Cairo University
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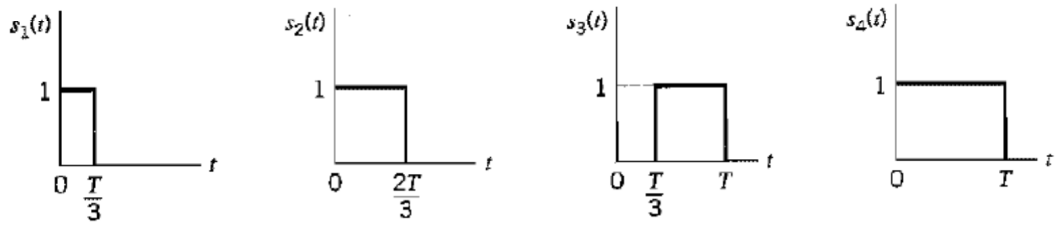
Sheet 6
Signal Space Representation

Problem 1

1 – In Fig.1, it displays the waveforms of four signals s_1 (t), s_2 (t), s_3 (t), and s_4 (t).
(a) Use Gram-Schmidt orthogonalization procedure; find an orthonormal basis for this set of signals.
(b) Construct the corresponding signal-space diagram.

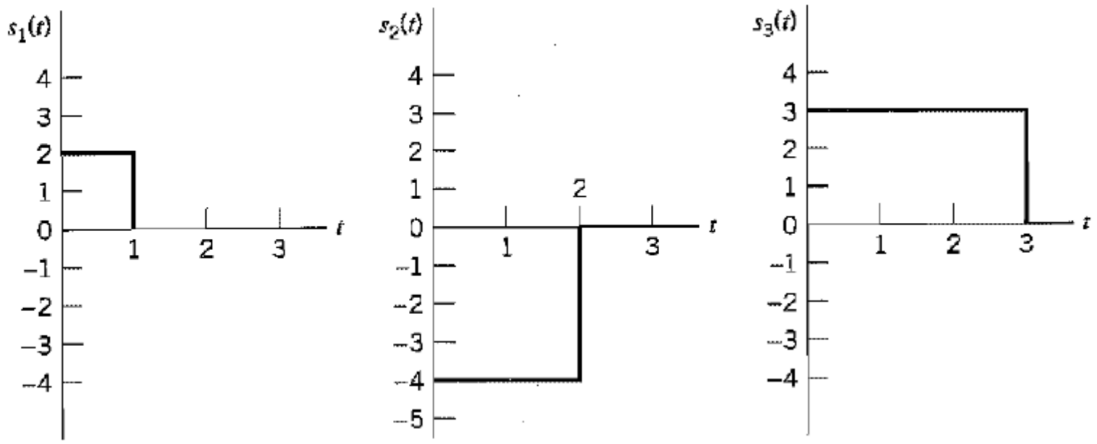


(Fig.1)

Problem 2

(Fig.1)

2 – i- using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis fuction to represent the three signals s_1 (t), s_2 (t), and s_3 (t) shown in the Fig.2.
ii- Express each of these signals in terms of the set of basic functions found in part(a).



(Fig.2)

Problem 3

3- The basis signals of a 3-dimensional signal space are given by:
$\Phi_1(t) = p(t)$, $\Phi_2(t) = p(t - T_o)$, and $\Phi_3(t) = p(t - 2T_o)$
Where: $p(t) = \frac{1}{\sqrt{T_o}}\{u(t) - u(t - T_o)\}$
Sketch the waveforms of the signals represented by (1,1,0), (2,-1,1), (3,2,-1/2), and (-1/2, -1,1) in this space.

Problem 4

4- If $p(t)$ is as in problem 3 and $\Phi_k(t) = p[t - (k - 1)T_o]$, $k = 1,2,3,4,5$.
a) Sketch the signals represented by (-1,2,3,1,4), (2,1,-4,-4,2), (3,-2,3,4,1), and (-2,4,2,2,0) in this space.
b) Find the energy of each signal.
c) Find the pairs of signals that are orthogonal.