BROKEN LINES SIGNALS AND SMARANDACHE STEPPED FUNCTIONS

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1. INTRODUCTION

The evolutive supermathematical functions (**FSM – Ev**) are discussed in the papers [1], [2], [3], [4], [5], [6], [7], [8]. They are combinations of the four types of **FSM** (**centric functions (FC), excentric functions (FE), elevated functions (FEl)** and **exotic functions** (**FEx**), taken by two, called **centricoexcentric functions**, **elevatoexotic functions**, **centricoelevated functions**, and so forth).

Aside from the **centric(super)matematical functions** (**FC**), that are only of **centric α** variable, all the others can be of **excentric θ** variable. In this way, between the three types of **excentric functions** (**FE, FE, FEx**) there are combinations between those of variable **θ** and those of variable **α**, as further proceeded.

From the website http://www.scritub.com/tehnica-mecanica/SEMNALE-ELECTRICE93336.php (**Fig. 1**) we present the main signals used in technics.

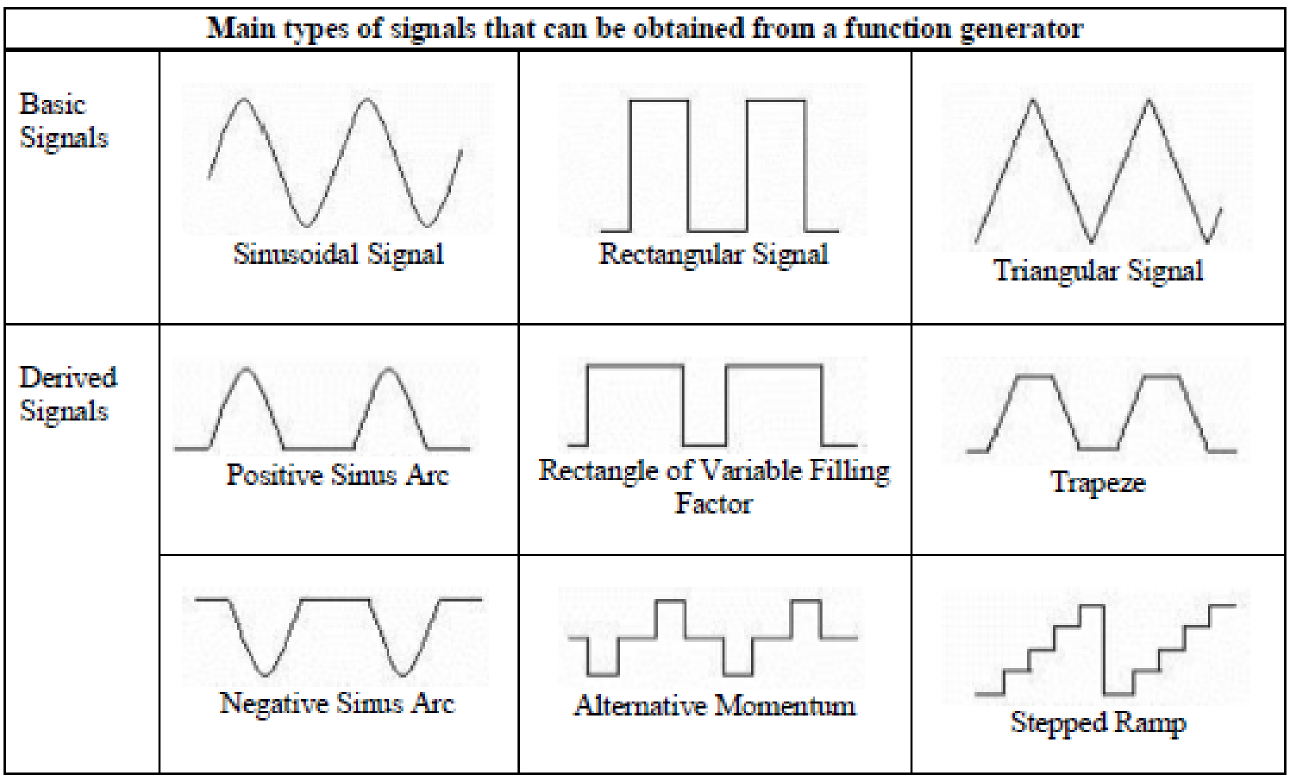


Fig. 1 **Sinusoidal centric signals ◀ and linear signals in straight line segments ● and ▶**

A number of **Smarandache stepped functions** are presented in the paper [13], so named in honor of the distinguished Professor Dr. Math. **Florentin Smarandache**, from the University of New Mexico, Gallup campus (USA). They were developed by means of **excentric circular supermathematical functions** (**FSM–CE**). Families of such **Smarandache stepped functions**, represented using **FSM–CE excentric amplitude** of **excentric θ variable**, are shown in **Figure 2**.

