Republic of Iraq

Ministry of Higher Education

and Scientific Research

Al-Mustaqbal University College

Computer Engineering Techniques Department

Subject: Digital Signal Processing

Third Class

Lecture Four

By

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Classification of Discrete time signals

a- Symmetric (even) and antisymmetric (odd) signals.

A real-valued signal x(n) is called symmetric (even) if :

$$x(-n) = x(n)$$

A signal x(n) is called antisymmetric (odd) if :

$$x(-n) = -x(n)$$

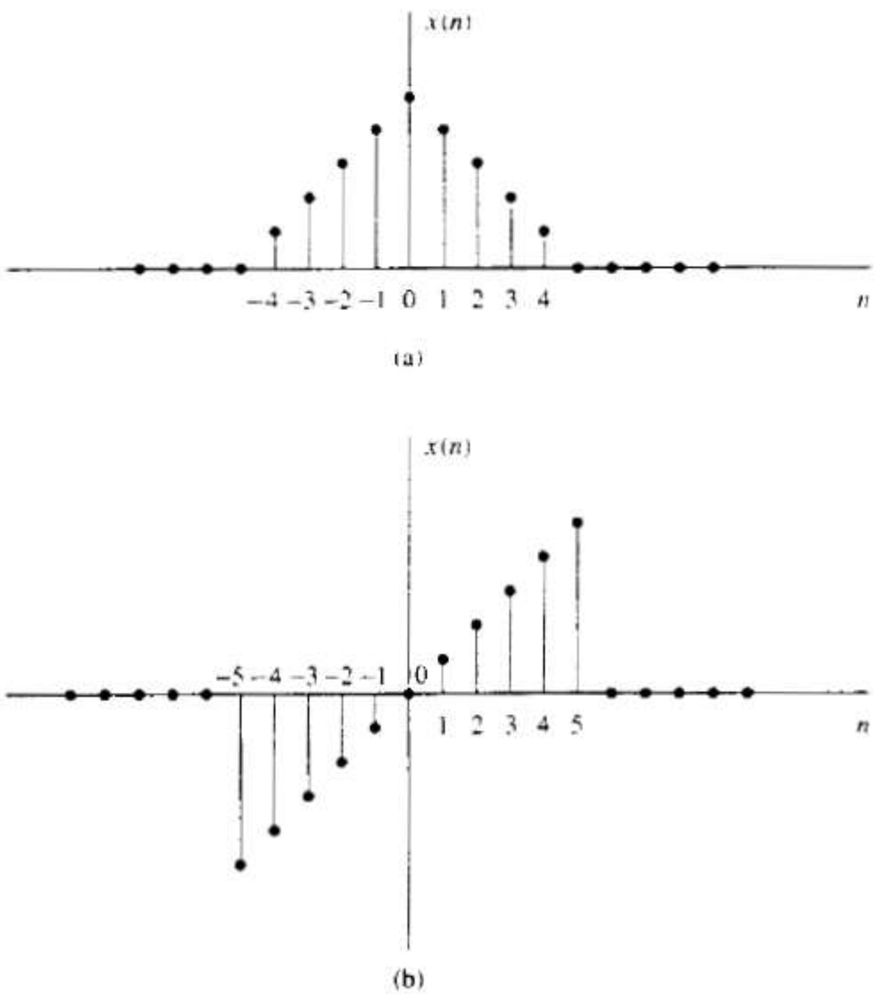

Fig 8. example of (a) even, (b) odd signals

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Any signal x(n) may be decomposed into a sum of its even part, x(n), and its odd part, x(n) as follows:

$$x(n) = x_e(n) + x_o(n)$$

To find the even part of x(n) we form the sum

$$x_e = \frac{1}{2}\{x(n) + x(-n)\}$$

whereas to find the odd part we take the difference

$$x_o = \frac{1}{2}\{x(n) - x(-n)\}$$

For complex sequences the symmetries of interest are slightly different

Definition: A complex signal is said to be **conjugate symmetric** if, for all n,

$$x(n) = x^*(-n)$$

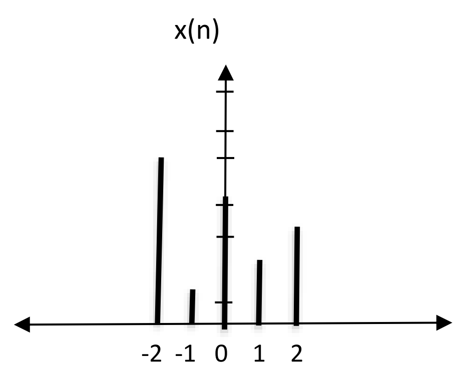
and a signal is said to be **conjugate antisymmetric** if, for all n,

$$x(n) = -x^*(-n)$$

Ex: Show that any signal can be decomposed into an even and odd component. Is the decomposition unique? Illustrate your argument using this signal

$$x(n) = \{5\ ,1\ ,\underline{4}\ ,2\ ,3\}$$

Sol: $x(n) = x_e(n) + x_o(n)$



$$x_e(n) = \frac{1}{2}[x(n) + x(-n)]$$

$$x_e(-2) = \frac{1}{2}[x(-2) + x(2)]$$

$$x_e(-2) = \frac{1}{2}[5 + 3] = \frac{1}{2} * 8 = 4$$

$$x_e(-1) = \frac{1}{2}[x(-1) + x(1)]$$

$$x_e(-1) = \frac{1}{2}[1 + 2] = \frac{1}{2} * 3 = 1.5$$

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$$x_e(0) = \frac{1}{2}[4+4] = \frac{1}{2} * 8 = 4$$

$$x_e(1) = \frac{1}{2}[2+1] = \frac{1}{2} * 3 = 1.5$$

$$x_e(2) = \frac{1}{2}[3+5] = \frac{1}{2} * 8 = 4$$

$$x_e(n) = \{4, 1.5\ , \underline{4}\ , 1.5\ , 4\}$$

$$x_o(n) = \frac{1}{2}[x(n) - x(-n)]$$

$$x_o(-2) = \frac{1}{2}[5-3] = \frac{1}{2} * 2 = 1$$

$$x_o(-1) = \frac{1}{2}[x(-1) - x(1)]$$

$$x_o(-1) = \frac{1}{2}[1-2] = \frac{1}{2} * -1 = -0.5$$

$$x_o(0) = \frac{1}{2}[4-4] = \frac{1}{2} * 0 = 0$$

$$x_o(1) = \frac{1}{2}[2-1] = \frac{1}{2} * 1 = 0.5$$

$$x_o(2) = \frac{1}{2}[3-5] = \frac{1}{2} * -2 = -1$$

$$x_o(n) = \{1\ , -0.5\ , 0\ , 0.5\ , -1\}$$