

CHAO AND HEART DATABASE

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Gratuit computed with matlab**

Animator :dit papa lamine ndao

From 3eme cycle grant DGRST France 1977 to 1979,treatment of Information and automatic university paris orsay 1979

Mail1:cardiorythmor2008@live.fr

Mail2:cardiacsimulator2005@yahoo.fr

Tele:221.764610503

Date:2009

Editorial

- 1)investigation autonomous chao of modele pacemaker VI1(dimension 2)and modele pacemaker VINAIK(dimension 3)
- 2)investigation autonomous chao of modele VI1 and modele VINAIK,case of neuro-signals(sinusoidal chao).
- 3)investigation chao non autonomous with relaxed oscillation(**relaxed oscillation of balth van der pol**)

Modele Pacemaker VI1

$$\begin{aligned} dV/dt &= (a/C)V^3 + (b/C)V^2 + (d_0/C)V + d_1/C - (1/C)I_1 + (A/C)\sin(\omega t) \\ dI_1/dt &= (1/L)V - (R/L)I_1 + E/L \end{aligned}$$

The cardiac parameters are:a,b,d0,d1,E,R,L, and C.

Modele Pacemaker VINAIK

$$\frac{dV}{dt} = (a/C)V^3 + (b/C)V^2 + (d_0/C)V + d_1/C - (1/C)(I_{Na} + I_K) + (1/C)A \sin \omega t$$

$$\frac{dI_{Na}}{dt} = (1/L_{Na})V - (R_{Na}/L_{Na})I_{Na} + E_{Na}/L_{Na}$$

$$\frac{dI_K}{dt} = (1/L_K)V - (R_K/L_K)I_K + E_K/L_K$$

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SERIE 3 VOLUME 1

1-Investigation non autonomous chao with modele pacemaker VI1(relaxed chao of Balth Van Der Pol).
a=-0.3;b=0.3;do=0.65;d1=-0.005;E=-90mV;L=100mH;
C=2600 μ F;R=0.4; Duration calcul=2400ms;N=1000
A=1; w=6.28; (excitation Asinwt)
Figure:plan (V,I1) of henri poincare ,strange attractor

Figure:plan henri poincare (V,I1)

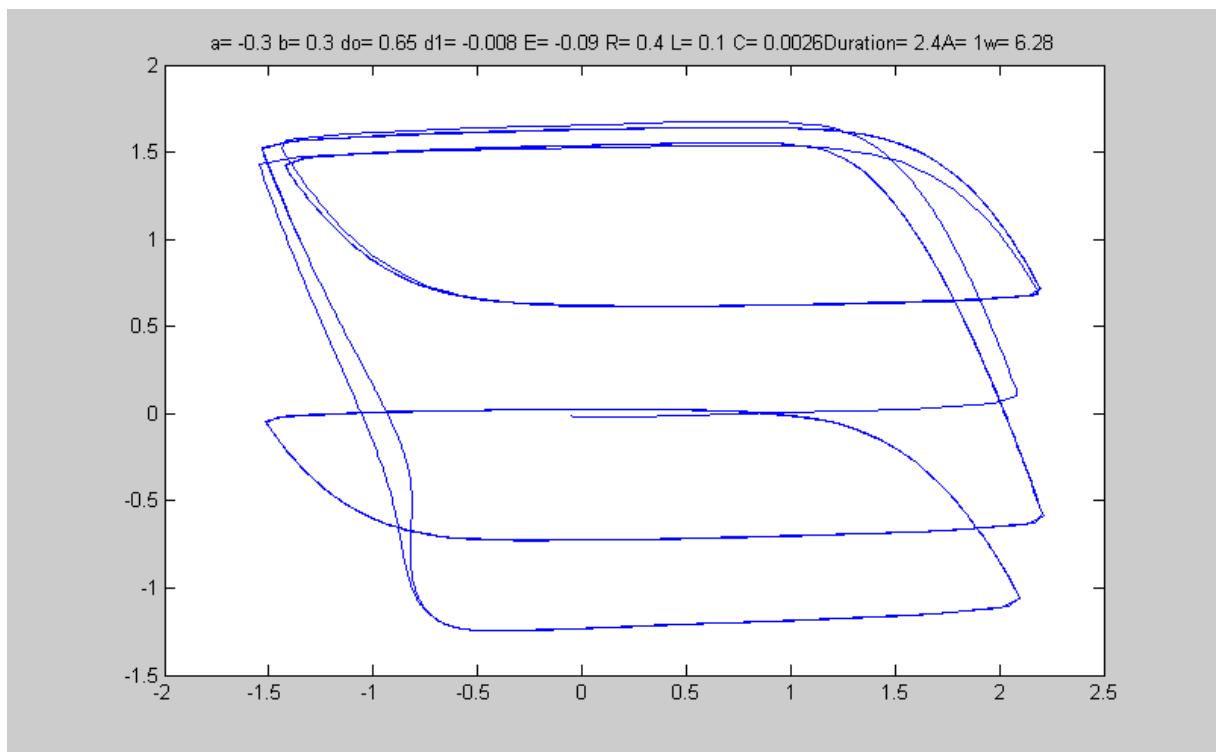
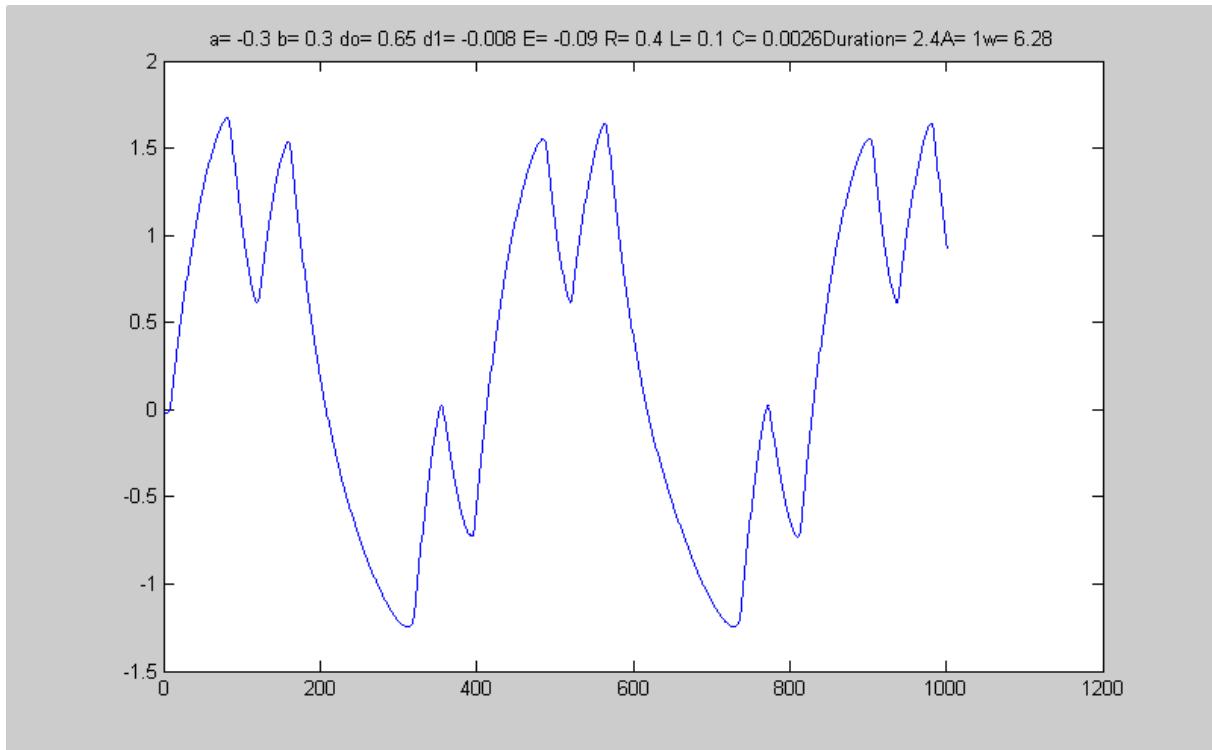


Figure:I1(t)



**When the correlative dimension,cd,is integer,the trajectory is a closed curve if CD=1 like our case.Suppose to set the state vector,
 $Y=(V(t),I_1(t))$. H is the heaver side function, and we have,**

CD= limit n(infinite)(1/n²)H($\epsilon - (Y_i - Y_j)$) I,j time sampled

$Y_i=(Y_{i+1},Y_{i+2},\dots,Y_{i+r})$

CD= ϵ^{cd} when goes to infinite.

1)cd=1 closed curve,cd integer

2)cd=2 torus

3)cd non integer ,strange attractor.

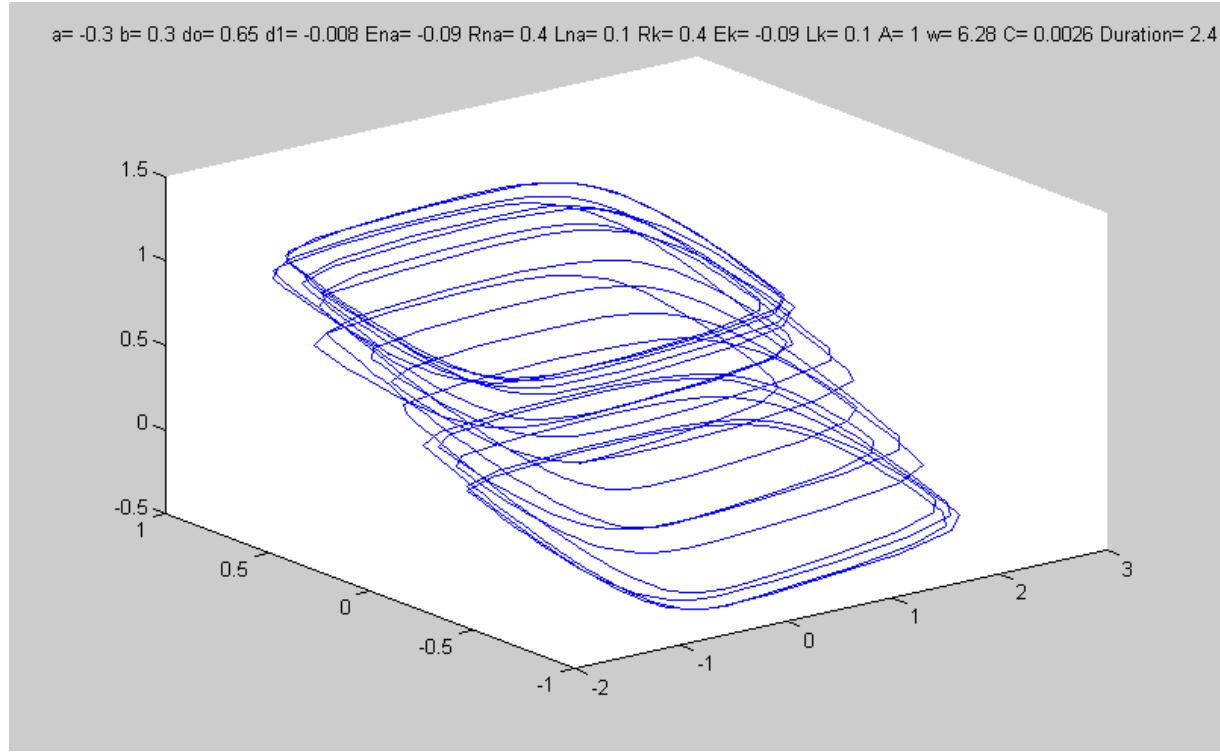
2-Investigation modele pacemaker VINAIK at same point like VI1

a=-0.3;b=0.3;do=0.65;d1=-0.008;Ena=-90mV;Lna=100mH;

Rna=0.4;duration=2.4;N=1000;Rk=0.4;Lk=100mH;C=2600μF

Ek=-90mV ;w=6.28 ;A=1

Figure :plan of phase henri poincare (V,I1)



It is seeming like closed curve in dimension 3.

Figure: $V(t)$

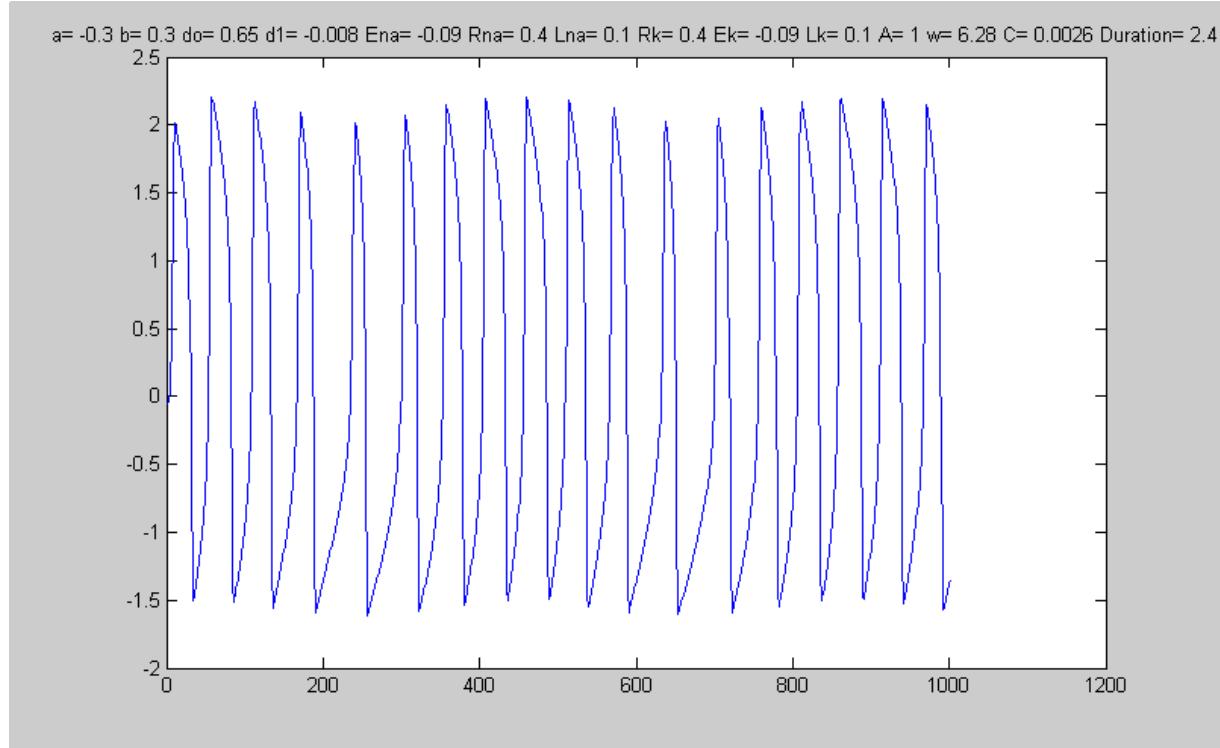


Figure : Ina(t)

