信号分析与处理. 第一次作业. (绪论)

1、信号按照能量和功率分类, 分别有什么特点?

能量信号: E有限, $P \to 0$

功率信号: $E \to \infty$, P为不为零的有限值.

非能量非功率信号: $\begin{cases} E \to \infty, & P = 0 \\ E \to \infty, & P \to \infty. \end{cases}$

P7.

2. (1). $x(t) = 2\cos(3t + \frac{\pi}{4})$　　周期信号, $T = \frac{2\pi}{\omega} = \frac{2\pi}{3}$

(2). $x(n) = \cos(\frac{8}{7}n\pi + 2)$.

$\Omega = \frac{8}{7}\pi$

$\frac{2\pi}{\Omega} = \frac{2\pi}{\frac{8}{7}\pi} = \frac{7}{4}$ 为有理数.

∴该信号为周期信号.

周期 $N = \frac{2\pi}{\Omega} \cdot k = \frac{2\pi}{\frac{8}{7}\pi} \cdot k = \frac{7}{4} \cdot k$.　　k取4. 则 $N = 7$.

(6). $x(t) = \cos 2\pi t \cdot u(t)$.

$x(t)$ 只有在 $t > 0$ 有取值. 该信号为非周期信号.

(8) $x(n) = 2\cos(\frac{n\pi}{4}) + \sin(\frac{n\pi}{8}) - 2\sin(\frac{n\pi}{2} + \frac{\pi}{6})$

$\Omega_1 = \frac{\pi}{4}$.　　$\Omega_2 = \frac{\pi}{8}$.　　$\Omega_3 = \frac{\pi}{2}$

则 $N_1 = \frac{2\pi}{\Omega_1} \cdot k_1 = 8$　　$N_2 = \frac{2\pi}{\Omega_2} \cdot k_2 = 16$

$N_3 = \frac{2\pi}{\Omega_3} \cdot k_3 = 4$.

∴N周期的最小公倍数为16.

∴该信号为周期信号. 周期为16.

P7.

3.(1). $x_1(t) = A\cdot e^{-t} \quad t \geq 0$

$$E = \lim_{T\to\infty} \int_0^T A^2 e^{-2t}\, dt = \lim_{T\to\infty} A^2 \cdot [-\frac{1}{2}e^{-2t}]\Big|_0^T$$

$$= -\frac{A^2}{2} \cdot \lim_{T\to\infty} (e^{-2T}-1) = \frac{A^2}{2}.$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_0^T A^2 e^{-2t}\, dt = -\frac{A^2}{2} \lim_{T\to\infty} (\frac{1}{2T\cdot e^{2T}} - \frac{1}{2T}) = 0$$

$\therefore x_1(t)$ 为能量信号.

(2) $x_2(t) = A\cos(w_0 t + \theta)$

$$E = \lim_{T\to\infty} \int_{-T}^{T} A^2 \cos^2(w_0 t+\theta)\, dt.$$

$$= A^2 \lim_{T\to\infty} \int_{-T}^{T} \frac{\cos(2w_0 t + 2\theta)+1}{2}\, dt$$

$$= \frac{A^2}{2} \lim_{T\to\infty} \frac{1}{2w_0} \sin(2w_0 t + 2\theta) + t \Big|_{-T}^{T}$$

$$= \frac{A^2}{2} \lim_{T\to\infty} \frac{1}{2w_0} \sin(2w_0 T + 2\theta) - \frac{1}{2w_0} \sin(-2w_0 t + 2\theta) + 2T$$

$$= \infty$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x_2^2(t)\, dt.$$

$$= \frac{A^2}{2} \lim_{T\to\infty} \frac{\frac{1}{2w_0}\sin(2w_0 T + 2\theta) - \frac{1}{2w_0}\sin(-2w_0 T + 2\theta)}{2T} + 1$$

$$= \frac{A^2}{2} + \lim_{T\to\infty} \frac{\sin(2w_0 T + 2\theta) - \sin(-2w_0 T + 2\theta)}{4w_0 T}$$

$$= \frac{A^2}{2}.$$

$x_2(t)$ 为功率信号.

P7.

3. (4) $x_4(t) = e^{-t}\sin 2t$

$$E = \lim_{T\to\infty}\int_{-T}^{T} e^{-2t}\sin^2 2t\,dt$$

$$= \lim_{T\to\infty}\int_{-T}^{T} e^{-2t}\,\frac{1-2\cos 4t}{2}\,dt$$

$$= \lim_{T\to\infty}\int_{-T}^{T}\frac{e^{-2t}}{2}\,dt - \lim_{T\to\infty}\int_{-T}^{T} e^{-2t}\cos 4t\,dt$$

$$= \lim_{T\to\infty}\left(-\frac{e^{-2t}}{4} + \frac{e^{-2t}}{4}\right) - \lim_{T\to\infty}\int_{-T}^{T} e^{-2t}\cos 4t\,dt$$

$$= 0 + \infty$$

$P = 0 + \infty$.

$x_4(t)$ 为非能量非功率信号.