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INSTITUTE OF APPLIED SCIENCES AND TECHNIQUES
NETWORKS AND TELECOMMUNICATIONS DEPARTMENT

Module: Telecommunications 1 **1st Year RT S2**

Last name & First name ....G:..........

corrigé type **FINAL EXAM**

Course questions: (08 points)

1. Give the expression for the finite energy?

$E_x = \int_{-\infty}^{+\infty} |x(t)|^2 dt$ (1)

Give the expression for the finite average power?

$P_x = \frac{1}{T_0}\int_{-T_0/2}^{T_0/2} |x(t)|^2 dt$ (1)

2. Consider a communication system made up of:

- A transmitter,
- A transmitting antenna,
- A receiving antenna distant d from the transmitting antenna,
- A receiver.

Give the expression for the link budget by giving the expression for Pr (power received by the receiver, including Losses)

$P_R = P_t + G_t + G_R - L_R - L_t - L_{FS}$ (1)

3. Give the three forms of the Fourier series expansion; with all the details.

• general form: $x(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos n\omega_0 t + b_n \sin n\omega_0 t$ (0,1)

$a_0 = \frac{1}{T}\int_0^T x(t)dt$, $a_n = \frac{2}{T_0}\int_0^{T_0} x(t)\cos n\omega_0 t\,dt$, $b_n = \frac{2}{T_0}\int_0^{T_0} x(t)\sin n\omega_0 t\,dt$ (0,75)

• cosine forme: $x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t + \varphi_n)$ (0,1)

(0,75) $C_0 = a_0$; $C_n = \frac{a_n + b_n}{2}$; $\varphi_n = -\arctan\left(\frac{b_n}{a_n}\right)$

• complex forme: $x(t) = \sum_{n=-\infty}^{\infty} X_n e^{+jn\omega_0 t}$ (0,1)

(0,25) $X_n = \frac{1}{2}(a_n - jb_n)$; $X_0 = a_0$; $X_{-n} = \frac{1}{2}(a_n + jb_n)$; $\varphi_n = -\arctan\left(\frac{b_n}{a_n}\right)$ (0,25)

4. Let m(t) be the baseband information signal. The carrier is written as follows :

$x_p(t) = A_p \sin(2\pi f_p t + \theta_p)$.

a. What is the modified characteristic for AM amplitude modulation?

A_p (0,1)

b. What is the modified characteristic for PM phase modulation?

θ_p (0,1)

c. What is the modified characteristic for frequency modulation FM?

f_p (0,1)

GOOD LUCK

Exo 3

$$X(f) = \int_{-\infty}^{+\infty} rect\left(\frac{t}{T}\right) e^{-j2\pi f t} dt = \int_{-T/2}^{T/2} e^{-j2\pi f t} dt$$

$$= -\frac{1}{j2\pi f}\left[e^{-j2\pi f t}\right]_{-T/2}^{T/2} = -\frac{1}{j2\pi f}\left[e^{-j2\pi f \frac{T}{2}} - e^{j2\pi f \frac{T}{2}}\right]$$

$$= \frac{1}{j2\pi f}\left[e^{j\pi f T} - e^{-j\pi f T}\right] = \frac{\cancel{2j}}{\cancel{2j}\pi f}\left[\sin \pi f T\right]$$

$$= \frac{T}{T\pi f} \sin(\pi f T) = T\,\mathrm{sinc}(fT) \quad (1)$$

2/ $x(t) = \sin(2\pi f_0 t)$

$$X(f) = \int_{-\infty}^{+\infty} \sin(2\pi f_0 t) e^{-j2\pi f t} dt$$

$$= \frac{1}{2j}\int_{-\infty}^{+\infty} \left(e^{j2\pi f_0 t} - e^{-j2\pi f_0 t}\right) e^{-j2\pi f t} dt$$

$$= \frac{1}{2j}\int_{-\infty}^{+\infty} \left(e^{-j2\pi(f - f_0)t} - e^{-j2\pi(f_0 + f)t}\right) dt$$