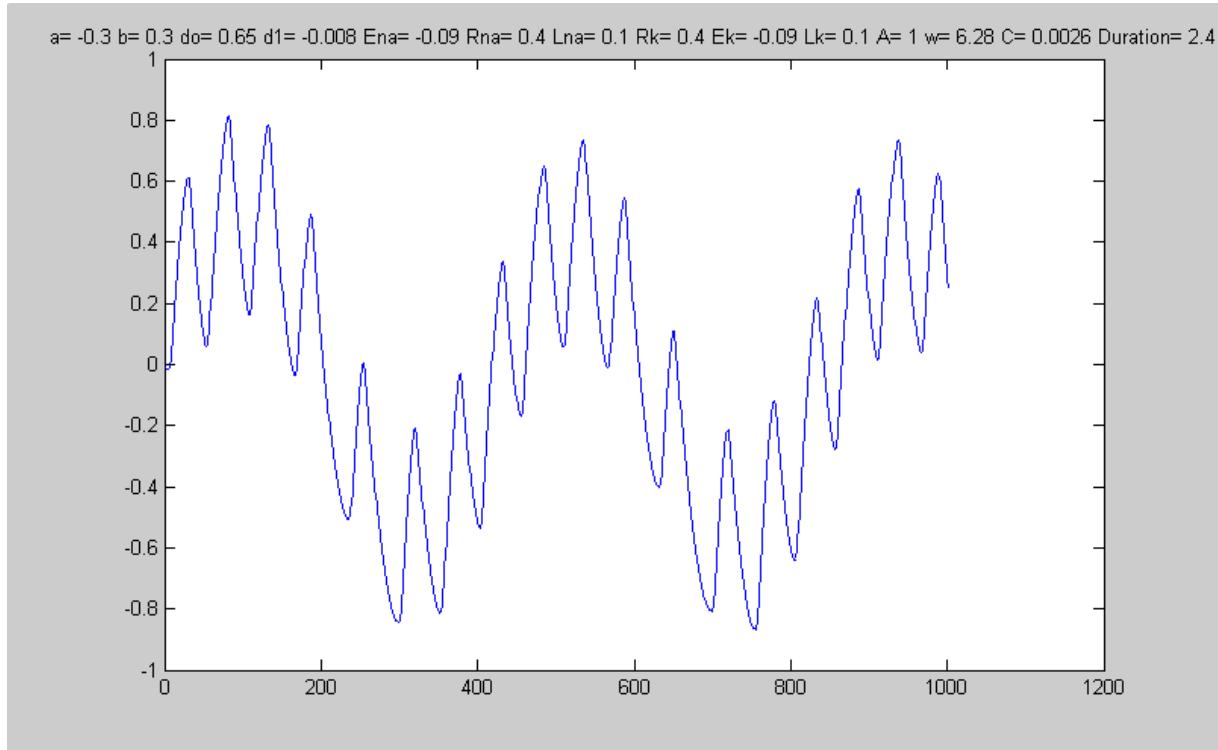


Figure :Ik(t)

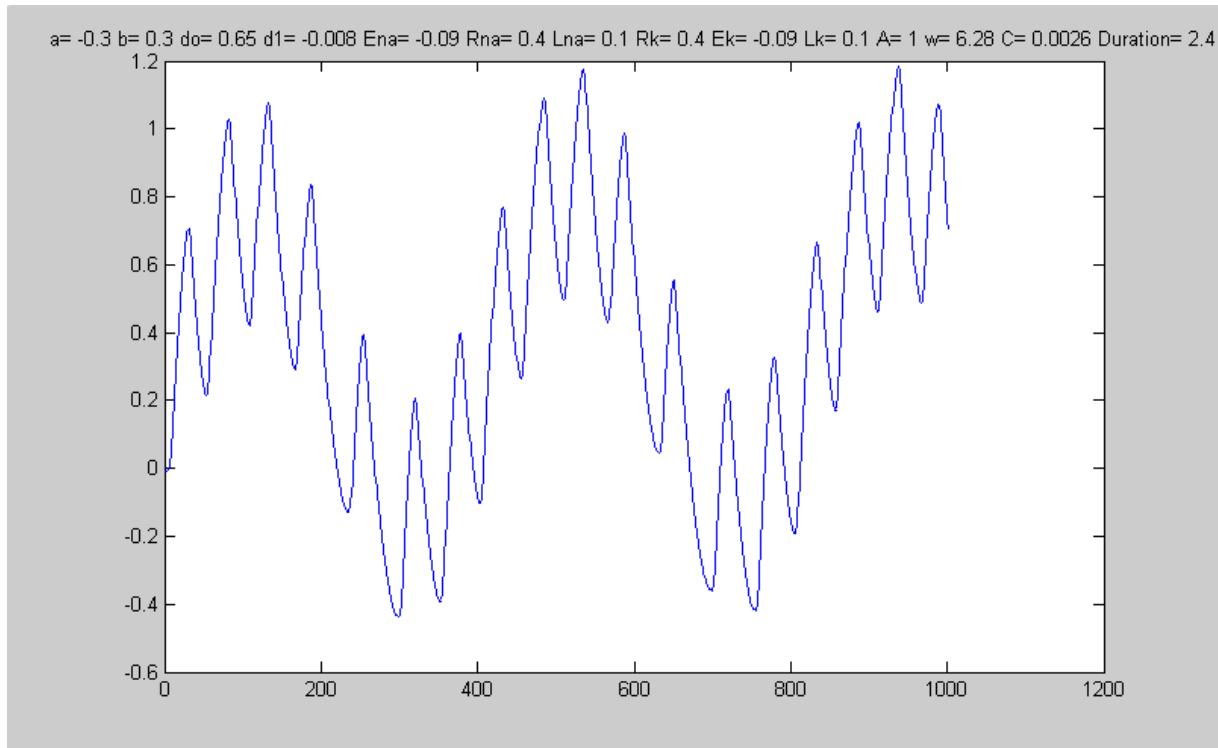


Figure:plan phase henri poincare (V,I_a)

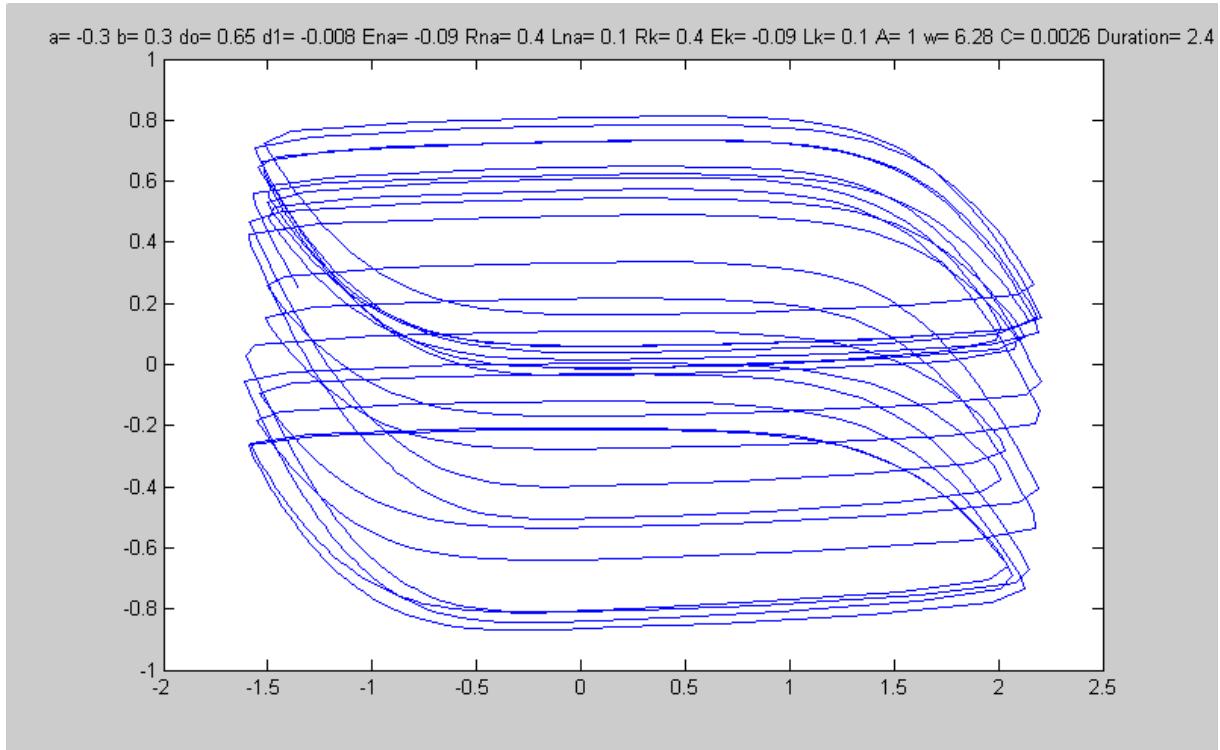


Figure: plan (V,I_k)

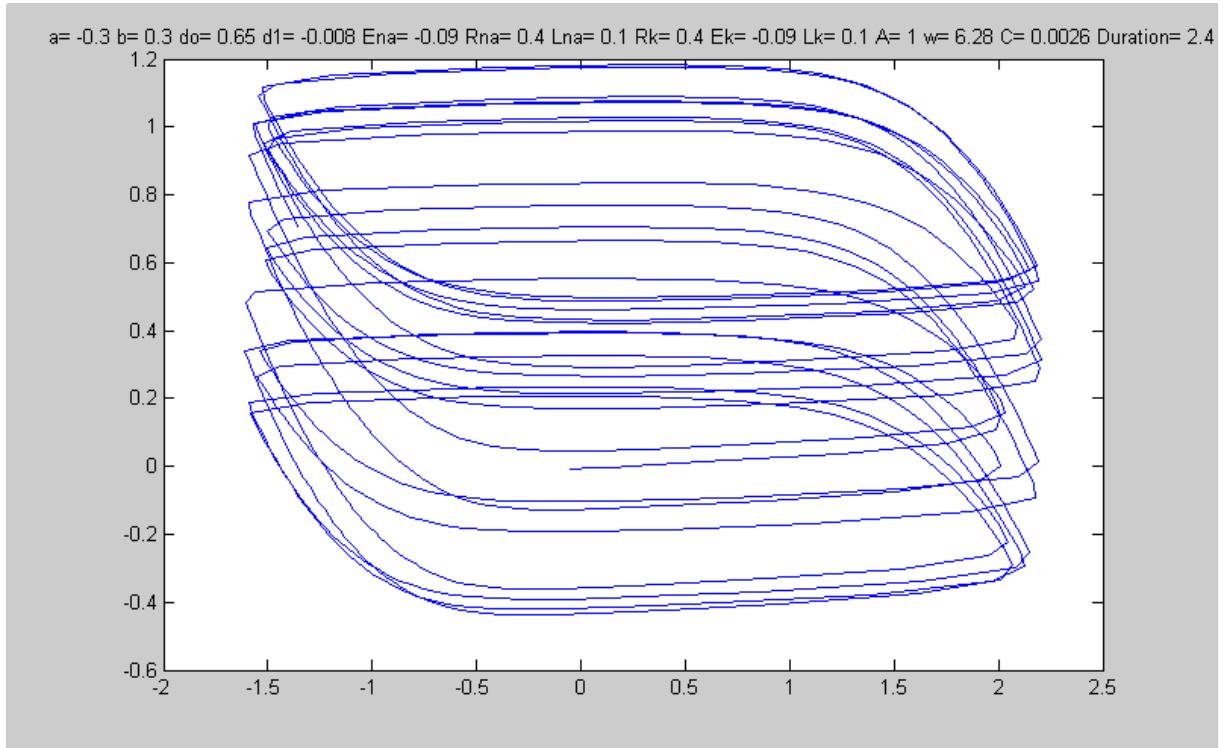
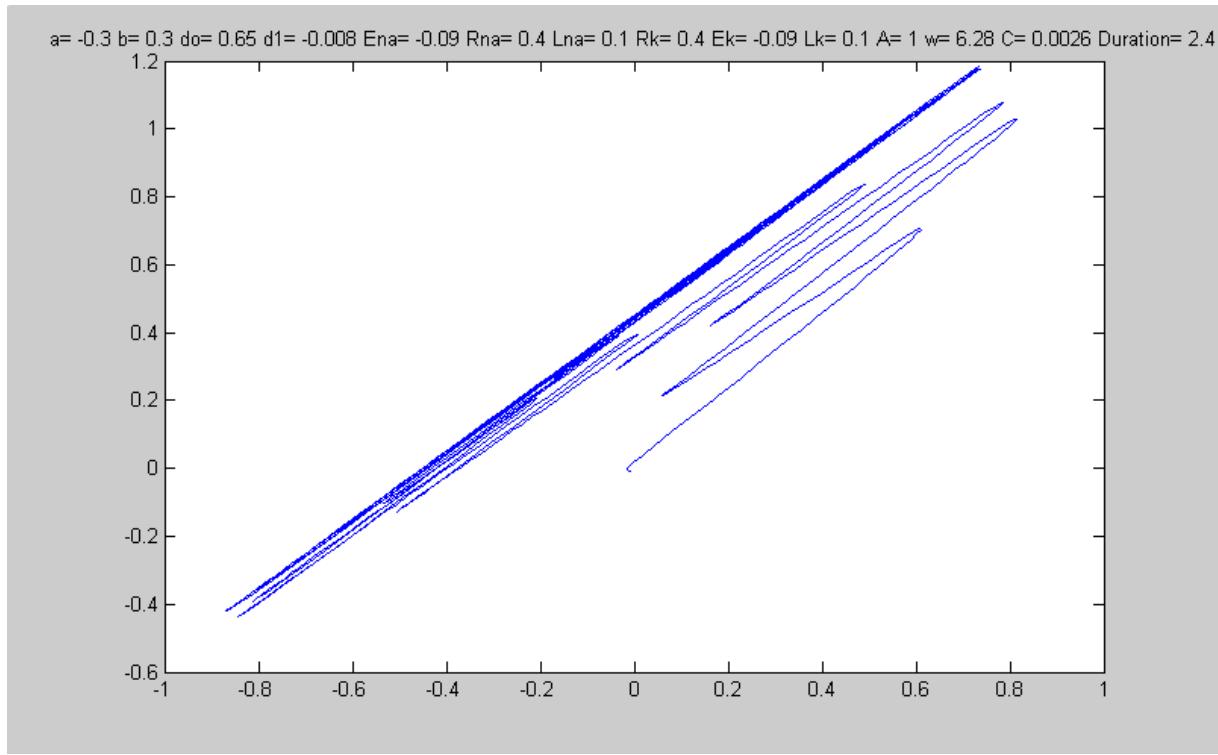


Figure : plan (I_a,I_k)



