y[k] = f(kT) \]

(i) The sampling system is: linear
nonlinear
can’t tell — not enough information.

(ii) The sampling system is: time-invariant
time-varying
can’t tell — not enough information.

(b) Quantization system: The output at any time \( t \) is equal to the input amplitude rounded to one of four levels, as shown on the plot of input \( f \) versus output \( y \).

\[
\begin{array}{c}
f(t) \\
\begin{array}{c}
2-bit \\
Quantizer
\end{array} \\
y(t)
\end{array}
\]

Any input in the range 0 to 1 is rounded to 0.5, any input greater than 1 is rounded to 1.5, etc.

(i) The quantizing system is: linear
nonlinear
can’t tell — not enough information.

(ii) The quantizing system is: time-invariant
time-varying
can’t tell — not enough information.
(c) Rectifier system: Output equals absolute value of the input at all time.

\[ f(t) \quad |\cdot| \quad y(t) = |f(t)| \]

(i) The rectifier system is:
- linear
- nonlinear
- can't tell — not enough information.

(ii) The rectifier system is:
- time-invariant
- time-varying
- can't tell — not enough information.

1.31. In this problem, we illustrate one of the most important consequences of the properties of linearity and time invariance. Specifically, once we know the response of a linear system or a linear time-invariant (LTI) system to a single input or the responses to several inputs, we can directly compute the responses to many other input signals. Much of the remainder of this book deals with a thorough exploitation of this fact in order to develop results and techniques for analyzing and synthesizing LTI systems.

(a) Consider an LTI system whose response to the signal \( x_1(t) \) in Figure P1.31(a) is the signal \( y_1(t) \) illustrated in Figure P1.31(b). Determine and sketch carefully the response of the system to the input \( x_2(t) \) depicted in Figure P1.31(c).

(b) Determine and sketch the response of the system considered in part (a) to the input \( x_3(t) \) shown in Figure P1.31(d).

![Figure P1.31](image-url)