E2.5 Signals & Linear Systems

Tutorial Sheet 2 – Introduction to Signals & Systems

1. Consider a discrete-time signal $x[n]$, fed as input into a system. The system produces the discrete-time output $y[n]$ such that

$$y[n] = \begin{cases} x[n], & n \text{ even} \\ 0, & n \text{ odd} \end{cases}$$

(i) Is the system described above memoryless? Explain.
(ii) Is the system described above causal? Explain.
(iii) Are causal systems in general memoryless? Explain.
(iv) Is the system described above linear and time-invariant? Explain.

2. State with a brief explanation if the following systems are linear/non-linear, causal/non-causal, time-invariant/time-varying.

(i) $y[n] = x[n] - x[n-1]$
(ii) $y[n] = \text{sgn}(x[n])$
(iii) $y[n] = n^2 x[n+2]$

3. State with a brief explanation if the following systems are linear/non-linear, causal/non-causal, time-invariant/time-varying.

(i) $y(t) = x(t)\cos(2\pi f_o t + \phi)$
(ii) $y(t) = A\cos(2\pi f_o t + x(t))$
(iii) $y(t) = \int_{-\infty}^{t} x(\delta)d\delta$
(iv) $y(t) = x(2t)$
(v) $y(t) = x(-t)$

4. To understand better the periodicity properties of a discrete-time sine function, write an M-file in Matlab that generates the function $y = \cos(2\pi f_0 n)$ where $n = 0,1,\ldots,50$ and f_0 is arbitrary, then plot the function using either 'plot' or 'stem' commands.