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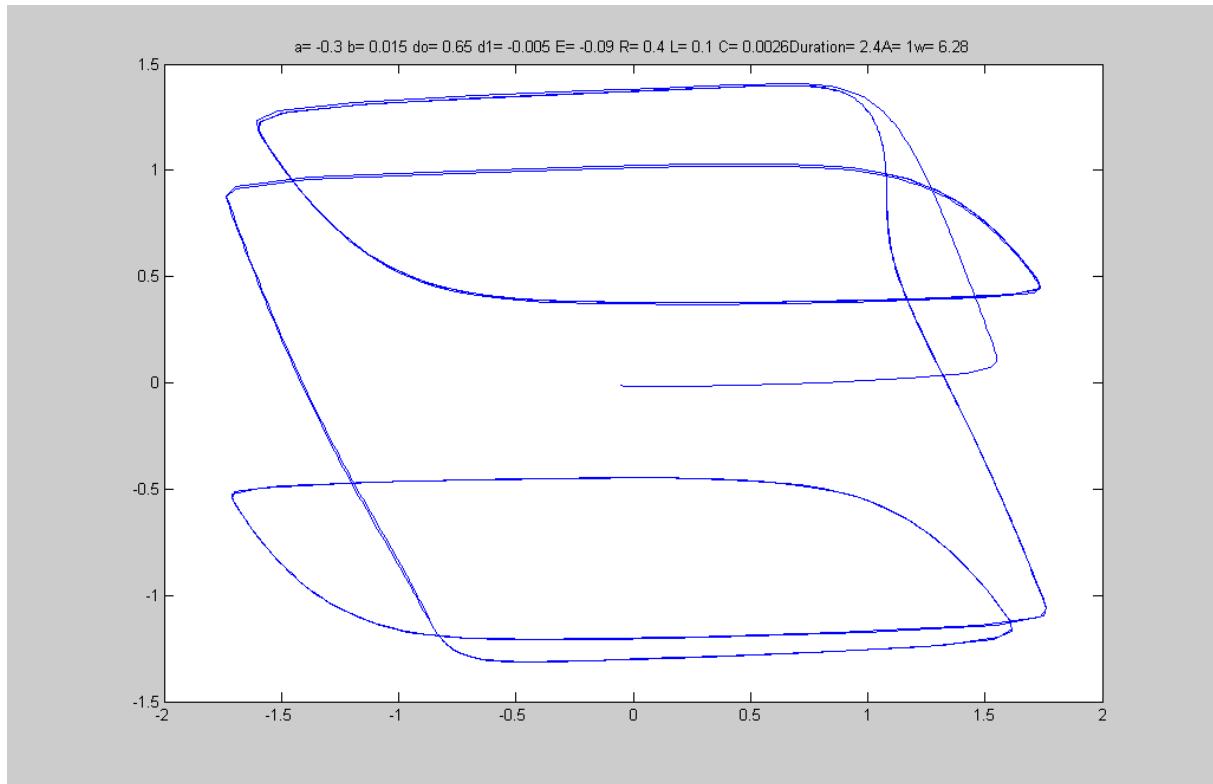
SERIE 3 VOLUME 2

1-investigation model pacemaker VI1

$a = -0.3; b=15e-3; do=0.65; d1=0.005; E=-90mV; L=100mH$

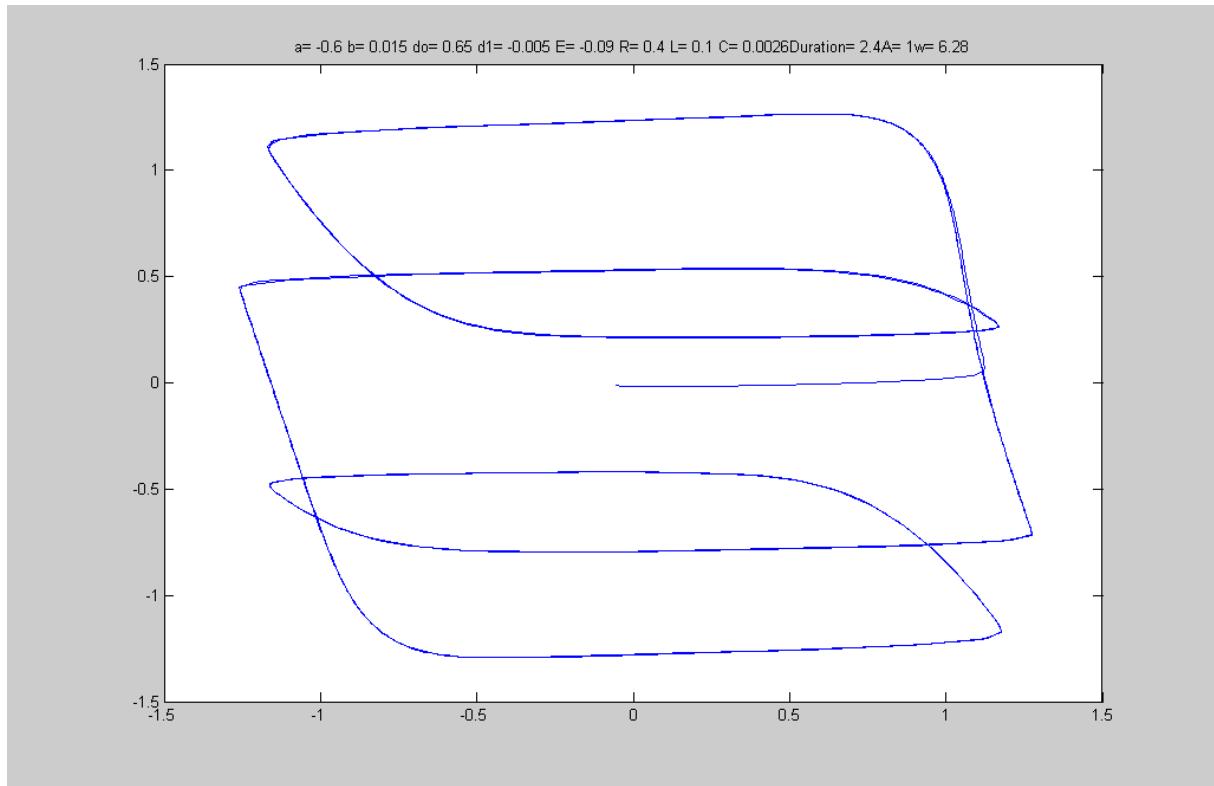
$C=2600\mu F; A=1; w=6.28; R=0.4;$

Figure : plan (V,I1)



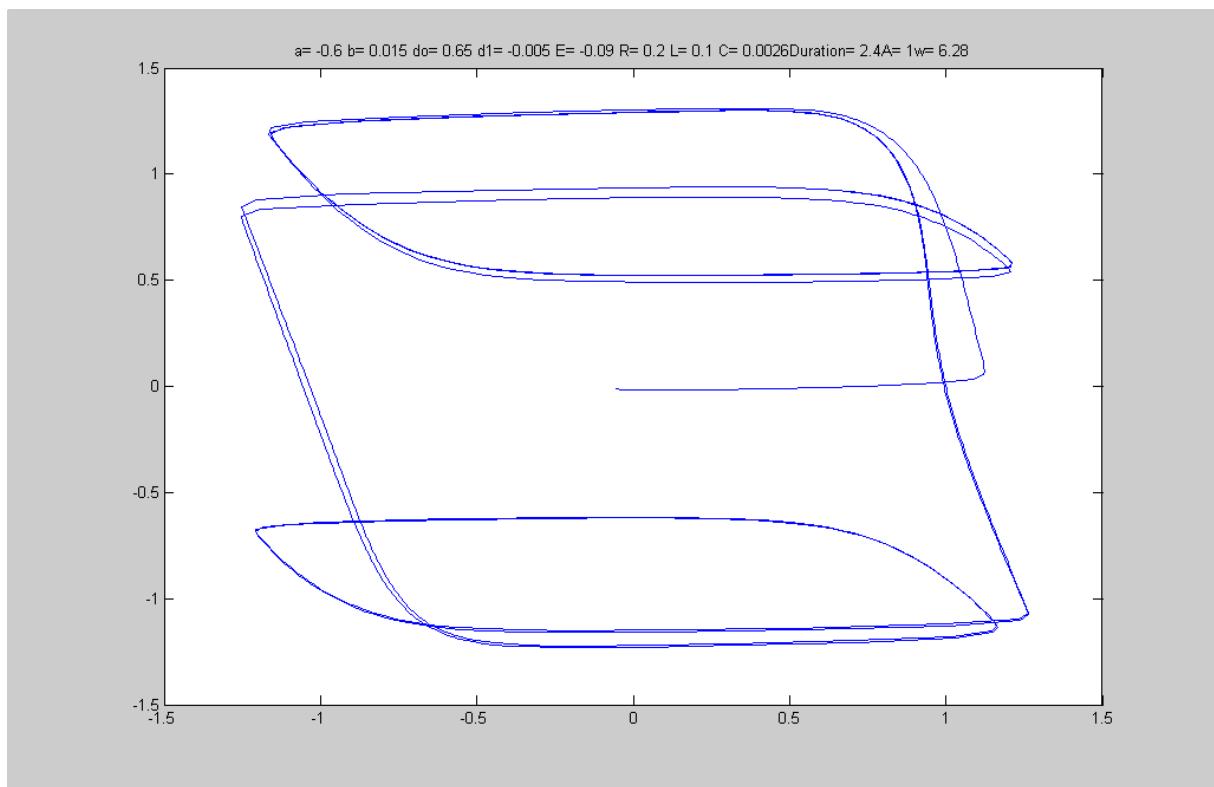
2-modele pacemaker VI1

$a=-0.6$ the other parameters are fixed

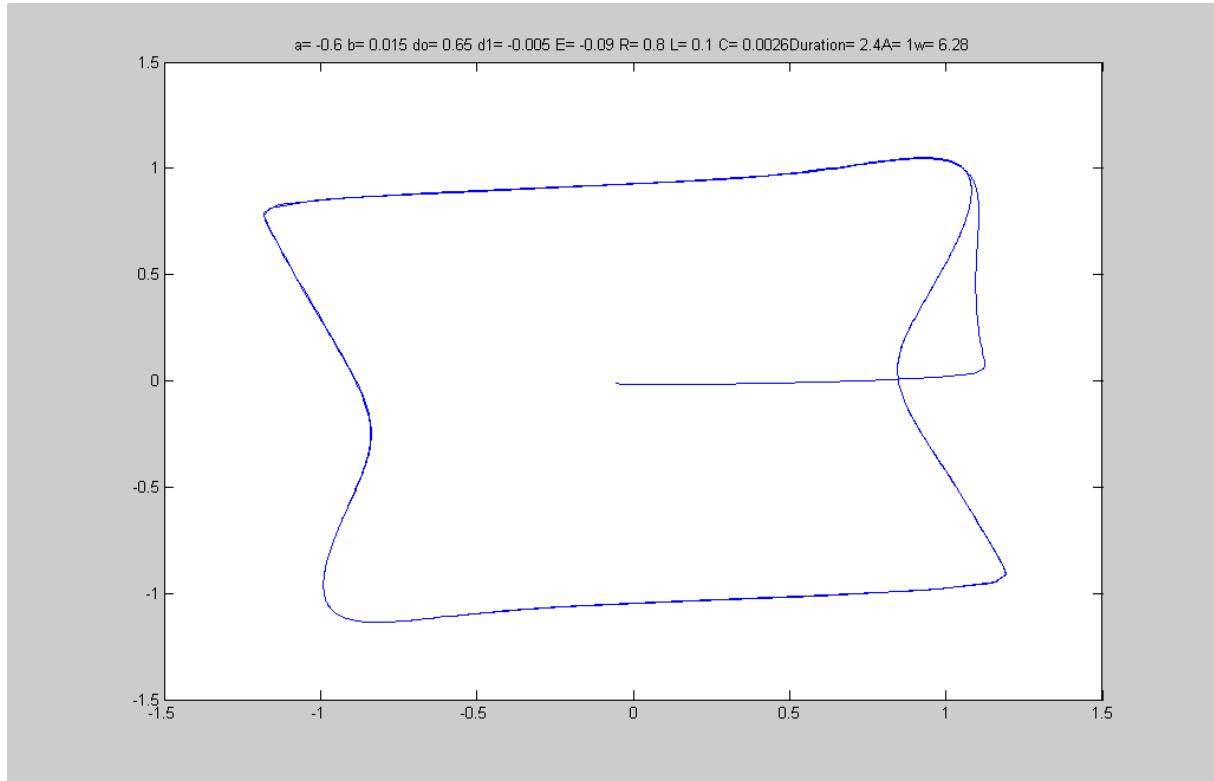


3) modèle pacemaker VI1

R=0.2; the other parameters are fixed



**4)modele pacemaker VII
R=0.8 the other parameters are fixed**



SERIE 3 volume 3

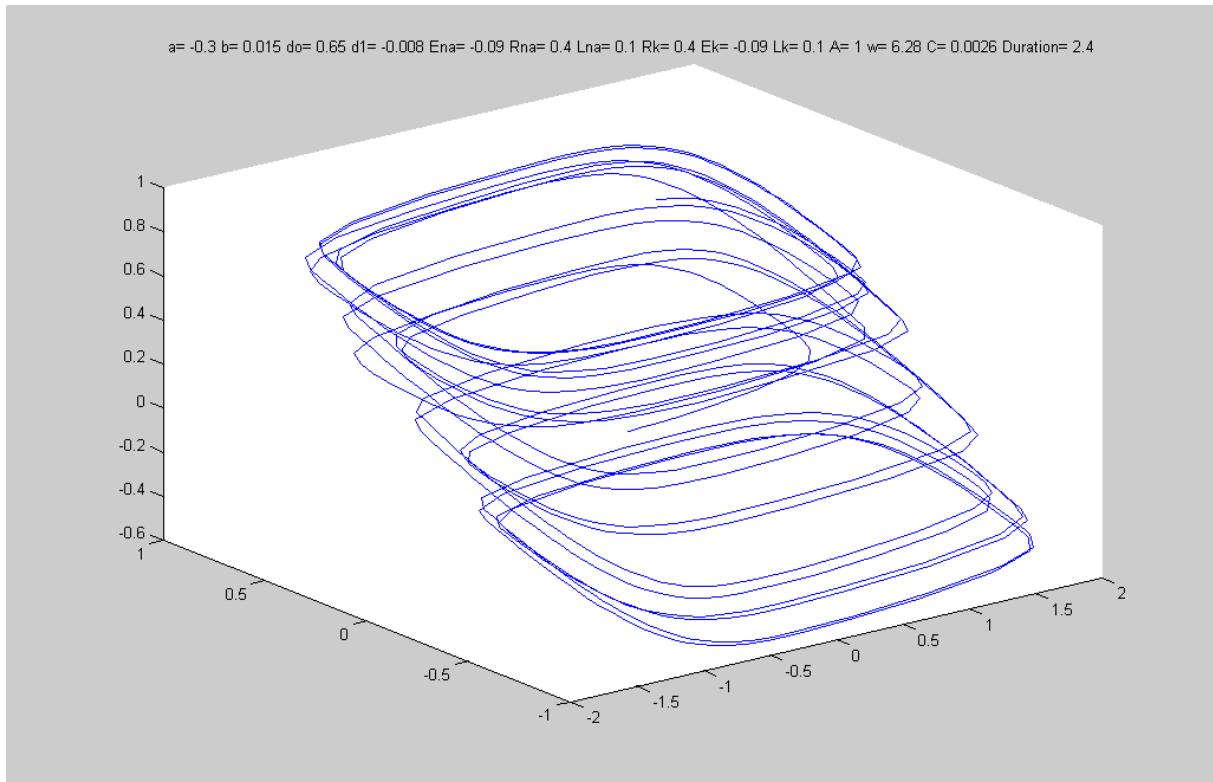
1)investigation modele pacemaker VINAIK

$a=-0.3$ $b=15e-3$; $d_0=0.65$; $E_{Na}=-90mV$; $L_{Na}=100mH$;