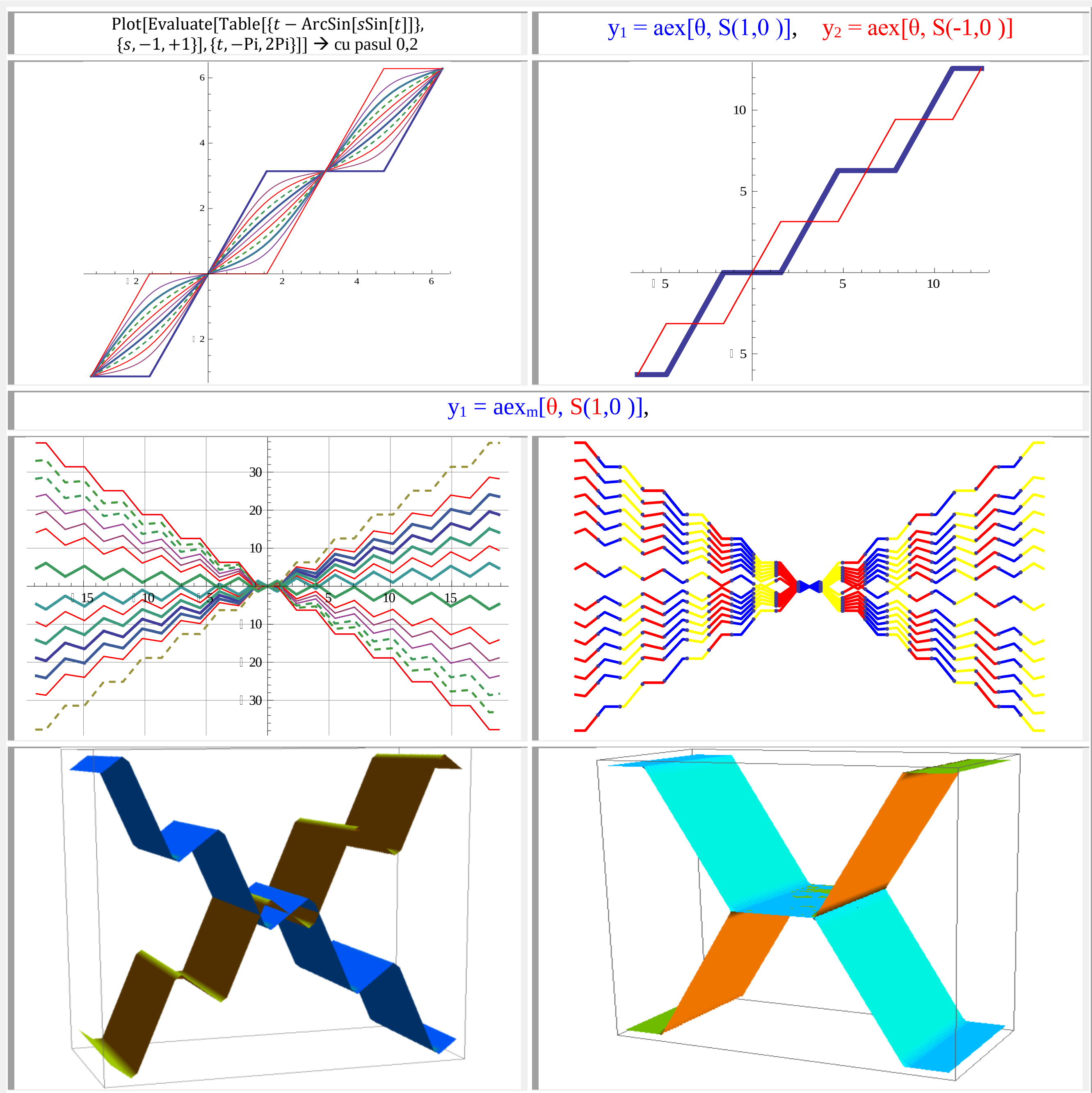


Fig. 2 Smarandache stepped functions represented using **FSM–CE aexθ** ▲ and **aex$_m$θ** ● and in 3D ▼

They have the equation:

(1) **aexθ** = **θ** – arcsin[s.sin(**θ** — **ε**)] = **θ** – **bexθ**, **Figure 1**▲

or the modified one:

(2) **aex$_m$θ** = **C**.**θ** – arcsin[s.sin(**n**.**θ** — **ε**)], **Figure 1**▼

with **C** ∈ [0,25; 2] and **n** = 2.

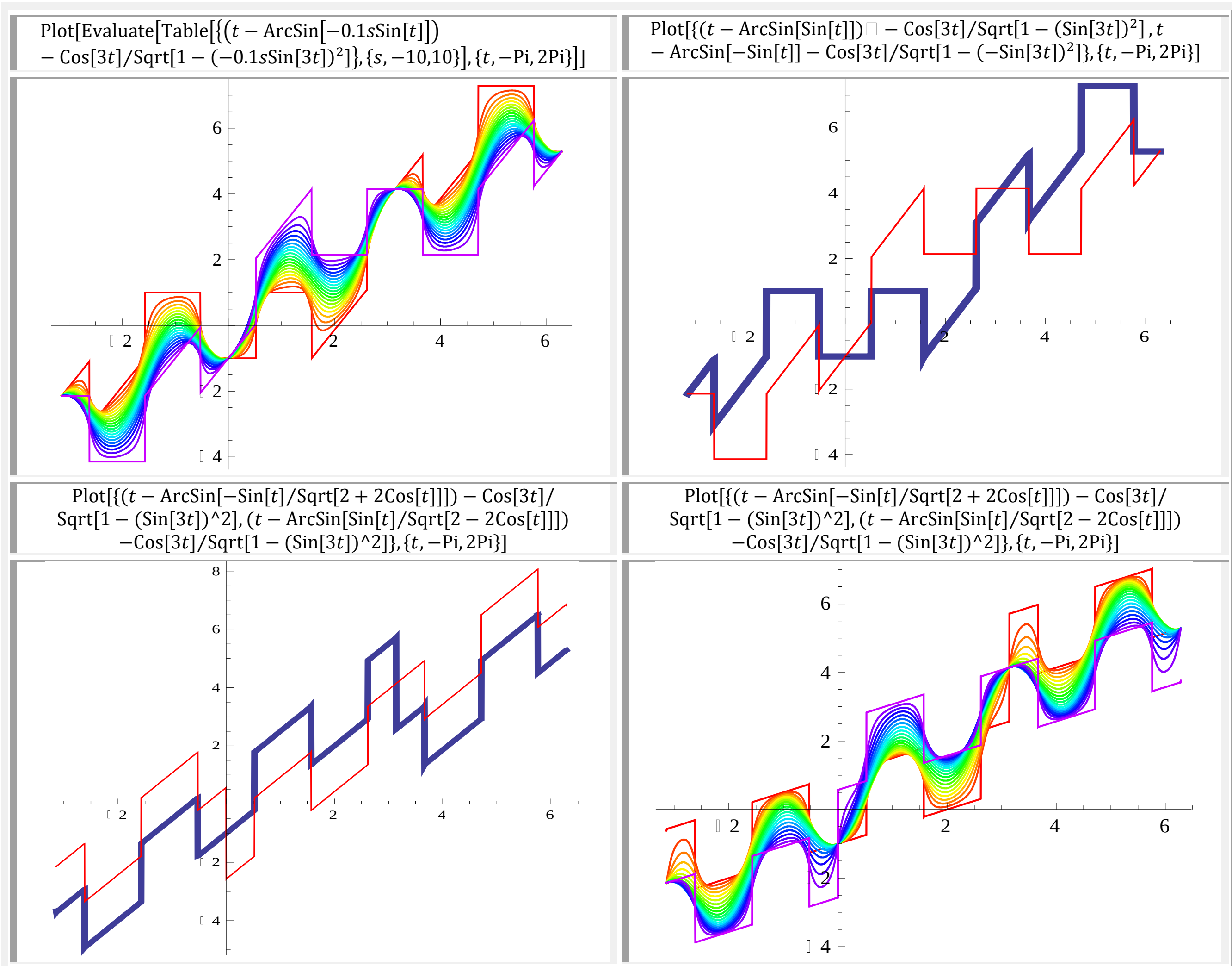


Fig. 3 Fascicle of graphs of **FSM–CE Smarandache** **$aex_m\theta$** with cascade aspect

Some graphs of the fascicle of **Smarandache stepped functions** have a "waterfall" or cascade aspect, such as those shown in **Figure 3 ◀** and because some graphics are in blue, of which were extracted, for **$s = \pm 1$**, **Smarandache stepped functions**; some steps are visibly harder to escalate, but not impossible.

2. BROKEN LINEAR FUNCTIONS OR SAW TOOTH LINEAR SIGNALS

Broken linear functions or symmetric saw tooth linear signals can be represented using **FSM–CE beta excentric** of **excentric variable θ :**

(3) **bexθ =** $\arcsin[s.\sin(\theta - \varepsilon)]$, **(Fig. 2 ◀)**

and asymmetric saw tooth linear signals using **FSM–CE beta excentric** of **centric variable α** :

(4) **Bexα** = $\arcsin \frac{s.\sin(\theta-\varepsilon),}{\sqrt{1+s^2-2s\cos(\theta-\varepsilon)}}$, **(Fig. 2 ▶)**

It can be observed from **Figure 2** that for extreme values of numerical linear excentricity **s**, i.e. for **s = ± 1**, the graphs of the functions are in broken straight lines, respectively they are symmetrical triangular signals for **bexθ** and asymmetrical triangular signals for **Bexα**.

