MAE 143A

SIGNALS AND SYSTEMS — Prof. M. Krstic

Homework 3

Problem 1. Compute the *impulse* response of the following systems:

(a) $H(s) = \mathrm{e}^{-5s}\dfrac{1}{(s+4)^2+2}$

(b) $H(s) = \dfrac{1}{(2s+3)^5}$

Problem 2. Compute the *step* response of the following systems:

(a) $H(s) = 2\dfrac{s^2+s+1}{s^2+3s+2}$

(b) $H(s) = \dfrac{1}{(s+1)^3}$

(c) $H(s) = \dfrac{2}{(s+1)(s^2+4)}$

Problem 3. For the system with a transfer function

$$H(s) = \frac{s+1}{3s^2+7} - \frac{1}{3s+2}$$

find the differential equation governing the relationship between the input $u(t)$ and the output $y(t)$, assuming zero initial conditions.

Problem 4.

(a) Let the persistent forcing signal $u(t) = \sin(2t)1(t)$ drive the system

$$Y(s) = \frac{2s^2+8}{s(s^2+2s+15)}U(s)\,.$$

Does this system, despite persistent forcing, reach a steady state? If so, what is $\lim_{t\to\infty} y(t)$?

(b) Same questions as in (a) for the system

$$Y(s) = \frac{2s^2+8}{s(s^2+2s-15)}U(s)\,.$$

Problem 5. Using the Laplace transform, solve the following differential equations:

(a) $\dddot{y} + 2\ddot{y} + 2\dot{y} = 0, \quad y(0) = 1,\ \dot{y}(0) = 2,\ \ddot{y}(0) = 3.$

(b) $\ddot{y} + 2\dot{y} + 4y = (1-t)\mathrm{e}^{-2t}, \quad y(0) = 1,\ \dot{y}(0) = 1.$