$R_{Na}=0.4$; $D=2400ms$; $N=1000$; $R_k=0.4$; $L_k=100mH$

$C=2600\mu F$; $w=6.28$; $A=1$

Figure:plan (V,I_{Na},I_k)



2)investigation modele pacemaker VINAIK

$a=-0.6$ the other parameters are fixed

it is seeming like the dynamics of 2 brins of AND in an unic loop

trajectory and cyclic

figure: plan(V,I_{Na},I_k)

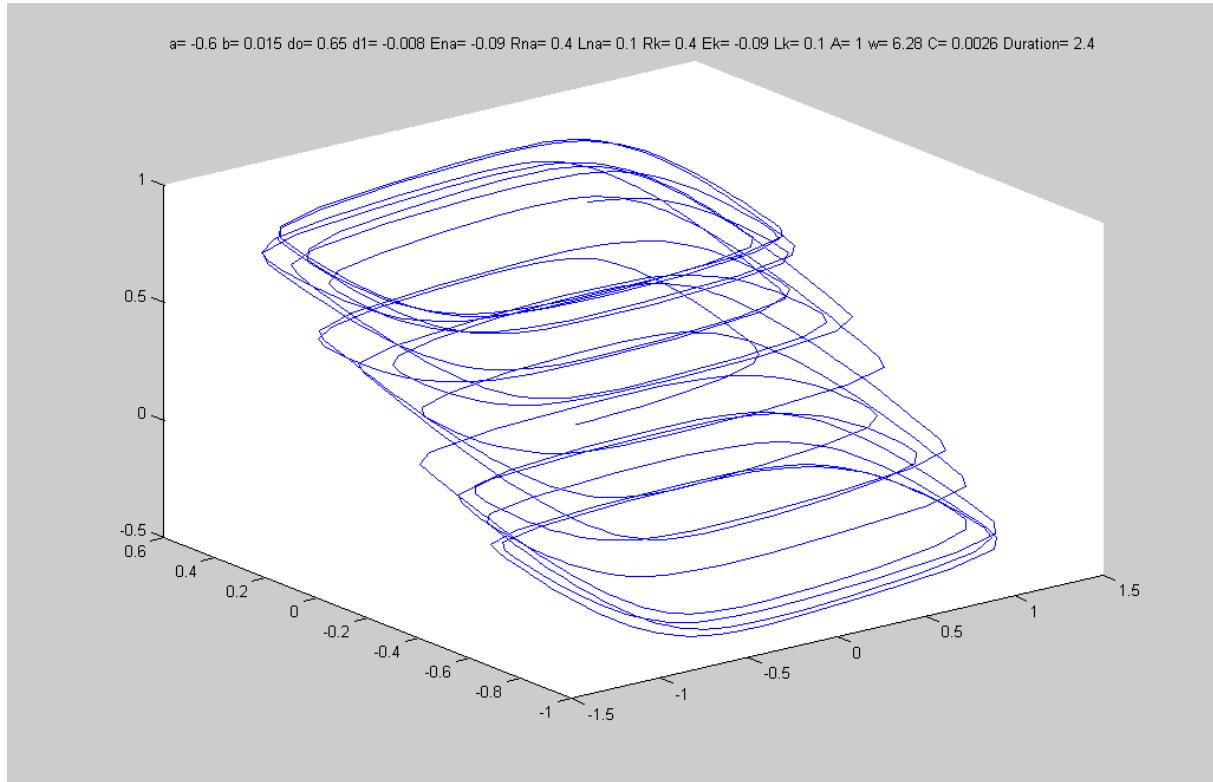


Figure:V(t)

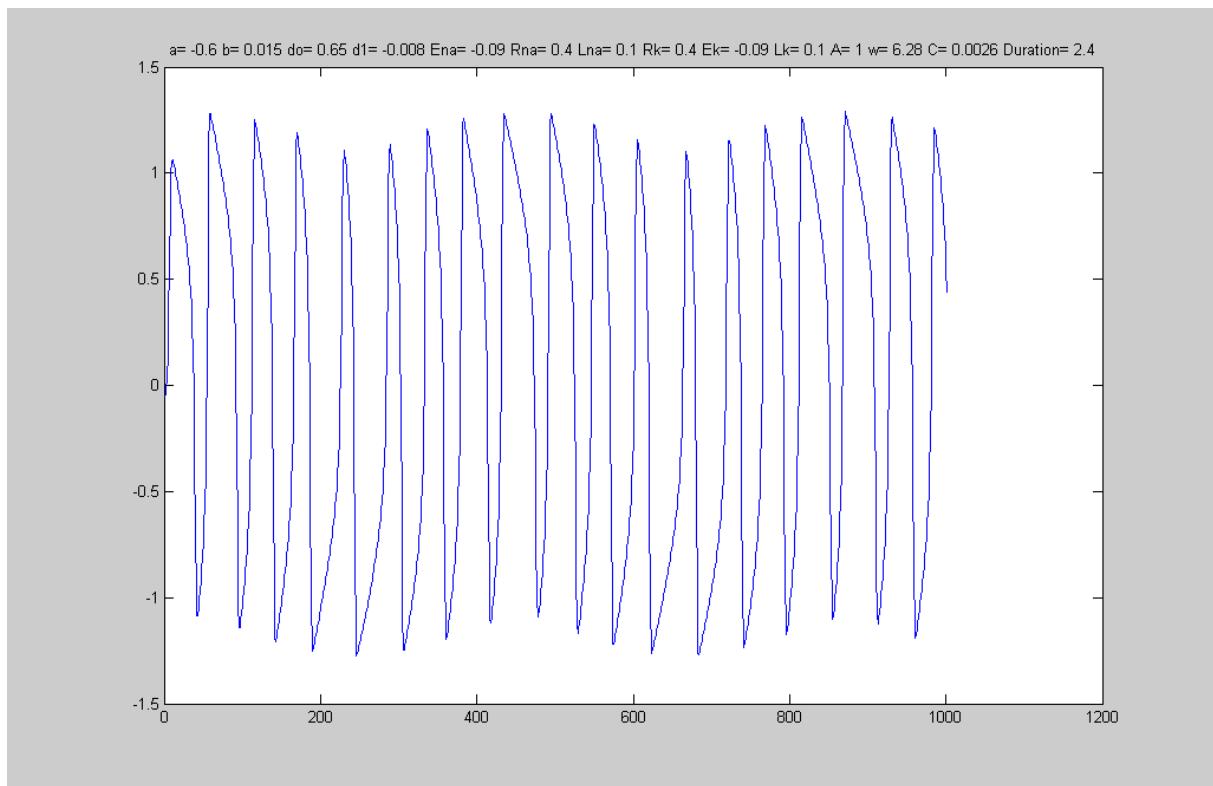


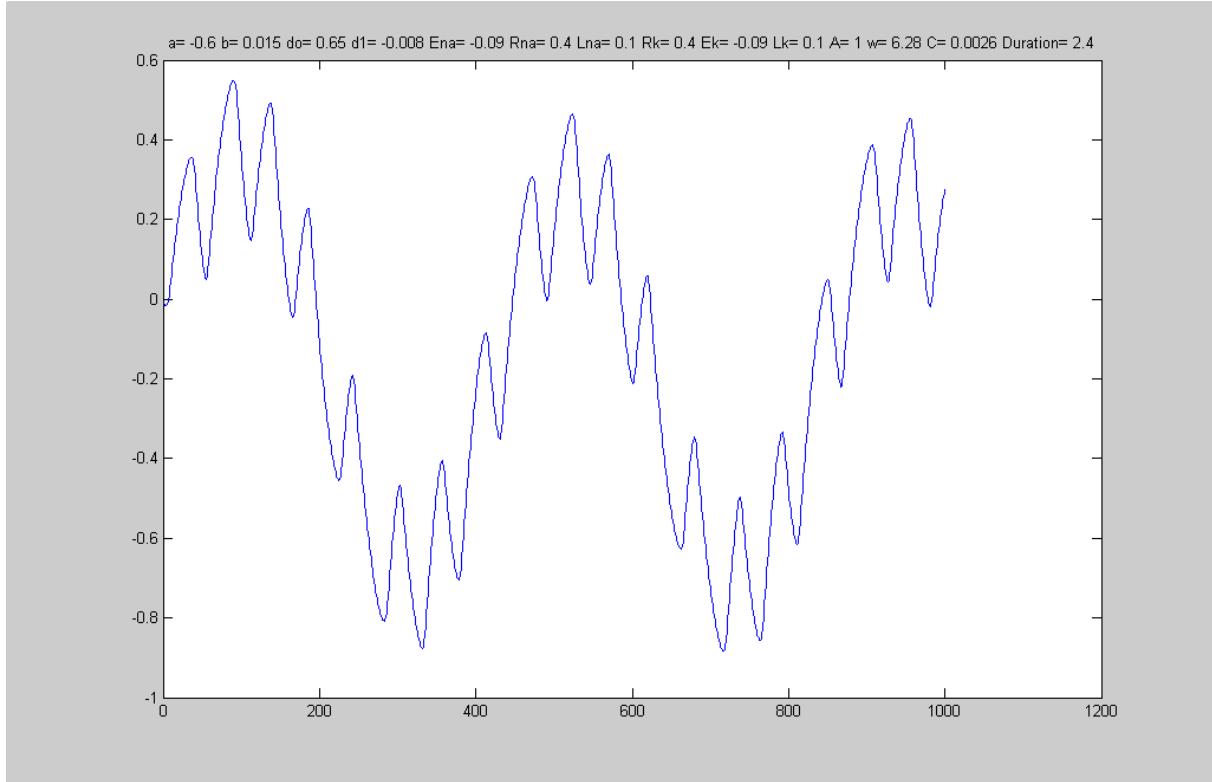
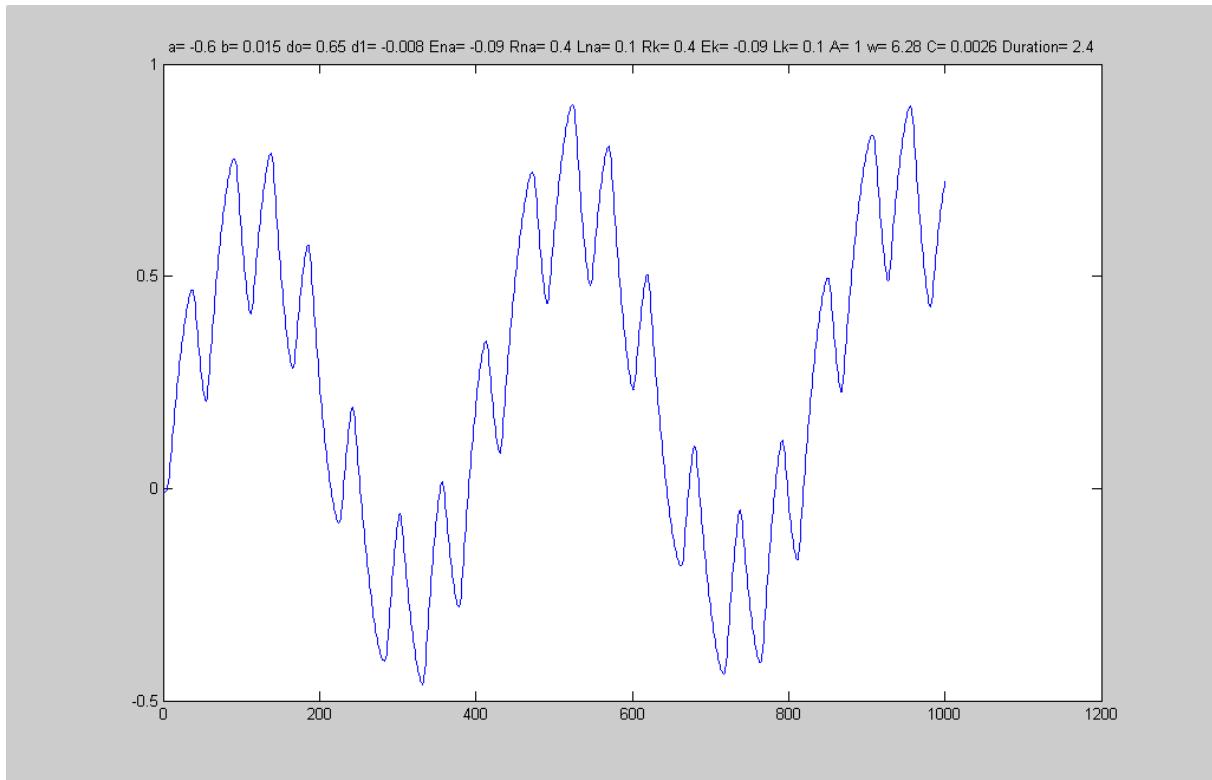
Figure:Ina(t)**Figure:Ik**

Figure:plan(V,I_na)

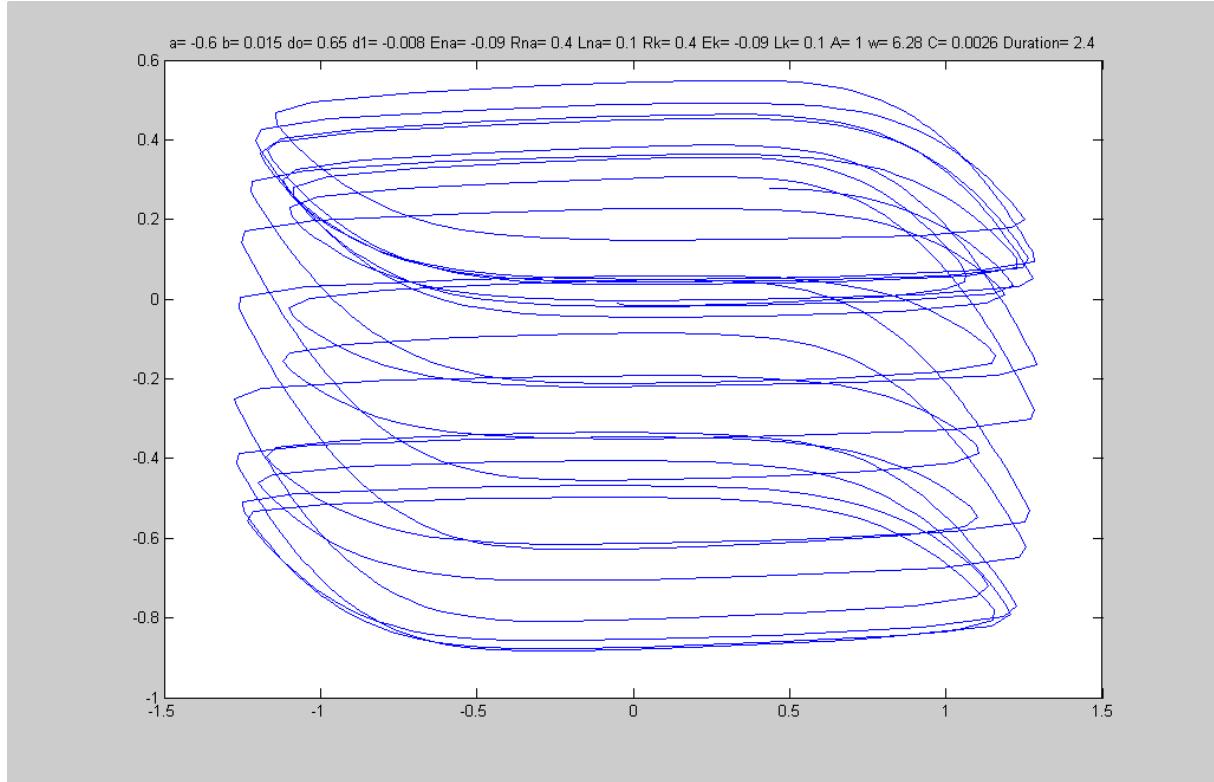


Figure:plan (V,I_k)