In the next paragraph **(§ 3)** it is shown how these signals can be converted into step signals, respectively in **FSM–CE Smarandache** stepped functions using modified **FSM–CE bexθ** (**$bex_m θ$**).

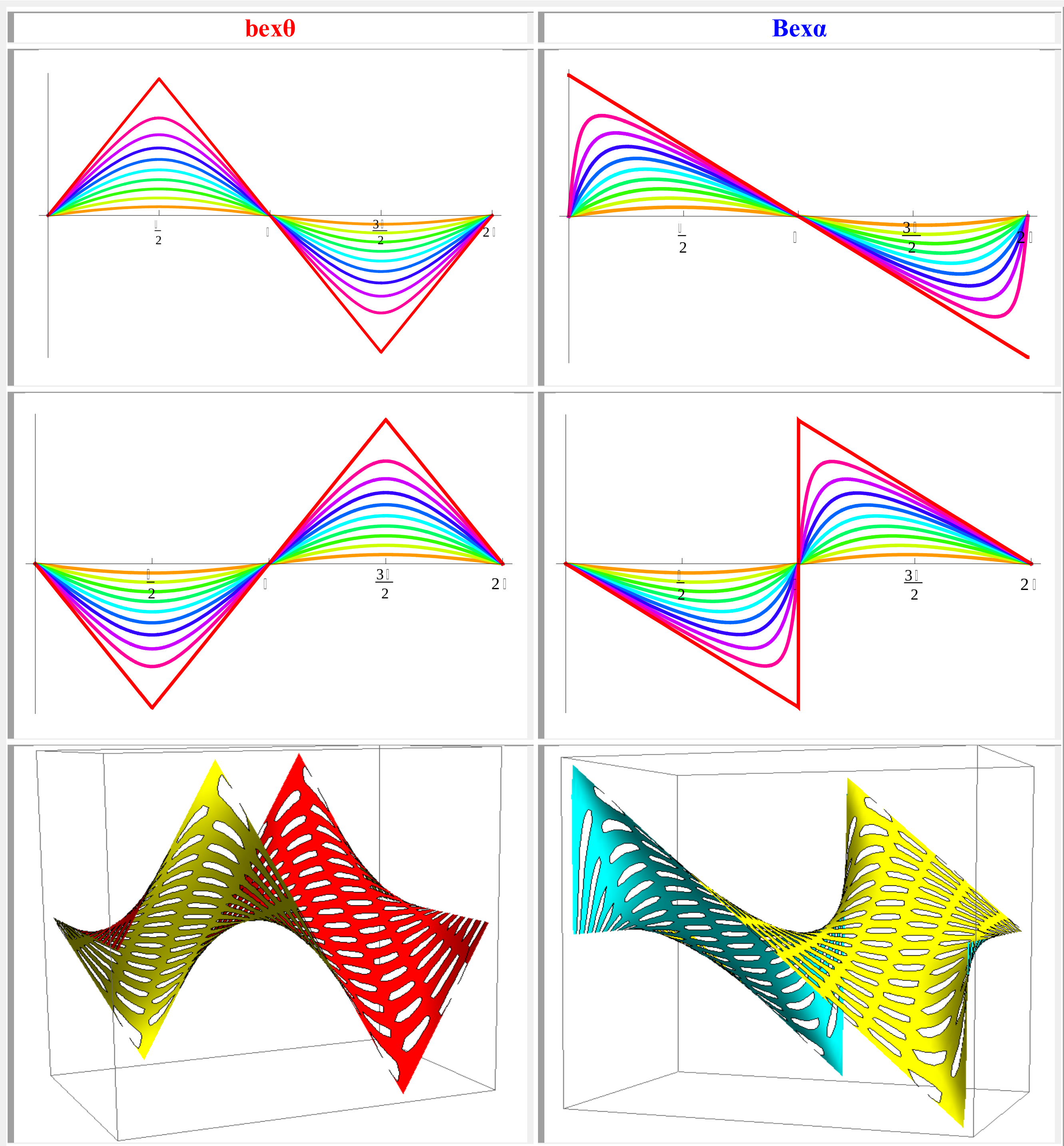


Fig. 4 The graphs FSM–CE bexθ ◀ and **Bexα ▶**

3. TRANSFORMATION OF LINEAR BROKEN FUNCTIONS IN EVOLUTIVE SMARANDACHE STEPPED FUNCTIONS

We will proceed as follows: From the family of **FSM–CE bexθ** ± **Bexα**, shown, for example, in **Figure 5**, for **s ∈ [-1, +1]** with the step **0,2** ▲ we will select those of **s = ± 1** ●, next by transformation **FSM–CE bexθ**, videlicet**:**

(5) $\mathbf{bex\theta} + \mathbf{Bex\alpha} = \arcsin[s.\sin(\theta - \varepsilon)] + \arcsin\frac{s.\sin(\theta-\varepsilon)}{\sqrt{1+s^2-2s\cos(\theta-\varepsilon)}}$ →

(6) $\mathbf{bex_m\theta} + \mathbf{Bex_m\alpha} = \mathbf{C_1.\theta} + \mathbf{bex\theta} \pm \mathbf{C_2\alpha} + \mathbf{Bex\alpha} = \mathbf{C.\theta} + \arcsin[s.\sin(\theta - \varepsilon)] \pm \arcsin\frac{s.\sin(\theta-\varepsilon)}{\sqrt{1+s^2-2s\cos(\theta-\varepsilon)}}$,

($\mathbf{C = C_1 + C_2}$) next, in footnote ▼, the **Smarandache** stepped functions graphs are shown (see **Fig. 5**).

