

Part II

Time response

lfi

Linear time-invariant system properties

1 In this chapter, we will extend our understanding of linear, time-invariant (LTI) system properties. We must keep in mind a few important definitions.

2 The transient response of a system is its response during the initial time-interval during which the initial conditions dominate. The steady-state response of a system is its remaining response, which occurs after the transient response. Fig. lfi.1 illustrates these definitions.

3 The free response of a system is the response of the system to initial conditions—without forcing (i.e. the specific solution of the io ODE with the forcing function identically zero). This is closely related to, but distinct from, the transient response, which is the free response plus an additional term. This additional term is the forced response: the response of the system to a forcing function—without initial conditions (i.e. the specific solution of the io ODE with the initial conditions identically zero).

Linear: $f(ax) = a f(x)$
 $f(x_1) + f(x_2) = f(x_1 + x_2)$

transient response

Time Invariant:

steady-state response

$$\dot{x} = Ax + Bu$$

Time Varying:

$$\dot{x} = A(t)x + B(t)u$$

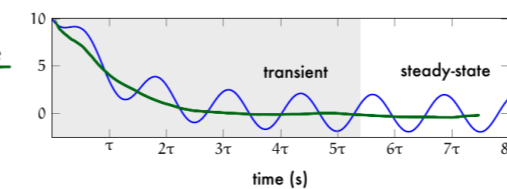


Figure lfi.1: transient and steady-state responses. Note that the transition is not precisely defined. (Figure adapted from Electronics: an introduction by Picone.)

free response
forced response