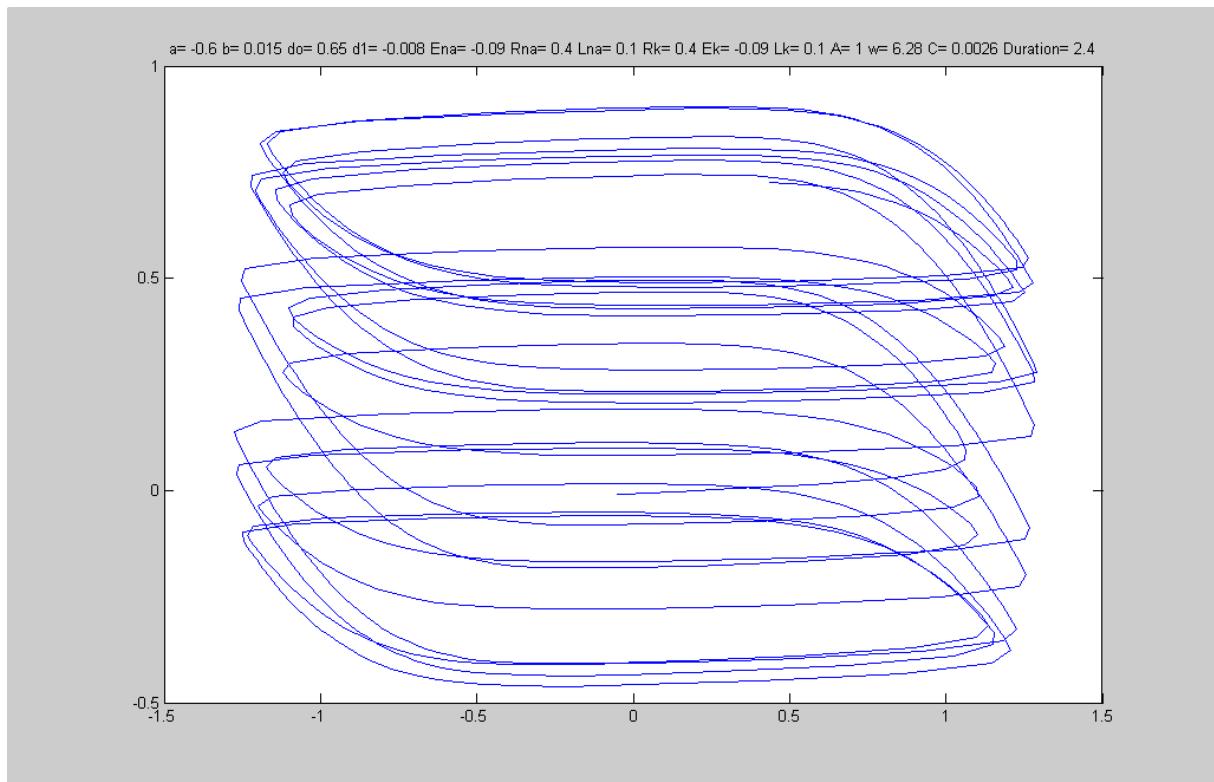
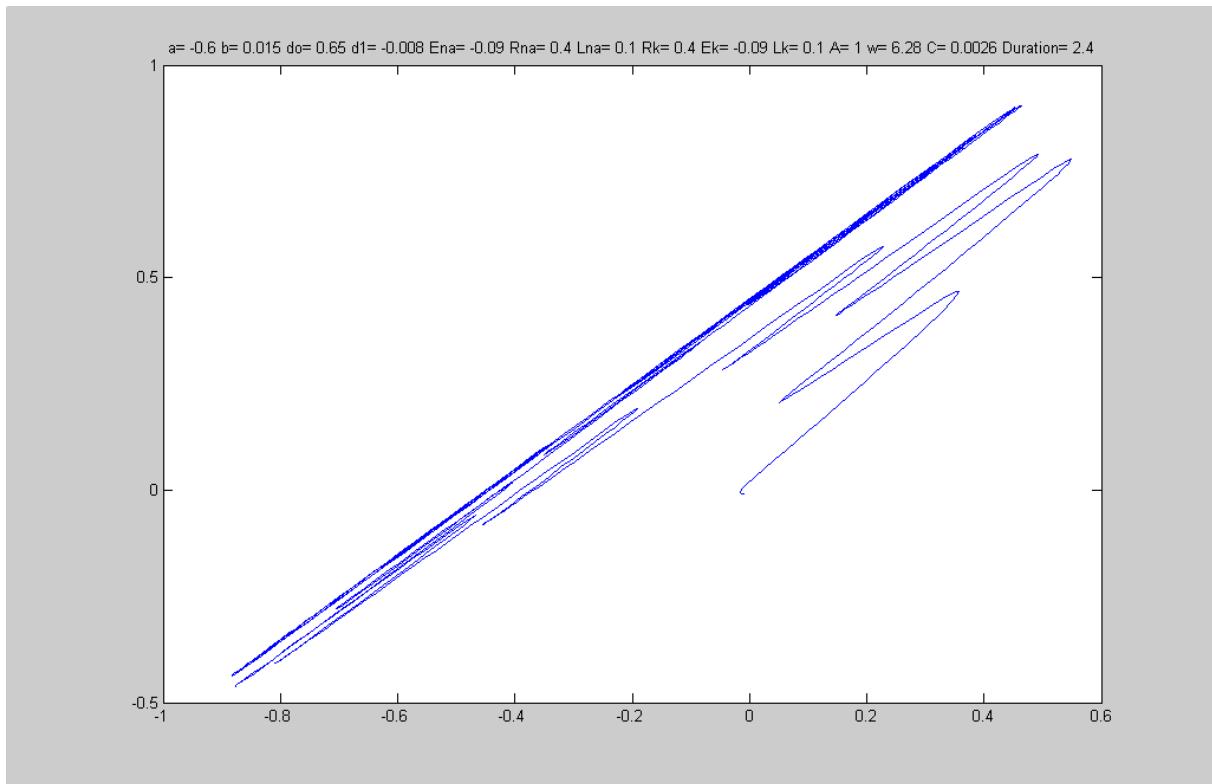


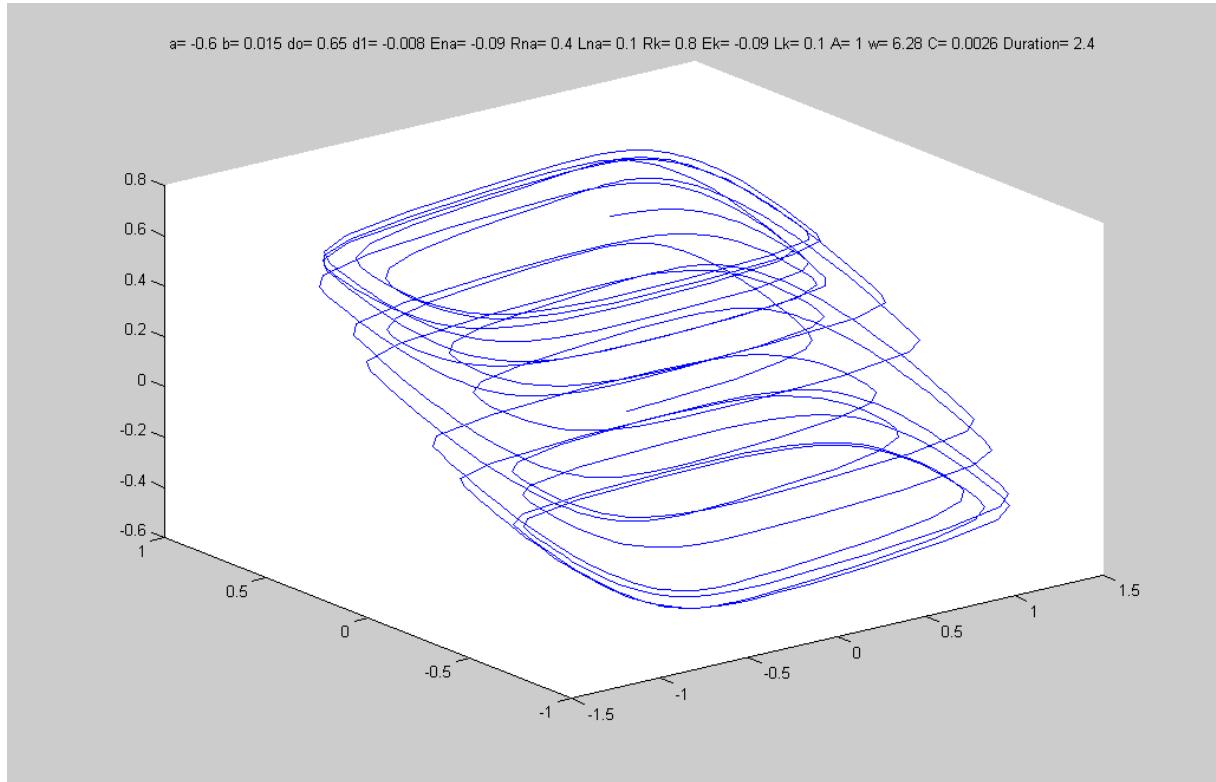
Figure: plan (Ina,Ik)



3)investigation pace VINA IK

$a = -0.6; b = 15e-3; do = 0.65; d1 = -0.008; Ena = -90\text{mV}; Lna = 100\text{mH}; Rna = 0.4; D = 2400\text{ms}; N = 1000; Rk = 0.8; Lk = 100\text{mH}; C = 2600\mu\text{F}; Ek = -90\text{mV}; w = 6.28; A = 1$

Figure:plan (V,Ina,Ik)



SERIE 3 VOLUME 4

1)investigation modele pacemaker VINAIK

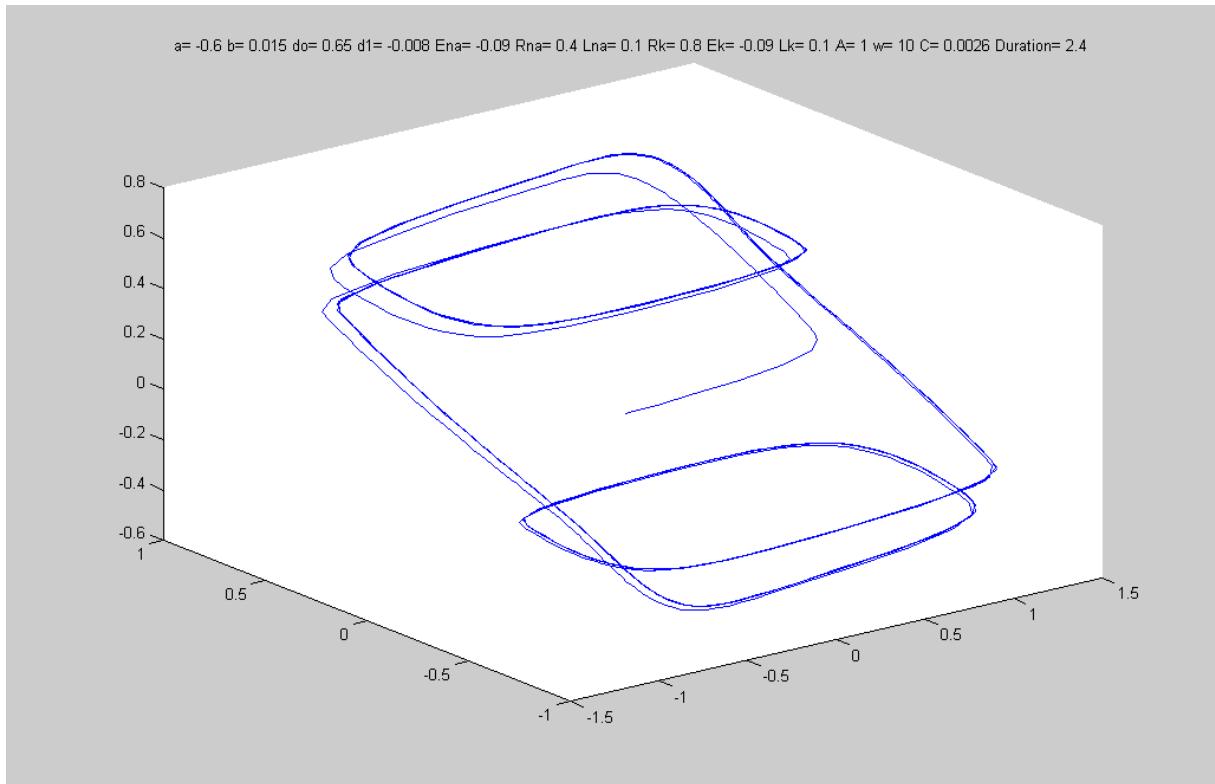
a=-0.6;b=15e-3;do=0.65;d1=-0.008;Ena=-90mV;Lna=100mH;

Rna=0.4;D=2400ms,Rk=0.8;LK=100mH;C=2600μF

Ek=-90mV;w=10;A=1

I get in variation w from w=6.28 to w=10.