$$X(f) = \frac{1}{2j}\left(\delta(f - f_0) - \delta(f + f_0)\right) \quad (1)$$

3/ $x(t) = e^{-\alpha t} u(t)\ ;\ \alpha > 0.$

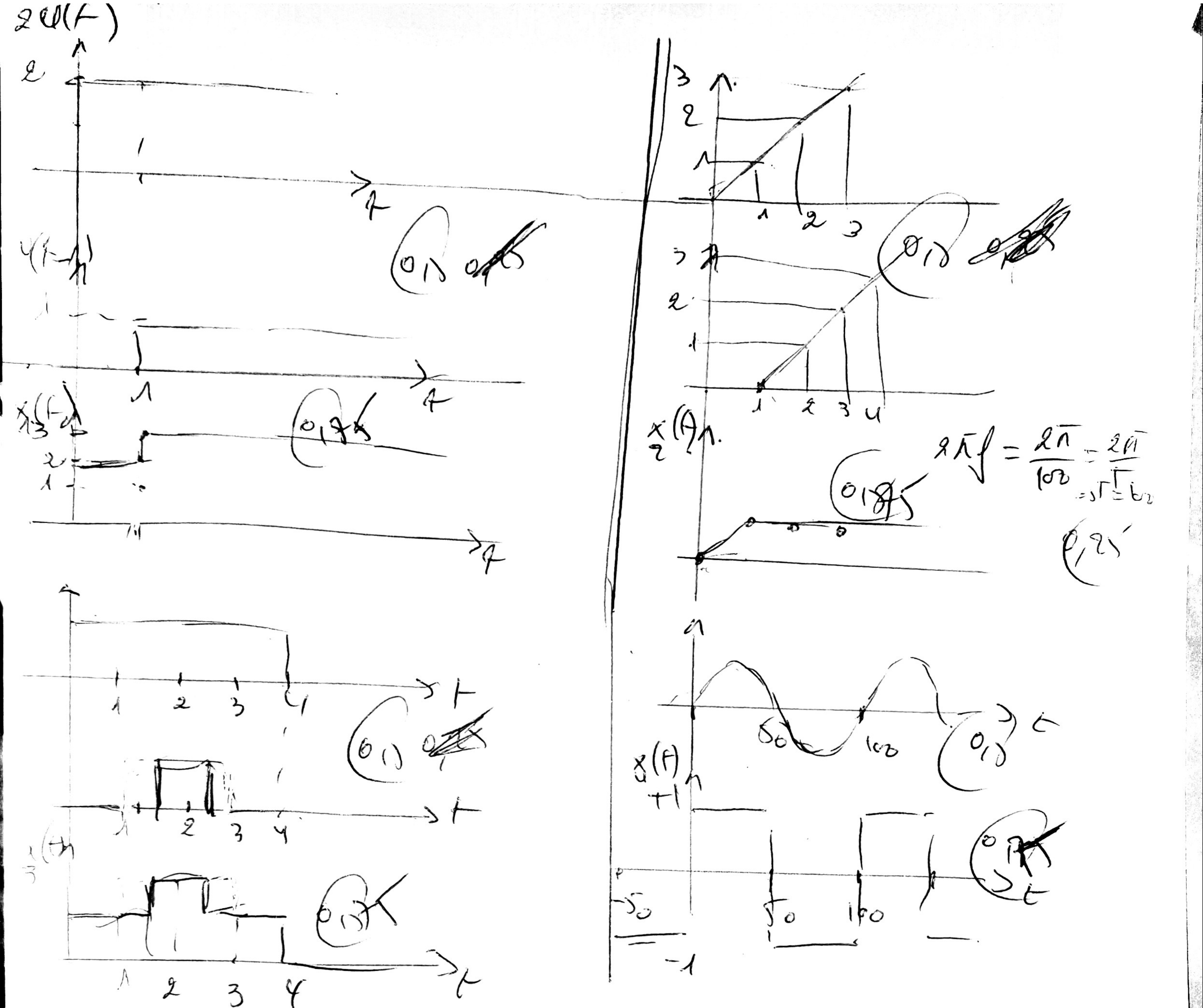
$$X(f) = \int_{-\infty}^{+\infty} e^{-\alpha t} u(t)\, e^{-j2\pi f t}\, dt$$

$$= \int_{0}^{+\infty} e^{-\alpha t}\, e^{-j2\pi f t}\, dt$$

$$= \int_{0}^{+\infty} e^{-(\alpha + j2\pi f)t}\, dt.$$

$$= -\frac{1}{\alpha + j2\pi f}\, e^{-(\alpha + j2\pi f)} \Big|_{0}^{+\infty}$$

$$X(f) = \frac{-1}{\alpha + j2\pi f}\left[0 - 1\right] = \frac{1}{\alpha + j2\pi f} \quad 1$$

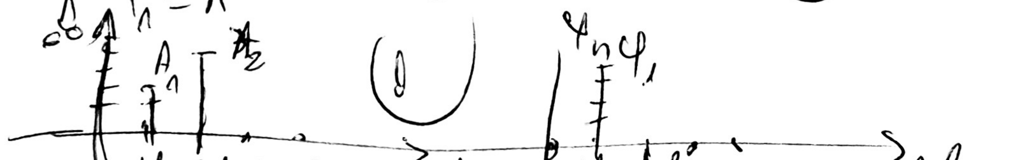


Ex/3

$x(t) = 6 - 2\cos(2\pi f_0 t) + 3\cos(4\pi f_0 t - \frac{\pi}{2})$ (1)

$A_0 = 6,\ A_1 = 2;\ A_2 = 3;\ A_3 = 0,\ A_4 = 0$ (0,5)

$\varphi_0 = 0;\ \varphi_1 = \pi;\ \varphi_2 = -\frac{\pi}{2};\ \varphi_3 = 0$ — (1)



$P_x = a_0^2 + \frac{1}{2}\sum(a_n^2+b_n^2) = 6^2 + \frac{1}{2}(4+9) = 36+6,5 = 42,5$ (1)