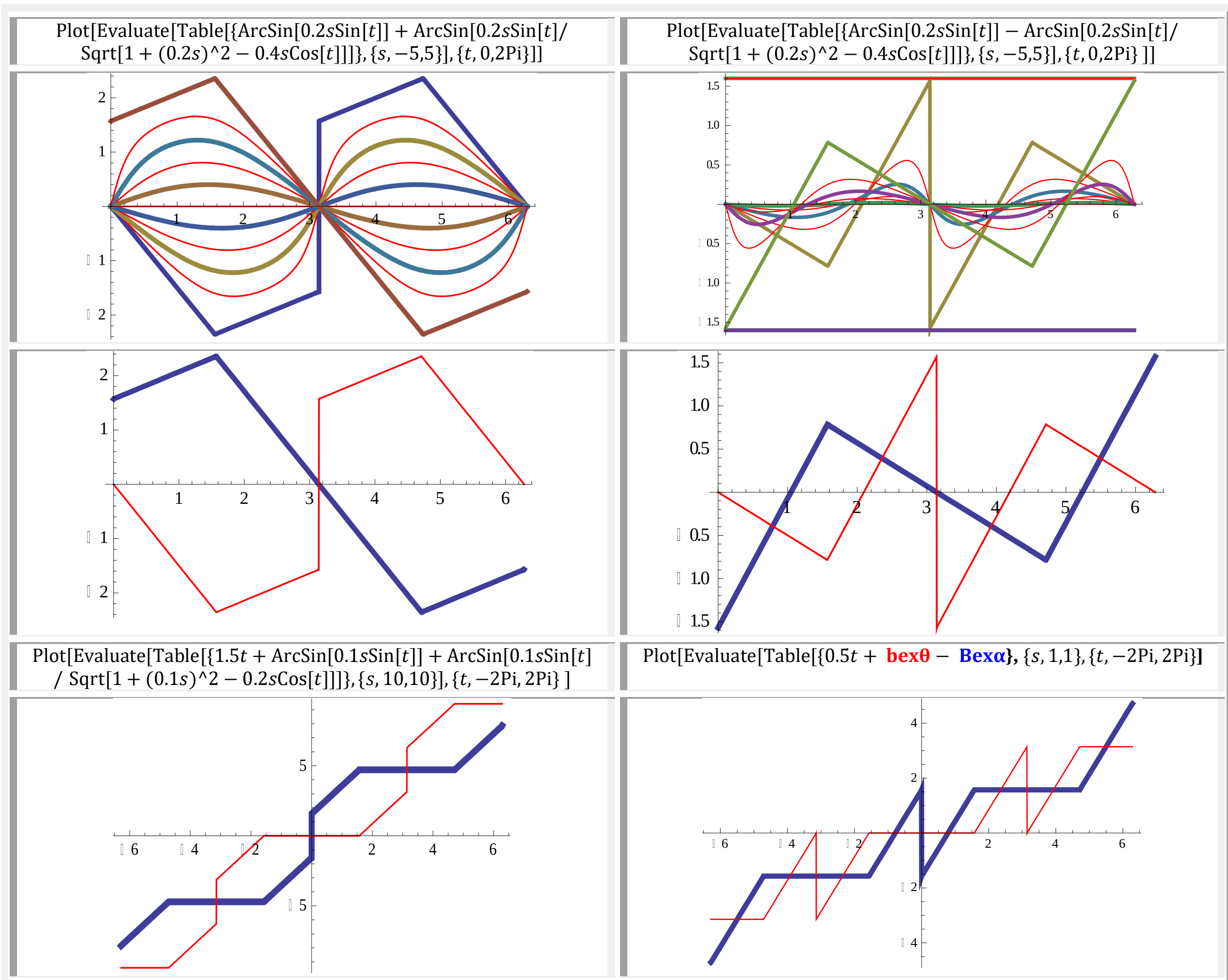


Fig.5 The graphs FSM–CE 1,5.θ + bexθ + Bexα ◀ and **0,5.θ + bexθ - Bexα** ▶

In this way, the resulting function, the stepped **Smarandache** function**,** is a **FSM–CE excentric evolutive function** of both variables. They can be added and / or subtracted, as in **Figure 5**, or multiplied and / or divided. Or the functions can be of **2θ**, **3θ**, … or **nθ** (see **Fig. 6**).

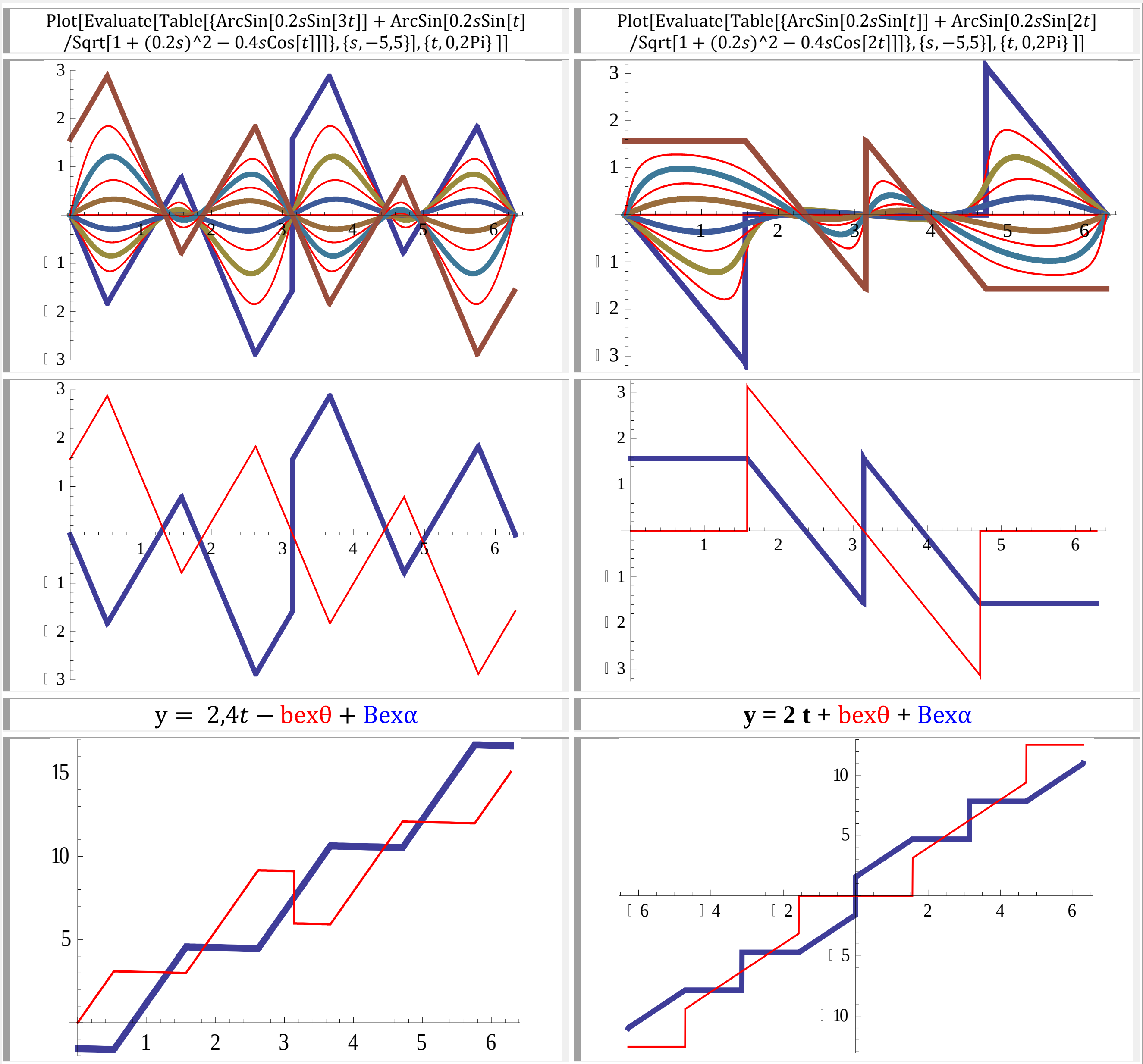
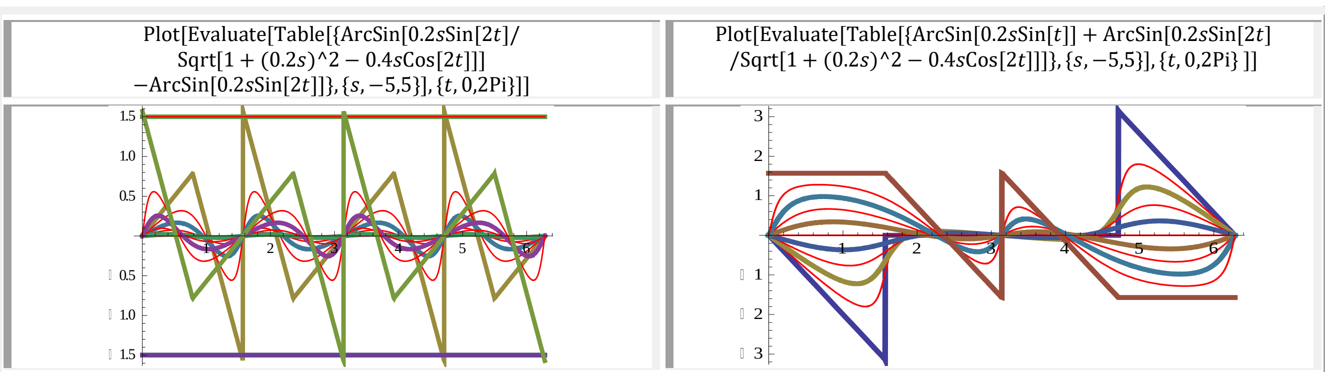