Figure:plan(V,Ina,Ik)



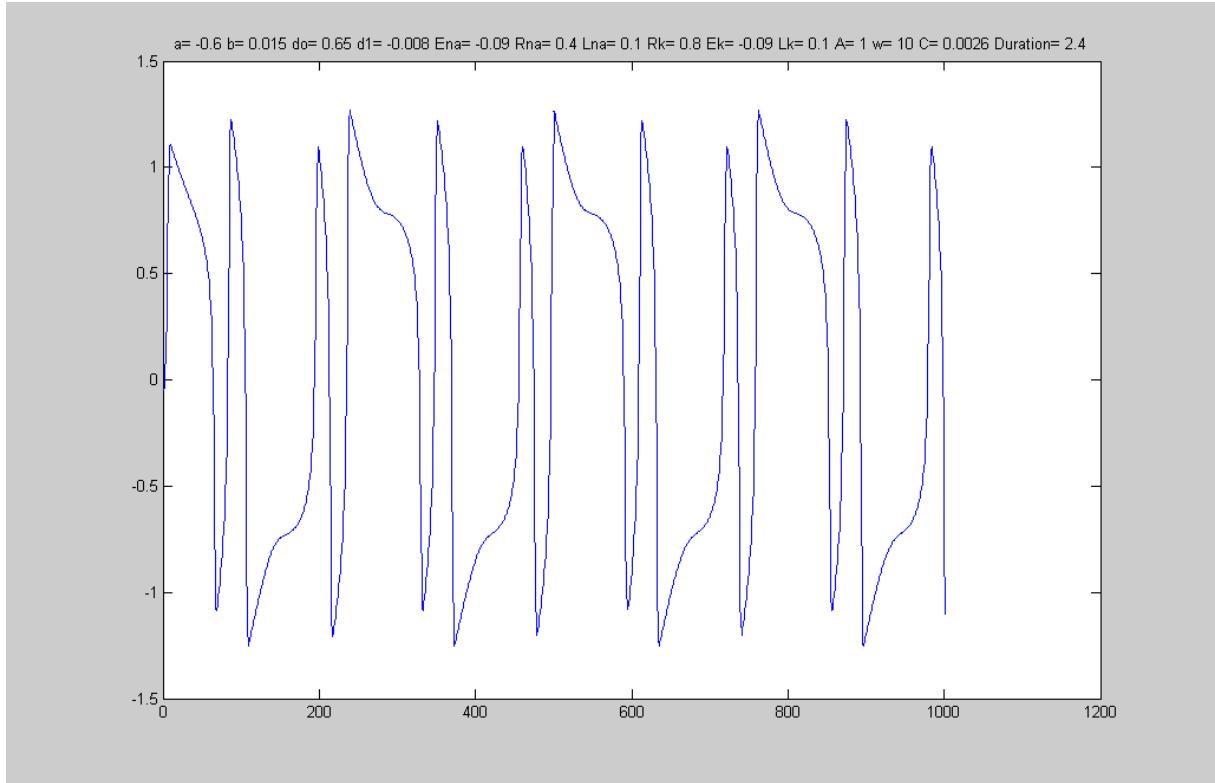


Figure:Ina(t)

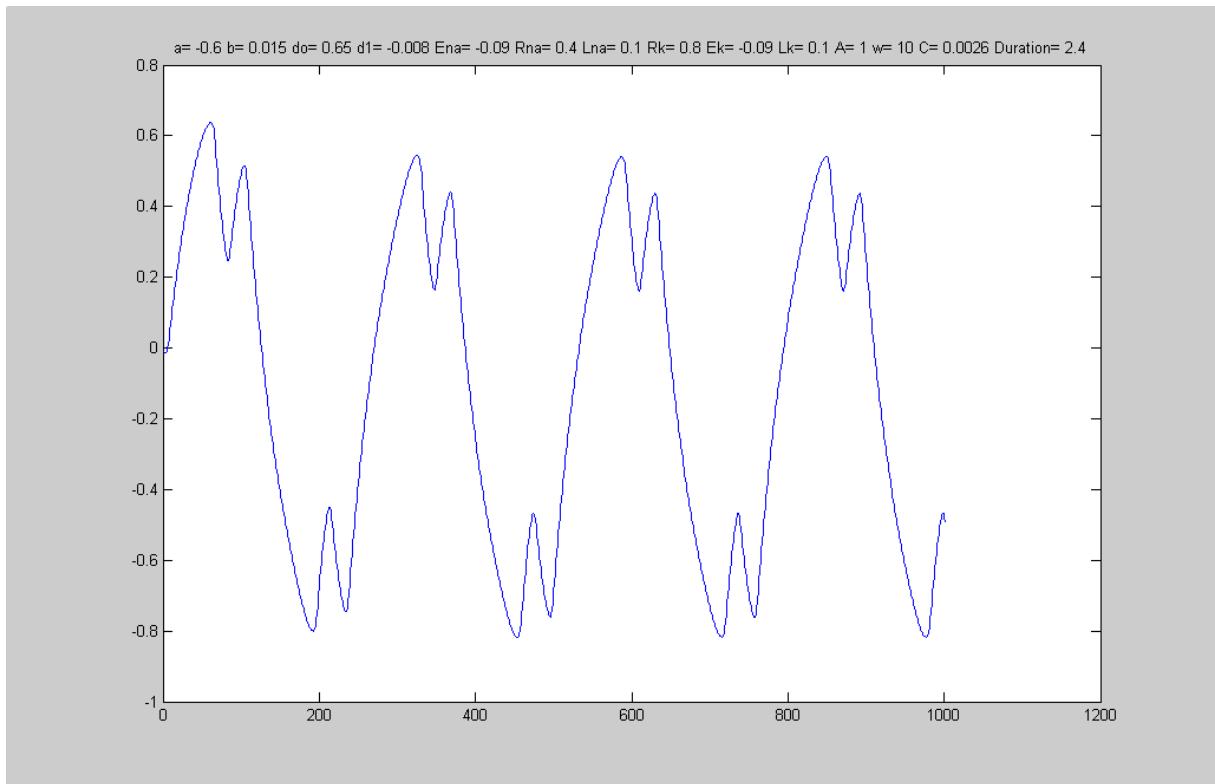


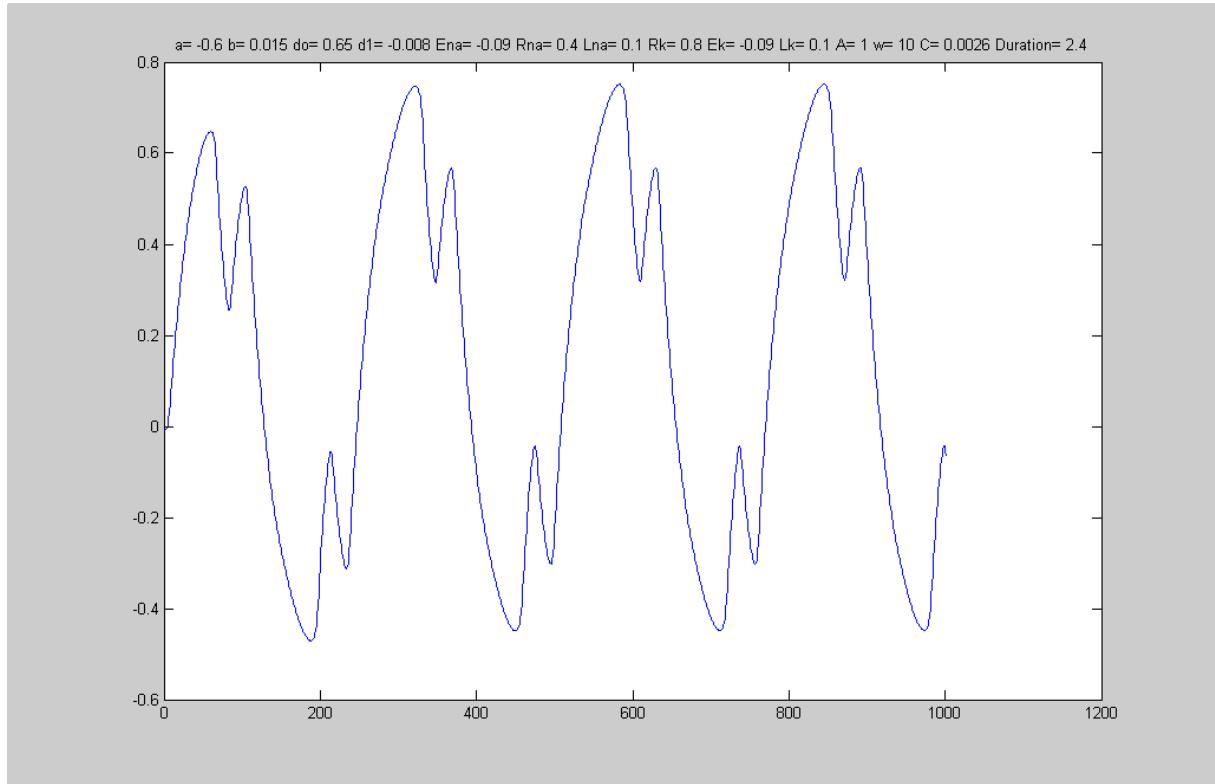
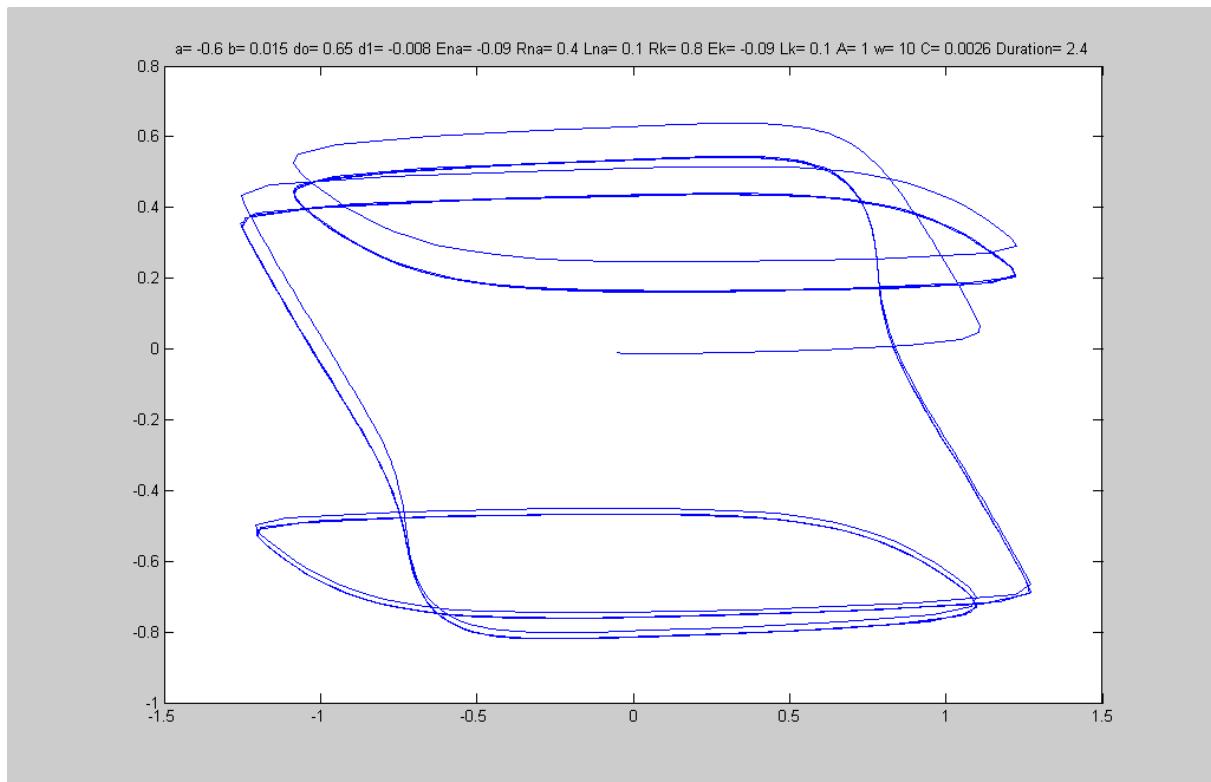
Figure :Ik(t)**Figure:plan (V,I_{Na})**

Figure: plan (V,Ik)

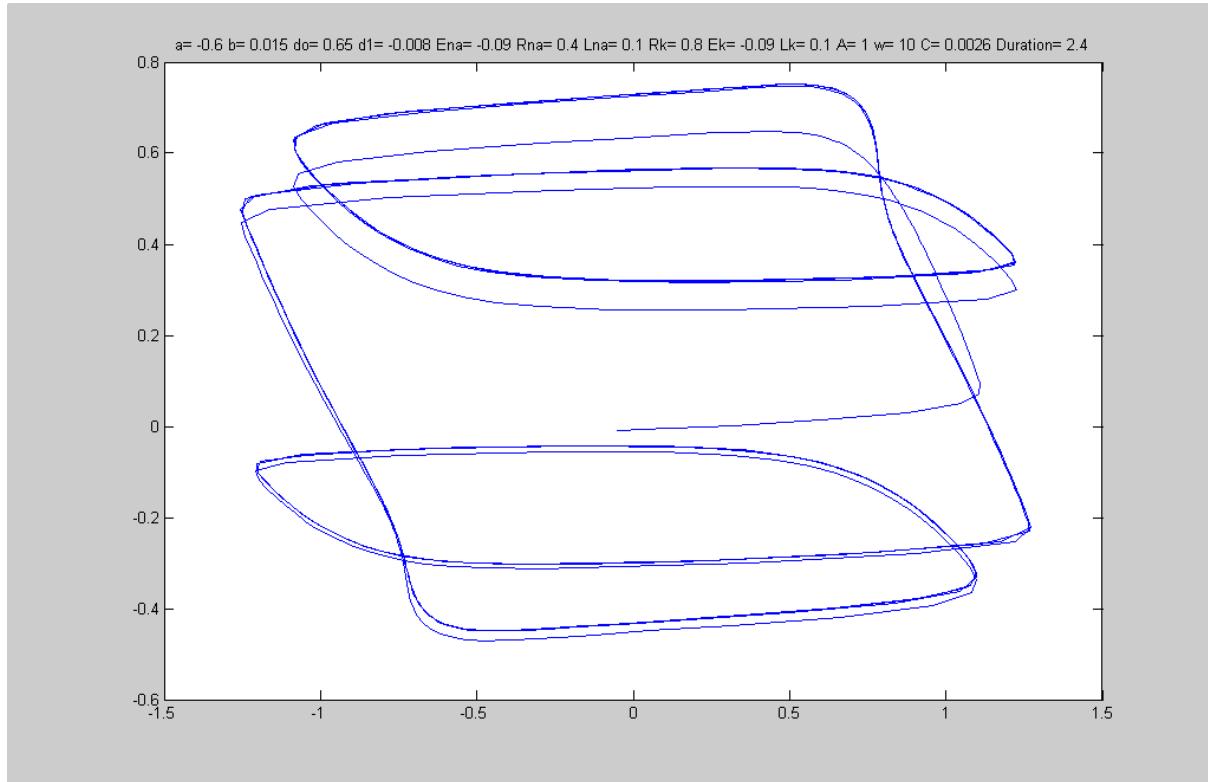
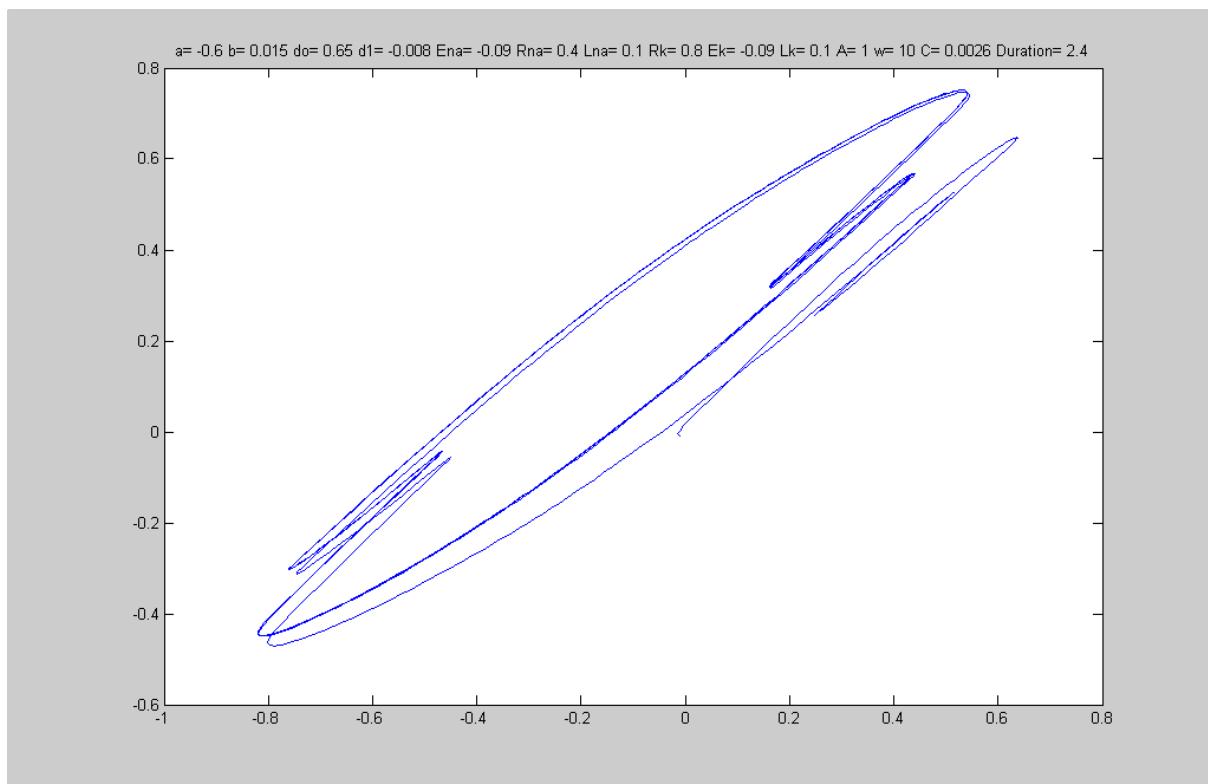


