Signal Analysis – Homework 02
(Signals)

1) – Determine E_∞ and P_∞ for:

a) $x(t) = \cos(t)$;

b) $x[n] = \cos(\pi n/4)$;

c) $x_1(t)$; given below in exercise 5;

d) $x_2(t)$; given below in exercise 7.

2) – a) – Show that $T_o = (2\pi/a)$ is a **period** of $x_1(t)$ given below:

$$x_1(t) = b\cos(at + c)$$

b) – Show that $T_o = (\pi/a)$ é um **period** de $x_2(t)$ given below:

$$x_2(t) = b\,|\cos(at)|$$

c) – Show that

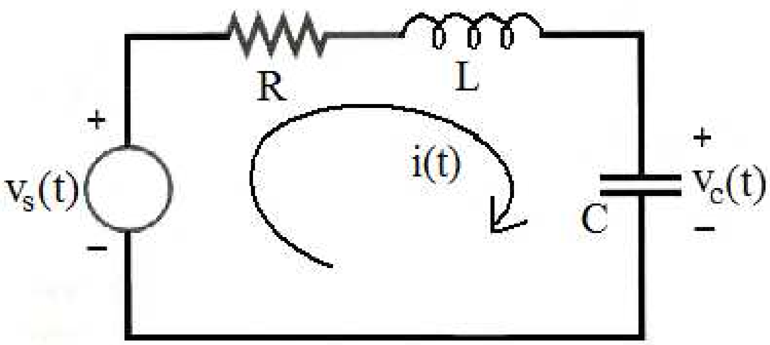
$$x(t) = e^{j3t} + e^{j6t}$$

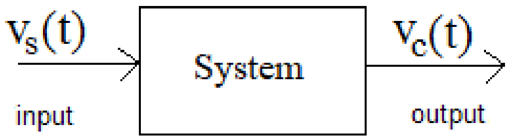
$$= 2\, e^{j4,5t} \cos(1{,}5\, t),$$

and therefore:

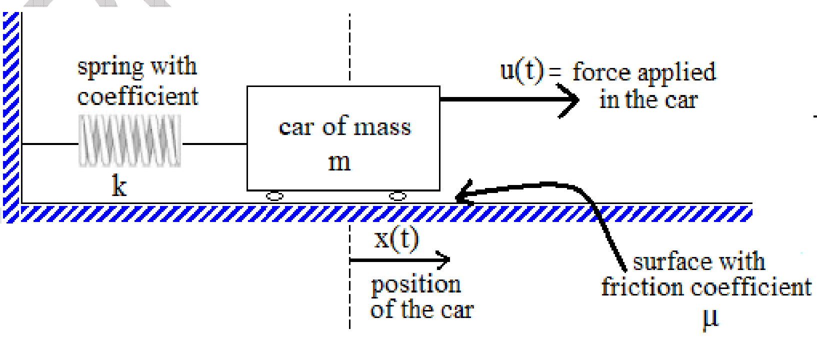
$$|x(t)| = 2\,|\cos(1{,}5\, t)|.$$

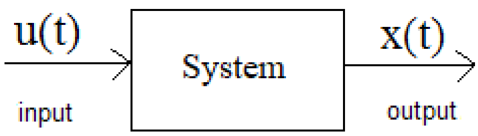
3) – Find the **ODE** (**ordinary differential equation**) that describe the *electric* SYSTEM of the RLC circuit below where the input is $v_s(t)$ (source voltage) and the output is $v_c(t)$ (voltage in the capacitor).





4) – Find the **ODE** (**ordinary differential equation**) that describe the *mechanic* SYSTEM of the car-mass-spring given below where the input is $u(t)$ (force applied in the car) and the output is $x(t)$ (position of the car).





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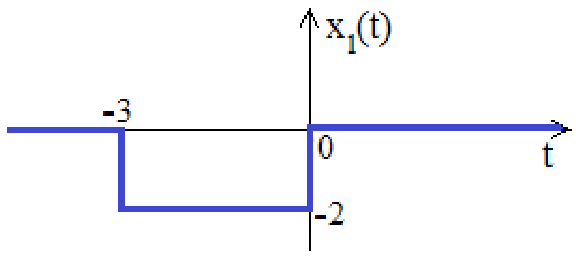
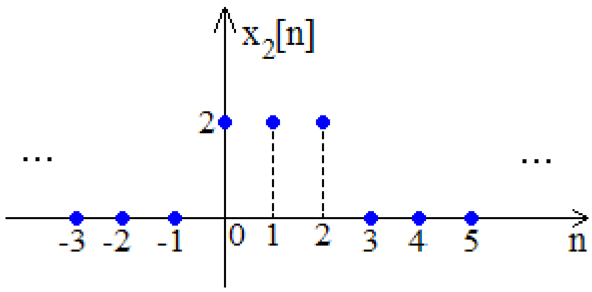
5) – Decompose the **continuous signal** $x_1(t)$ given below by the sum of 2 **signals**, one being **even** [$x_{1ev}(t)$] and the other one being **odd** [$x_{1od}(t)$].

6) – For $x_1(t)$ given below, make a sketch of $x_1\left(\frac{t}{2} - 2\right)$.

7) – Decompose the **discrete signal** $x_2[n]$ given below by the sum of 2 **signals**, one being **even** ($x_{2ev}[n]$) and the other one being **odd** ($x_{2od}[n]$).