Fig.6 The graphs FSM–CE 1,5.θ + bex3θ + Bexα ◀ and 0,5.θ + bexθ – Bex2α ▶ (θ ≡ α ≡ t)



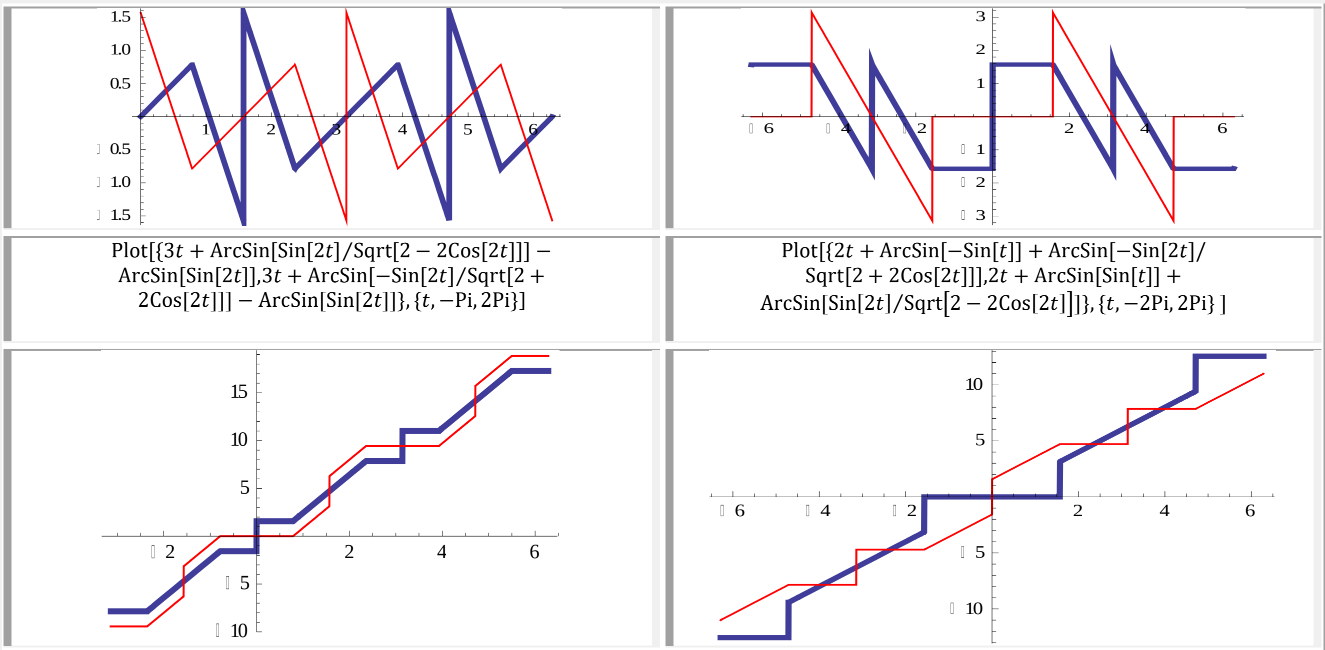


Fig. 7 The graphs of evolutive stepped Smarandache FSM–CE
3.θ + bex2θ + Bex2α ◀ and 2.θ + bexθ – Bex2α ▶ (θ ≡ α ≡ t)

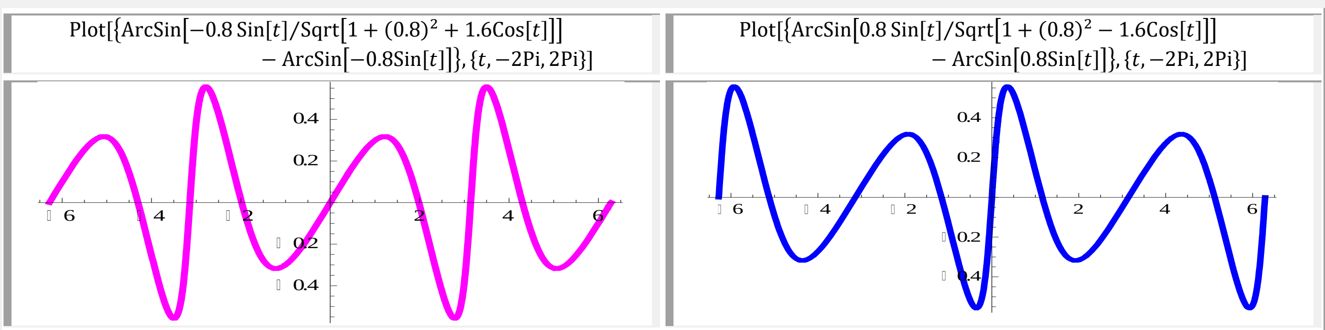


Fig. 8 The graphs of some **evolutive FSM–CE** found in science

It's very interesting how, by simply adding the term **nθ**, the graphs transformation is so profound. Actually, for **n = 2**, distributing **2t** in **θ** and **α** to the two **beta excentric** (**bexθ** and **Bexα**) functions, we reach the **excentric amplitude** (**aexθ** and **Aexα**) **functions**, as result from relation (1).

In **Figure 8**, out of topic, the graphs of some functions are presented, which the author met in the scientific literature, and to which, in due course, did not know the equation, which is not currently the case.

