L2 Télécom S4 Télécommunications fondamentales Travaux Dirigés 2025-2026

TD n°1

Part 1 : Math reminders

Using Euler's formulas, linearize the following expressions:

a) $A(\omega t) = \cos^3(\omega t)$
b) $B(\omega t) = \sin^3(\omega t)$
c) $C(\omega t) = \cos^5(\omega t /2)$
d) $D(\omega t) = \cos^3(\omega t)\sin^3(\omega t)$
e) $E(\omega t) = 2(1+\sin^2(\omega t))\cos^2(\omega t)$
f) $F(\omega t) = \cos(\omega t)\sin^2(\omega t)$
g) $G(\omega t) = \cos(2\ \omega t)\sin^2(\omega t)$

Partie2 : Signal analysis

Calculation of total energy and total average power

Exercice 1 : Are the following signals finite-energy, finite-average-power, or neither? Calculate the total energy and total average power in each case. (a>0).

1. $x_1(t) = A\ \mathbf{rect}\left(\frac{t}{T}\right)$
2. $x_2(t) = A\mathbf{sin}\,\mu\, t$
3. $x_3(t) = A\mathbf{sin}\,\mu\, t\ \mathbf{u}(t)$
4. $x_4(t) = \mathbf{u}(t)$
5. $x_5(t) = t\,\mathbf{u}(t)$
6. $x_6(t) = A\mathbf{exp}(-at)\,\mathbf{u}(t)$
7. $x_7(t) = A\mathbf{exp}(-at)$
8. $x_8(t) = A\ \mathbf{tri}\left(\frac{t}{T}\right)$

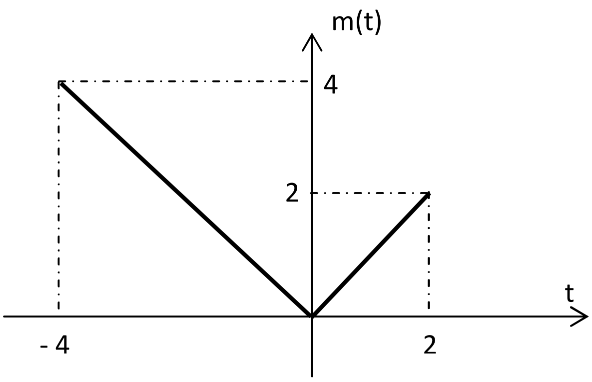
Exercice 2 : Calculate the total energy and average total power of the signals:

1- $x_1(t) = A\mathbf{cos}\left(\frac{®}{a}t\right)\mathbf{rect}\left(\frac{t-a}{2a}\right)$

2- $x_2(t) = \mathbf{tri}\left(\frac{t+a}{a}\right) + \mathbf{tri}\left(\frac{t-a}{a}\right)$

Exercice 3 : Consider a signal with finite energy.

1. Show that the energy of the following signals: $-m(t)$, $m(-t)$ et $m(t-T)$ est égale à E_m.
2. Show that the energy of the following signals: $m(at)$ et $m(at-T)$ est égale à $\frac{E_m}{a}$.



3. Consider the signal shown opposite.

Plot the waveform and calculate the total energy of each of the following signals : $m(t-4)$, $m\left(\frac{t}{1.5}\right)$, $m(2t-4)$ et $m(2-t)$