MA2011 — Mechatronics System Interfacing

Tutorial 1

1.   If the following input (V_{in}) and output (V_{out}) relationships exist for different measurement systems, indicate whether each is linear or nonlinear and explain why:

   a) $V_{out}(t) = 5V_{in}(t)$;

   b) $V_{out}(t)/V_{in}(t) = 5t$;

   c) $V_{out}(t) = V_{in}(t) + 5$;

   d) $V_{out}(t) = V_{in}(t) + V_{in}(t)$;

   e) $V_{out}(t) = V_{in}(t)*V_{in}(t)$;

   f) $V_{out}(t) = V_{in}(t) + 10t$;

   g) $V_{out}(t) = V_{in}(t) + \sin(5)$

2.   What is the Fourier series and fundamental frequency (in Hertz) of the waveforms

   a) $f(t) = 5 \sin(2\pi t)$.

   b) $f(t) = 5 \cos(2\pi t)$

   c) $f(t) = -5 \sin(2\pi t)$

3.   The power we use at home has a frequency of 60 Hz. What is the period of this sine wave?

<div align="right">Ans: 0.0166s=16.6ms</div>

4.   For the Fourier series given by

$$y(t) = 4 + \sum_{n=1}^{\infty} \frac{2n\pi}{10} \cos\frac{n\pi}{4}t + \frac{120n\pi}{30}\sin\frac{n\pi}{4}t$$

   where t is the time in seconds,

   a).   What is the fundamental frequency in hertz and radians per second, rad s^{-1}?

   b).   What is the period T associated with the fundamental frequency?

   c).   Express this Fourier series as an infinite series containing sine terms only.

$$\text{Ans: } f_0 = \frac{1}{8} \text{ Hz; } T = 8 \text{ s; } y(t) = 4 + 4n\pi\sum_{n=1}^{\infty}\sin\left(\frac{n\pi}{4}t + 0.05\right)$$