From **Figure 9** ● ▶ it results a new possibility to represent **exactly** the graphs of **rectangular signals**, in addition to their representation by derivative excentric **FSM–CE** of **excentric dexθ** variable, and by the **excentric quadrilobic functions FSM–QE siqθ** and **coqθ** of equations:

$$(7)\quad \begin{cases} \mathbf{dex\theta} = 1 + \dfrac{s.\cos(\theta-\varepsilon)}{\sqrt{1-s^2\sin^2(\theta-\varepsilon)}} \\ \mathbf{coq\theta} = \dfrac{\cos\theta}{\sqrt{1-s^2\sin^2(\theta-\varepsilon)}} \\ \mathbf{siq\theta} = \dfrac{\sin\theta}{\sqrt{1-s^2\cos^2(\theta-\varepsilon)}} \end{cases}$$

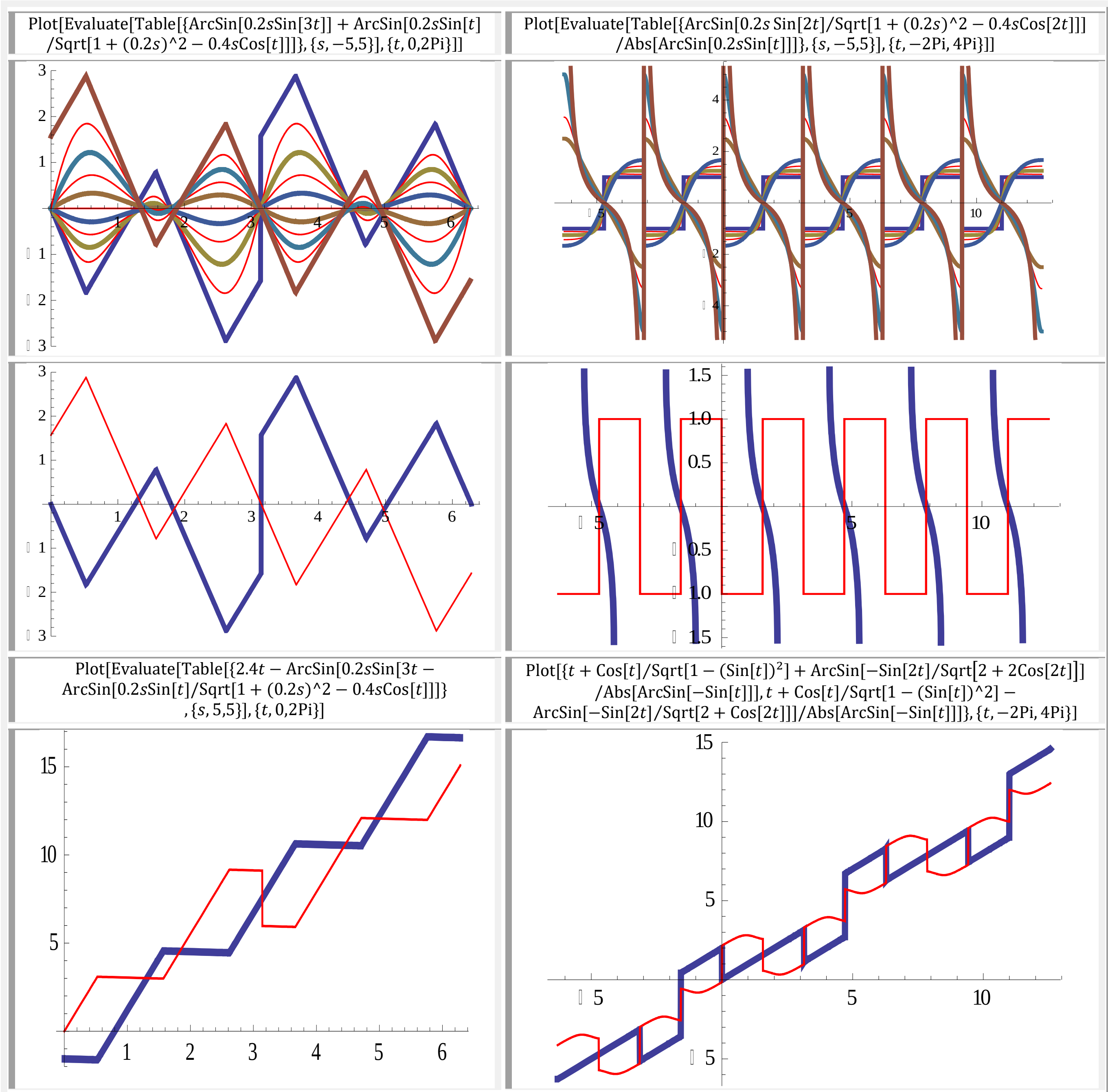


Fig. 9 The graphs FSM–CE 2,4.θ + bex3θ + Bexα ◀ and C.θ + Bex2α / bexθ ▶ (θ ≡ α ≡ t)

4. SMARANDACHE STEPPED FUNCTIONS ACHIEVED BY EXCENTRIC QUADRILOBIC FUNCTIONS OF NUMERICAL LINEAR EXCENTRICITY s= ± 1

Excentric quadrilobic functions FSM–QE siqθ and coqθ have the equations from the relations (7) and the graphs from **Figure 10.** It can be observed without difficulty that for **s = ± 1** perfect rectangular functions / signals are obtained.