Figure:plan(I_{Na},I_k)



2) w=10 A=1 the other parameters are fixed.

Figure:plan(V,Ina,Ik)

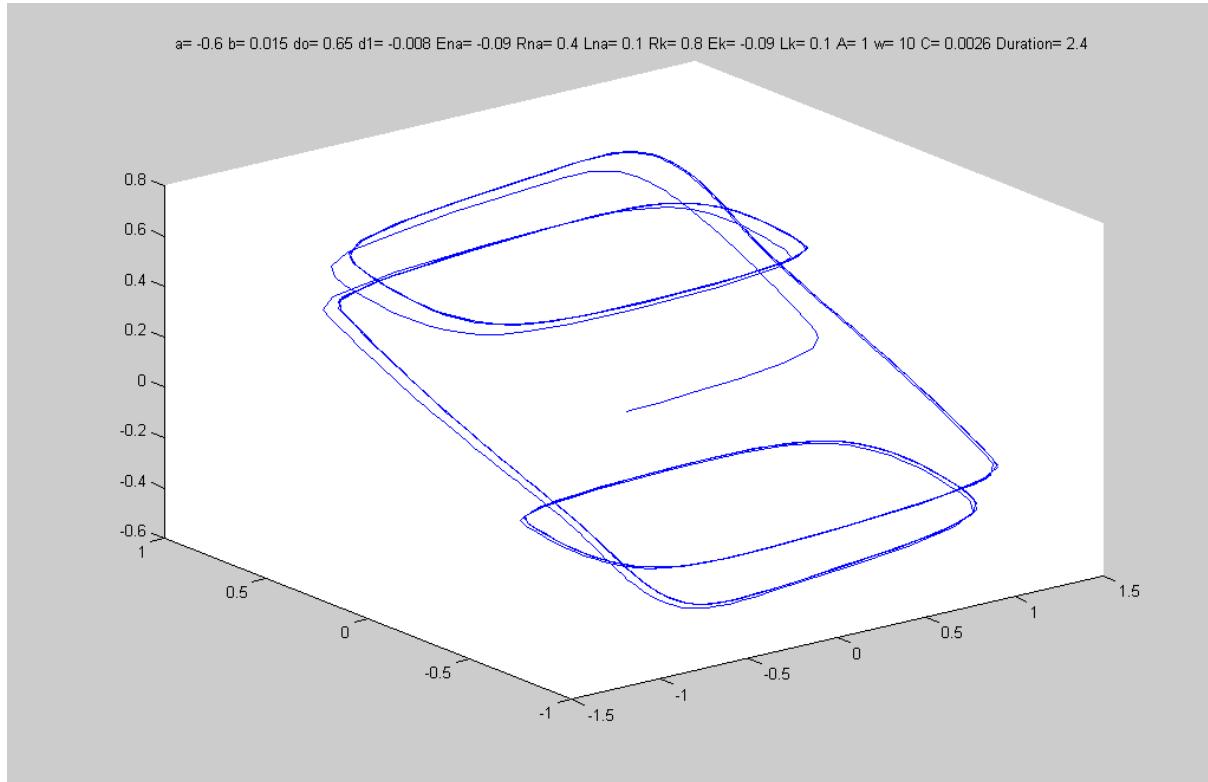


Figure: $V(t)$

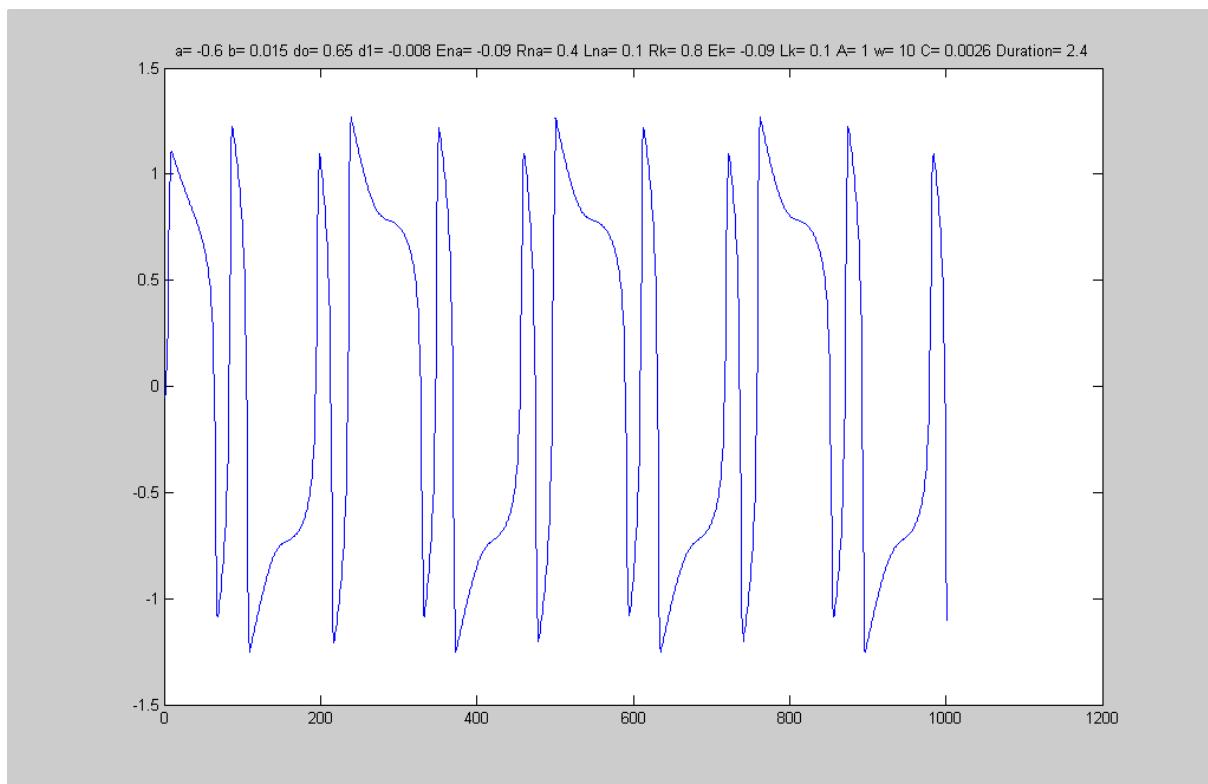
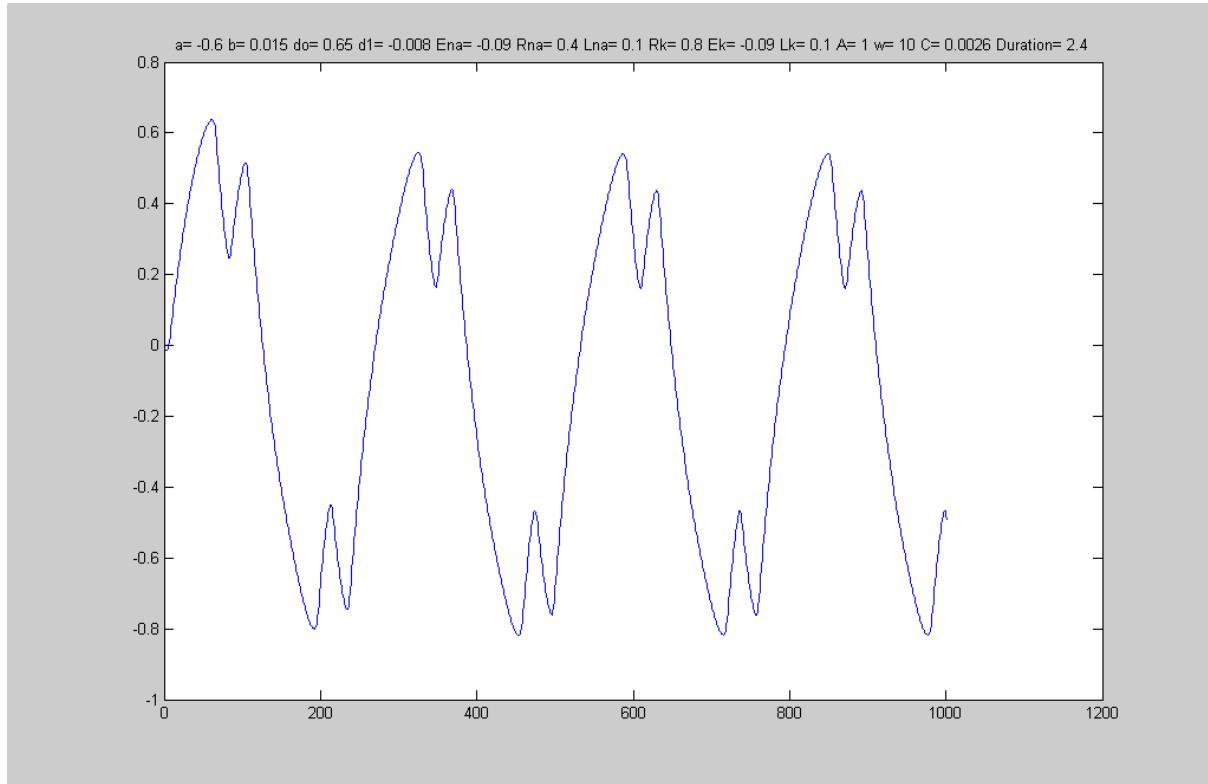
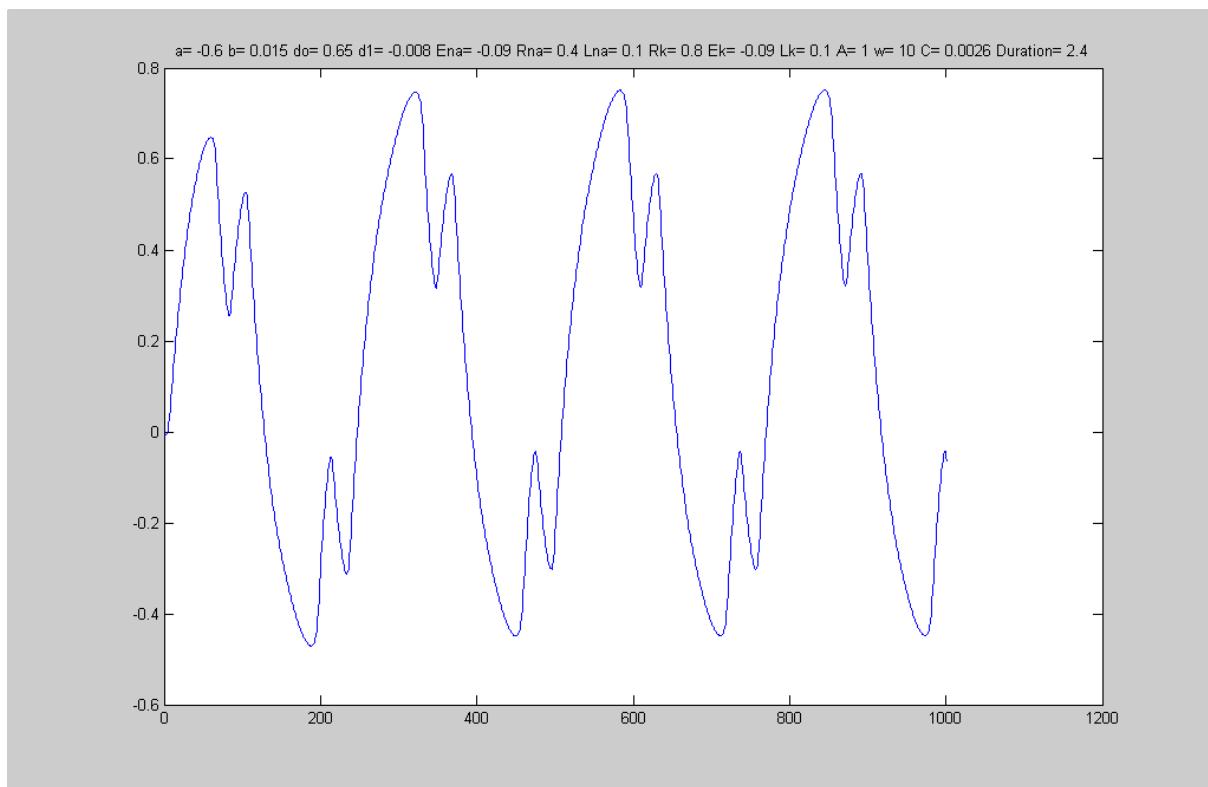


