**AMERICAN UNIVERSITY OF BEIRUT**
**ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT**
**EECE 340**
**Homework 1 – Solution**

## Problem 1

Determine whether the following signal is periodic. If it is periodic, find its period.

$$x(t) = \sin\left(\frac{5}{13}\pi^2 t\right)$$

x(t) is periodic with a period T=26/5π seconds

## Problem 2

Determine whether or not the following signal f(t)=4u(t)+2sin(3t) is periodic. If the signal is periodic, determine its fundamental period.

The signal f(t) is not periodic

Reason: u(t) is not a periodic signal

## Problem 3

Determine whether or not each of the following signals is periodic. If the signal is periodic, determine its fundamental period.

a) $x(t) = [\cos(\frac{\pi}{3}t - \pi)]^3$

X(t) is periodic with a period T=6 seconds

b) $x(t) = \cos(\frac{\pi}{3}t) + \sin(\frac{3\pi}{4}t - \pi)$

The cosine function is periodic with a period T=6 seconds. The sine function is also periodic with a period T=8/3 seconds. X(t) is also periodic with a period of 24 seconds

## Problem 4

Consider the periodic signal x(t) given by the expression

$$x(t) = (2+2j)e^{-j3t} - 3je^{-j2t} + 5 + 3je^{j2t} + (2-2j)e^{j3t}$$

Determine the period of x(t) and its fundamental frequency.

$T = 2\pi$ seconds, $\omega_0 = 1\,rad/s$

**Problem 5**

a. Consider the everlasting signal $X(t)=e^{-at}$ . Is X(t) an energy signal?

$$E = \int_{-\infty}^{\infty} x^2(t)dt = \infty$$ , therefore X(t) is not an energy signal.

b. For which values of "a" X(t) is a power signal? Determine its average power.

X(t) is a power signal if a is a complex quantity. In this case $P_{av}$=1Watt.

**Problem 6**

Classify these signals into energy-type signals, power-type signals, and signals that are neither energy type nor power type signals. For energy-type and power-type signals, find the energy or the power content of the signals

a. $f(t) = 4e^{j2\pi f_0} + 3e^{j(2\pi f_1+\theta)}$

Solution: Each of the above signal is periodic. Each is a power signal, therefore f(t) is a power signal if the sum is periodic. Average power=16+9=25 Watts

b. $f(x) = e^{-2|t|}$

Solution: The above signal is an energy signal as most of the energy is concentrated within a finite period of time.

$$E = 2\int_0^{\infty} e^{-t}dt = 2\,Joules$$

**Problem 7**

Categorize each of the following signals as an energy signal or a power signal. Sate the reason for your answer.

(a) The continuous-time signal x(t) , defined by

$$x(t) = \begin{cases} 3e^{-2t}, & t \geq 0, \\ 0, & \text{otherwise.} \end{cases}$$

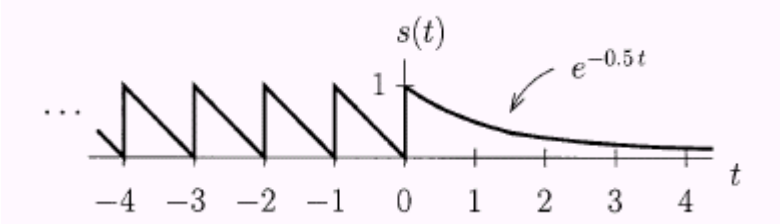
E is finite. Energy Signal

(b) The continuous-time signal z(t) , defined for $-\infty < t < \infty$ by

$z(t) = 3\sin(\pi t) + 2\cos(3\pi t)$

Periodic. Power Signal

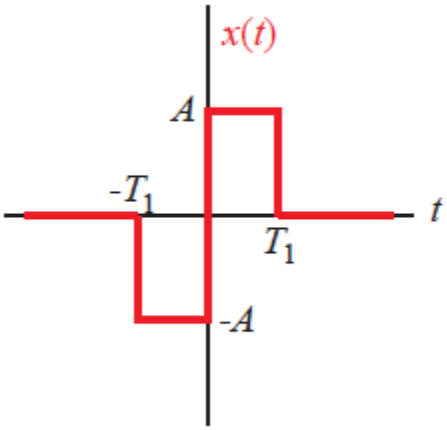
(c)




None

**Problem 8**

Consider the signal shown below




a. What is the total energy of the signal x(t)

The total energy is given by:

$$E = \int_{-\infty}^{+\infty} |f(t)|^2 dt = \int_{-T_1}^{T_1} A^2 dt = 2A^2 T_1 \text{ Joules}$$

b. What is the time-averaged power of the signal x(t)

The time-averaged power is given by:

$$P = \lim_{T\to\infty} \frac{1}{T} \int_{-T_1/2}^{T_1/2} |f(t)|^2 dt = 0$$

**Problem 9**

Consider the signal shown below

$$x(t)=\begin{Bmatrix}\frac{1}{\sqrt{t}} & t>1\\ 0 & t\le 1\end{Bmatrix}$$

a. Determine the total energy of this signal. Is x(t) an Energy Signal?

$$E=\int_{1}^{\infty}\frac{1}{t}dt=\infty$$

X(t) is not an energy signal

b. Determine the average power of this signal. Is x(t) a power signal.

$$P=\lim_{T\to\infty}\frac{1}{T}\int_{-t/2}^{T/2}\frac{1}{t}dt=\text{does not exist}.$$

X(t) is not a power signal.

**Problem 10**

A continuous-time signal g(t) is defined as:

$$g(t)=\begin{cases}12\cos^2(2\pi t), & -8<t<31\\ 0, & \text{elsewhere}\end{cases}$$

a. Is g(t) an energy signal? Show your work.
g(t) is an energy signal as it is a finite duration signal.

b. Is g(t) a power signal? Show your work.
g(t) is not a power signal as it cannot be both energy and power.