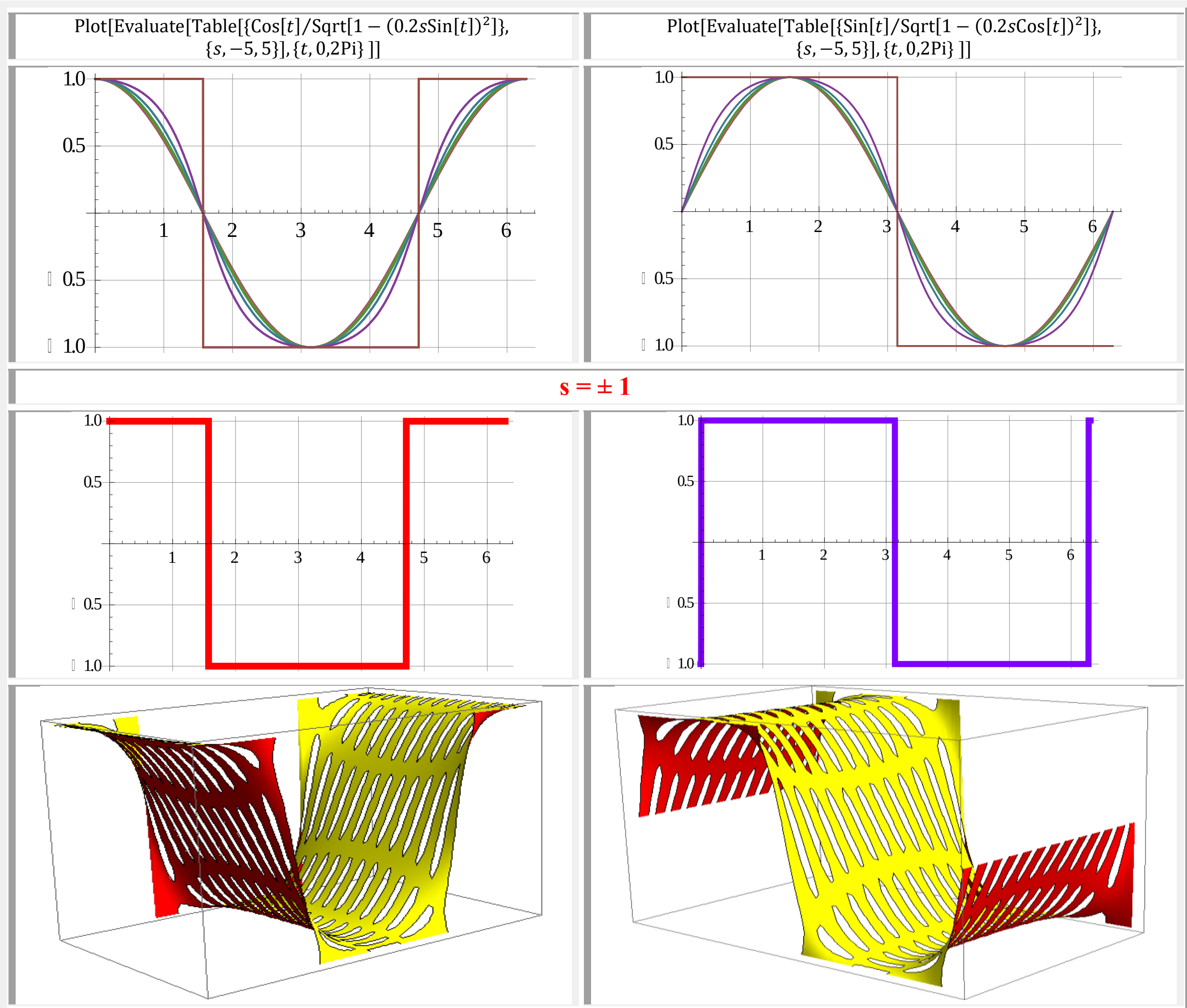
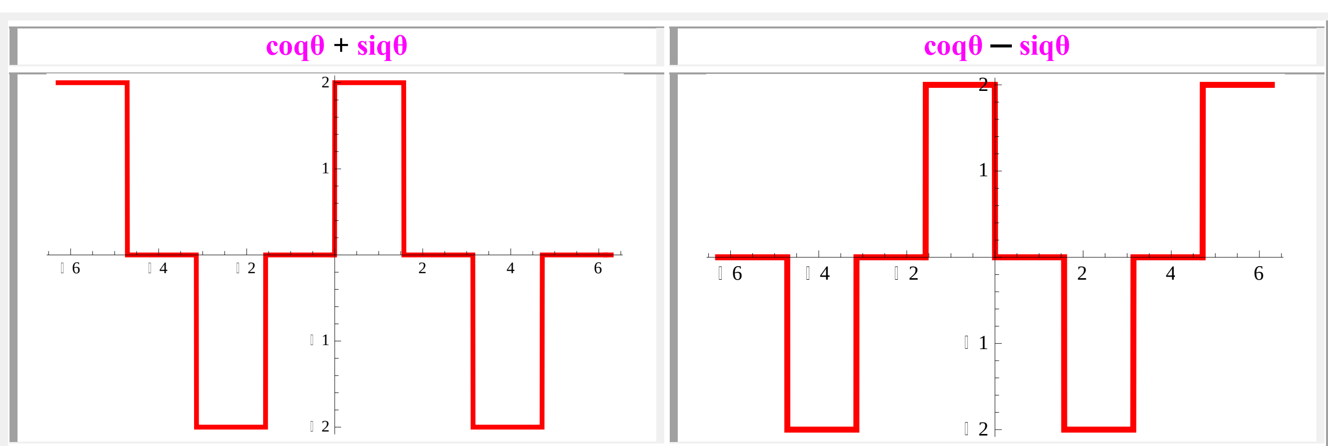


Fig. 10 The graphs **FSM**– **QE coqθ** ◀ and **siqθ** ▶



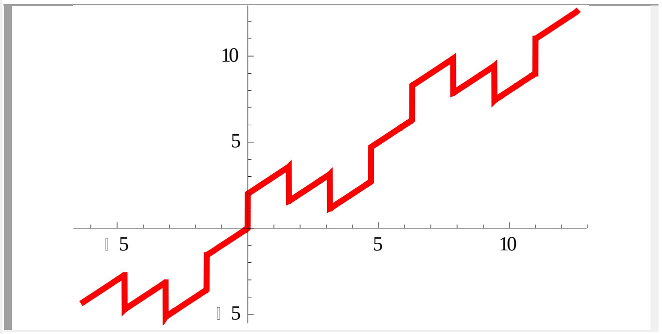
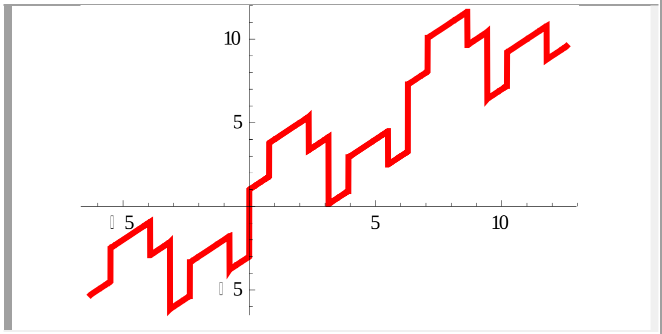
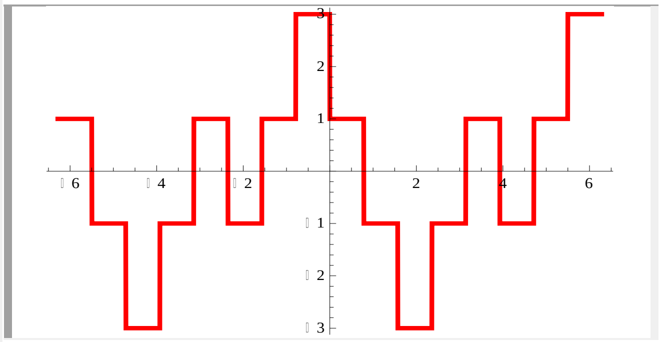
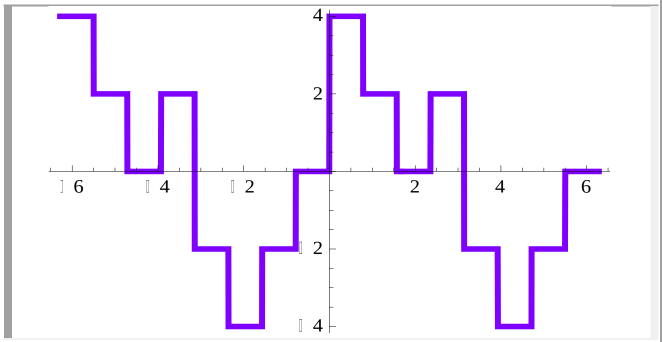
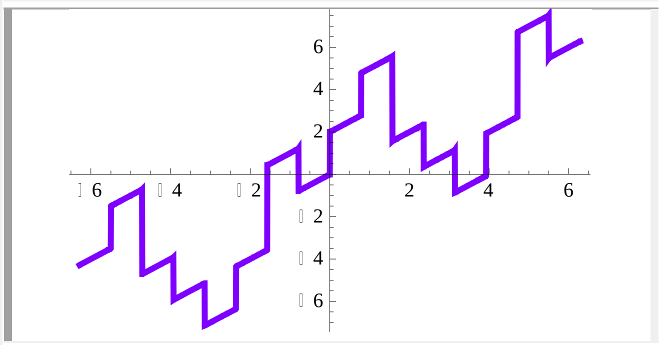
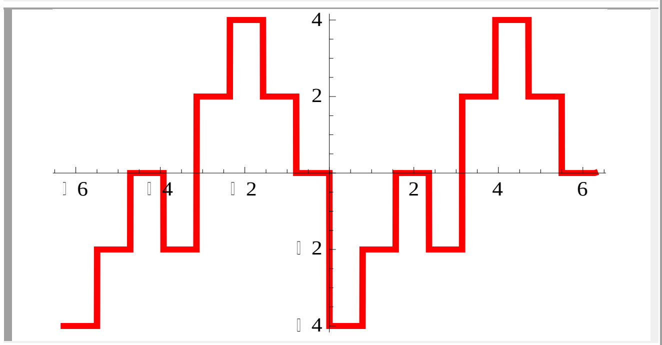
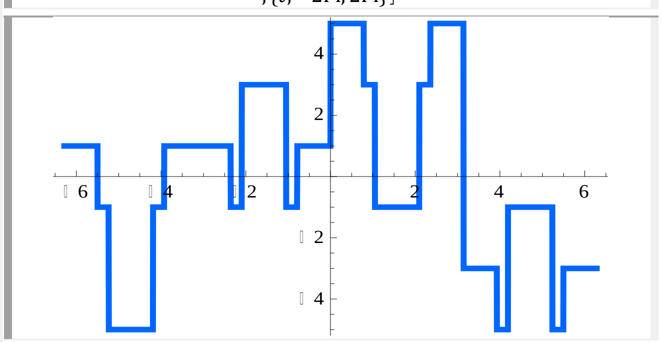
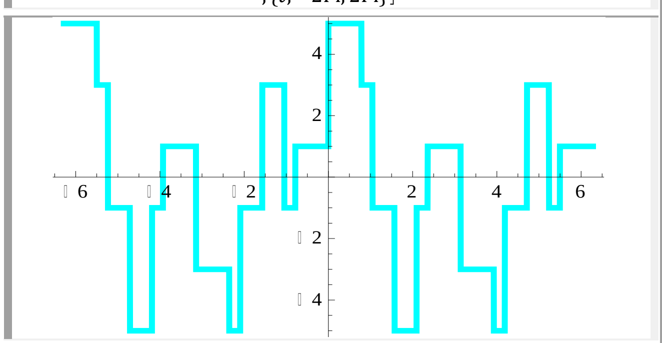
θ + coqθ + siqθ	**θ – coq2θ + siqθ**
	