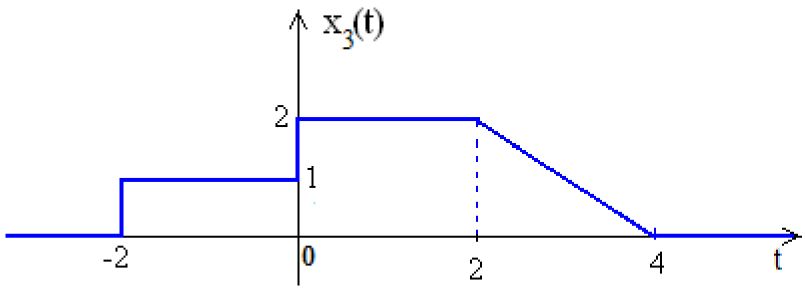
8) – For $x_2[n]$ given below, make a sketch of $x_2\left(\frac{n}{3} + 1\right)$.

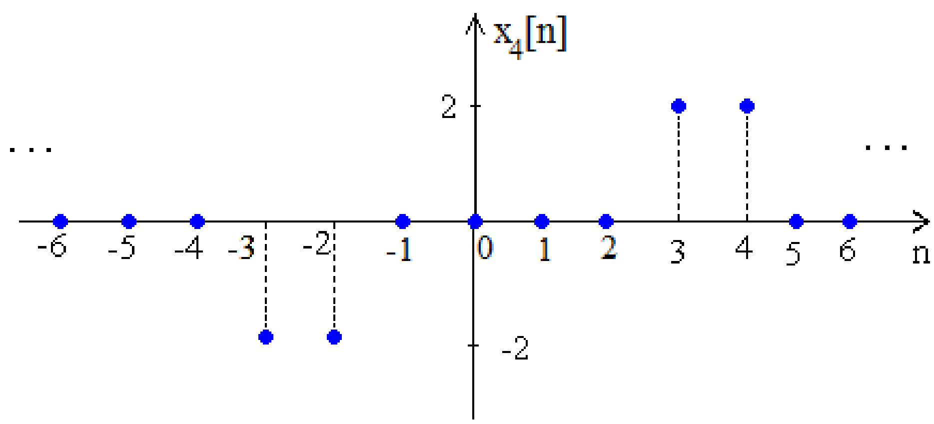




9) – Decompose the **continuous signal** $x_3(t)$ given below by the sum of 2 **signals**, one being **even** [$x_{3ev}(t)$] and the other one being **odd** [$x_{3od}(t)$].

10) – Decompose the **discrete signal** $x_4[n]$ given below by the sum of 2 **signals**, one being **even** ($x_{4ev}[n]$) and the other one being **odd** ($x_{4od}[n]$).





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11) – For $x_3(t)$ given above, make a sketch of $x_3(2t+3)$.

12) – For $x_4[n]$ given above, make a sketch of $x_4\left[\frac{(t-2)}{2}\right]$.

13) – Show that the **signal** $x(t)$ described in the form of a linear combination of a ***sine*** and a ***co-sine*** with the same frequency $\omega_o t$ and without phase displacement, can be written as a ***sine*** with the same frequency $\omega_o t$ and phase displacement ϕ; and vice-versa. That is:

$$x(t) = \alpha \cdot \sin\,(\omega_o t) + \beta \cdot \cos\,(\omega_o t)$$
$$= A \cdot \sin\,(\omega_o t + \varphi)$$

where: $\alpha = A \cdot \cos\varphi$ and $\beta = A \cdot \sin\varphi$

$A = \sqrt{\alpha^2 + \beta^2}$ and $\phi = \text{arctg}\,(\beta/\alpha)$

14) – For each one of the items below, find the values of a, b, c and θ que satisfy the equality presented.

a) – $x(t) = 3\cos(at) + b\,\text{sen}(2t) = 5\cos(at + 36.86^o) = c\,\text{sen}(at + \theta)$

b) – $x(t) = a\cos(bt + 36.86^o) = a\,\text{sen}(2t + \theta) = 8\,\text{sen}(bt) + c\cos(bt)$

15) – Find the values of φ, k and θ that satisfy the equation below.

$$3{,}48 \cdot \cos(\theta t) = 8 \cdot \sin\left(2{,}7t + \phi\right) + k \cdot \sin(\theta t)$$

16) – Find the values of α, λ (in radians) and γ (in degrees) that satisfy the equation below.

$$12{,}5 \cdot \sin\left(\frac{3\pi}{2} t + 2\gamma\right) = \frac{\alpha}{2} \cdot \cos(2\lambda t) + 3\alpha \cdot \sin(2\lambda t)$$

17) – Find the values of α , of θ_1 and of θ_2 that satisfy the equation below.

$$\alpha \cdot e^{(\theta_1 t)} \cdot \cos(\theta_2 t) = \left(e^{-2jt} + e^{jt}\right)$$

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18) – Calculate the values of the β , θ_1 and θ_2 that satisfy the equation below.

$$\beta \cdot \left(e^{2jt} - e^{-5jt} \right) = 3{,}5 \cdot e^{j\theta_1 t} \cdot \sin(\theta_2 t)$$

19) – Write the **discrete periodic signals** $x[n]$ given below in terms of the trigonometric functions sine and co-sine.