E2.5 Signals & Linear Systems

Tutorial Sheet 2 – System Responses

1. A Linear Time Invariant (LTI) system is specified by system equation

$$(D^2 + 4D + 4)y(t) = Df(t)$$

   a) Find the characteristic polynomial, characteristic equation, characteristic roots and characteristic modes of this system.

   b) Find $y_0(t)$, the zero-input component of the response y(t) for t ≥ 0, if the initial conditions are $y_0(0) = 3$, and $\dot{y}_0(0) = -4$.

2. Repeat question one with

$$D(D+1)y(t) = (D+2)f(t)$$

And initial conditions of $y_0(0) = 1$, and $\dot{y}_0(0) = 1$.

3. Repeat question one with

$$(D^2 + 9)y(t) = (3D+2)f(t)$$

And initial conditions of $y_0(0) = 0$, and $\dot{y}_0(0) = 6$.

4. Evaluate the following integrals:

   a) $\int_{-\infty}^{\infty} f(\tau)\delta(t-\tau)d\tau$

   b) $\int_{-\infty}^{\infty} \delta(\tau)f(t-\tau)d\tau$

   c) $\int_{-\infty}^{\infty} \delta(t)e^{-j\omega t}dt$

   d) $\int_{-\infty}^{\infty} \delta(t-2)\sin \pi t\, dt$

5. Find the unit impulse response of the LTI system specified by the equation

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 3y(t) = \frac{dx}{dt} + 5x(t).$$

6. Find the unit impulse response of the LTI system specified by the equation

$$(D+1)(D^2 + 5D + 6)y(t) = (5D+9)f(t).$$