Plot[{Cos[*t*]/Sqrt[1 – (Sin[*t*])^2] + Cos[2*t*]/Sqrt[1 – (Sin[2*t*])^2] – Sin[*t*]/Sqrt[1 – (Cos[*t*])^2]}, {*t*, –2Pi, 2Pi}]	Plot[{Cos[*t*]/Sqrt[1 – (Sin[*t*])^2] + Cos[2*t*]/Sqrt[1 – (Sin[2*t*])^2] + 2 Sin[*t*]/Sqrt[1 – (Cos[*t*])^2]}, {*t*, –2Pi, 2Pi}]
	
Plot[{*t* + 2 Cos[*t*]/Sqrt[1 – (Sin[*t*])^2] – Cos[2*t*]/ Sqrt[1 – (Sin[2*t*])^2] + Sin[*t*]/ Sqrt[1 – (Cos[*t*])^2]}, {*t*, –2Pi, 2Pi}]	Plot[{–(Cos[*t*]/Sqrt[1 – (Sin[*t*])^2] + Cos[2*t*]/Sqrt[1 – (Sin[2*t*])^2] + 2 Sin[*t*]/Sqrt[1 – (Cos[*t*])^2])}, {*t*, –2Pi, 2Pi}]
	
Plot[{(2 Cos[0.5*t*]/Sqrt[1 – (Sin[0.5*t*])^2] + Cos[2*t*]/ Sqrt[1 – (Sin[2*t*])^2] + 2 Sin[3*t*]/Sqrt[1 – (Cos[3*t*])^2])} , {*t*, –2Pi, 2Pi}]	Plot[{(2 Cos[*t*]/Sqrt[1 – (Sin[*t*])^2] + Cos[2*t*]/ Sqrt[1 – (Sin[2*t*])^2] + 2 Sin[3*t*]/Sqrt[1 – (Cos[3*t*])^2])} , {*t*, –2Pi, 2Pi}]
	

Fig. 11 The graphs **FSM– QE coqmθ ◀ siqnθ ▶** and their combinations for **s = 1**

BIBLIOGRAPHY

1	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA I** : **FUNCŢII SUPERMATEMATICE EFECTIVE (FSEf)**	Internet
2	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA II** : **FUNCŢII SUPERMATEMATICE EVOLUTIVE**	Internet
3	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA III** : **FUNCŢII SM REPREZENTÂND SEMNALE LINIARE FRÂNTE**	Internet
4	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA IV** : **FUNCŢII SUPERMATEMATICE EXCENTRICOELEVATE**	Internet
5	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA V** : **FUNCŢII SUPERMATEMATICE EVOLUTIVE EXCENTRICE DE VARIABILE EXCENTRICOCENTRICE**	Internet
6	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA VI** : **FUNCŢII SUPERMATEMATICE EVOLUTIVE ELEVATOEXCENTRICE DE θ şi, respectiv, α**	Internet
7	Mircea E. Şelariu	NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII. **NOTA VII** : **FUNCŢII SUPERMATEMATICE EVOLUTIVE ELIPTICE CENTRICOEXCENTRICE DE PERIOADĂ 4K(k)**	Internet
8	Mircea E. Şelariu	**NEMĂRGINIREA ŞI MĂREŢIA SUPERMATEMATICII Nota VIII:FUNCŢII SUPERMATEMATICE EVOLUTIVE ELIPTICE CENTRICOEXCENTRICE DE PERIOADĂ 2π**	Internet
9	Mircea E. Şelariu	**SUPERMATEMATICA. FUNDAMENTE**	Ed. POLITEHNICA, Timişoara, 2007
10	Mircea E. Şelariu	**SUPERMATEMATICA. FUNDAMENTE VOL.I ŞI VOL. II EDIŢIA A 2-A**	Ed. POLITEHNICA, Timişoara, 2012
11	Mircea E. Şelariu	**SUPERMATEMATICA. FUNDAMENTE VOL.I ŞI VOL. II EDIŢIA A 3-A**	Ed, Matrix Rom, Buc, 2015
12	Mircea E. Şelariu	**SUPERMATEMATICA**	Com.VII Conf. Internaţ. de Ing. Manag. şi Tehn. TEHNO'95, Timişoara Vol. 9 Matematică Aplicată, pag. 41…64
13	Mircea E. Şelariu	**SMARANDACHE STEPPED FUNCTIONS**	Scientia Magna Vol. 3 (2007), No. 1, 81-92
14	Mircea E. Şelariu, Smarandache Florentin, Niţu Marian	**CARDINAL FUNCTIONS AND INTEGRAL FUNCTIONS**	INTERNATIONAL JOURNAL OF GEOMETRY Vol. 1 (2012), No. 1, 27 - 40
15	Mircea E. Şelariu,	**TECHNO-ART OF SELARIU SUPERMATHEMATICS FUNCTIONS VOL I ŞI VOL. II**	American Research Press, 2007