Figure:Ina(t)**Figure:Ik(t)****Figure : plan(V,Ina)**

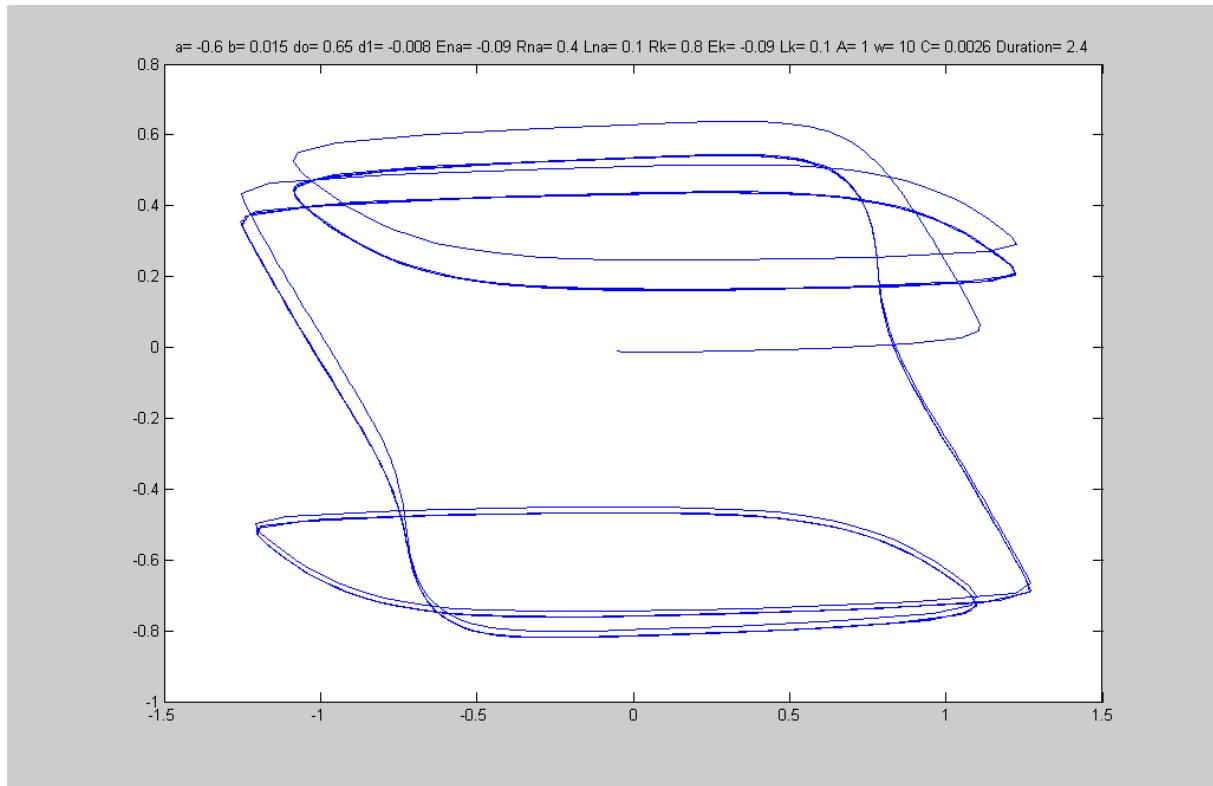


Figure:plan (V,I_k)

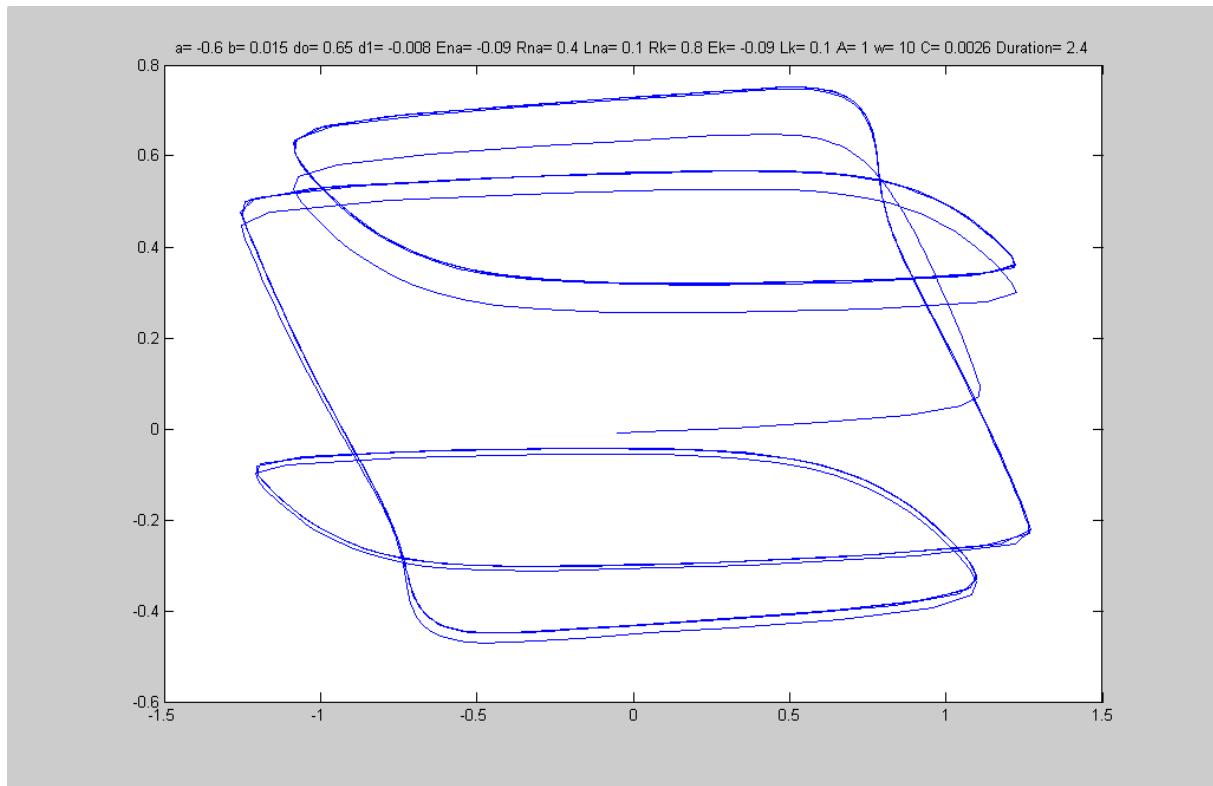
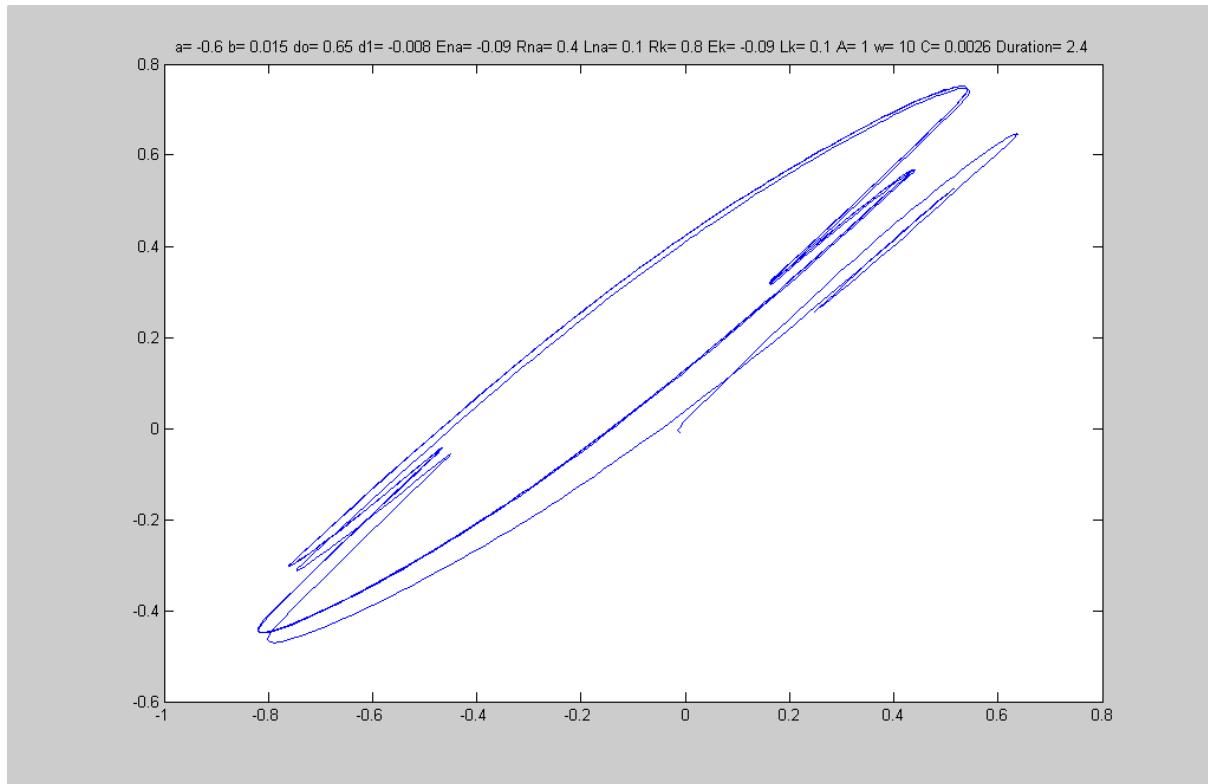


Figure:plan (Ina,Ik)



3) $w=15$ $A=1$ the other parameters are fixed.

Figure:plan(V,Ina,Ik)

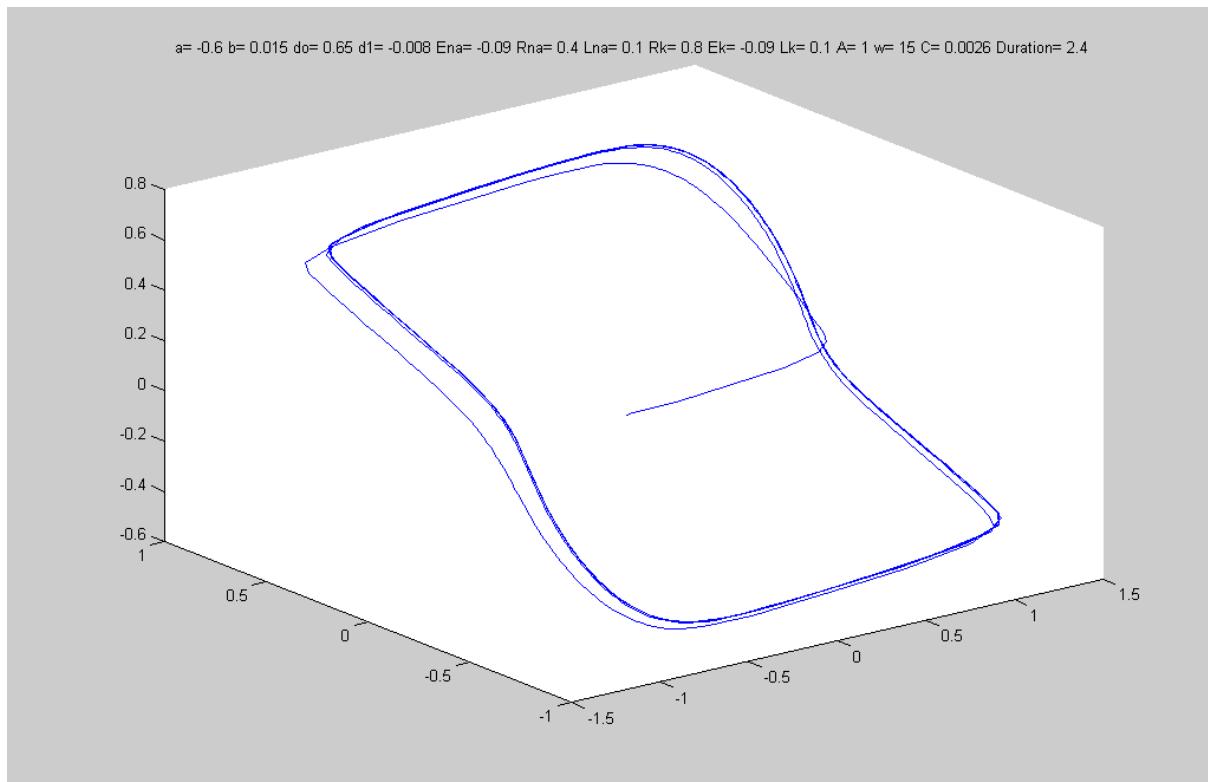


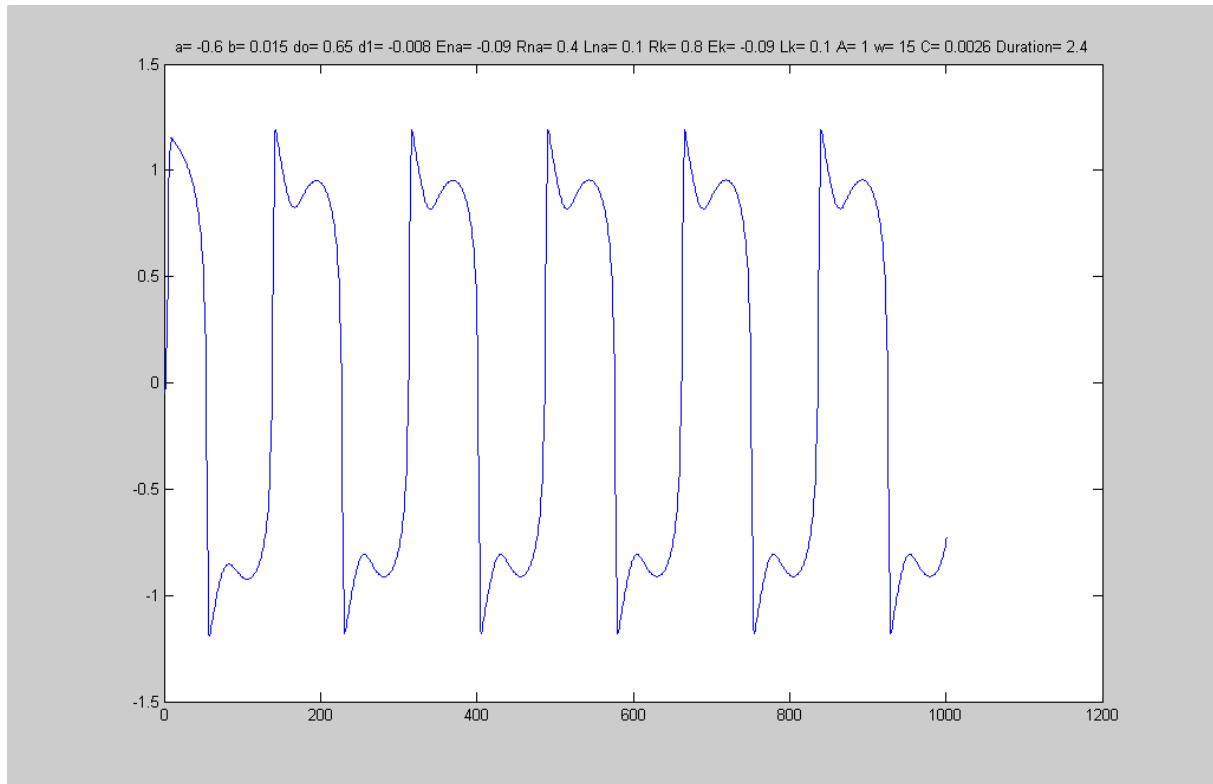
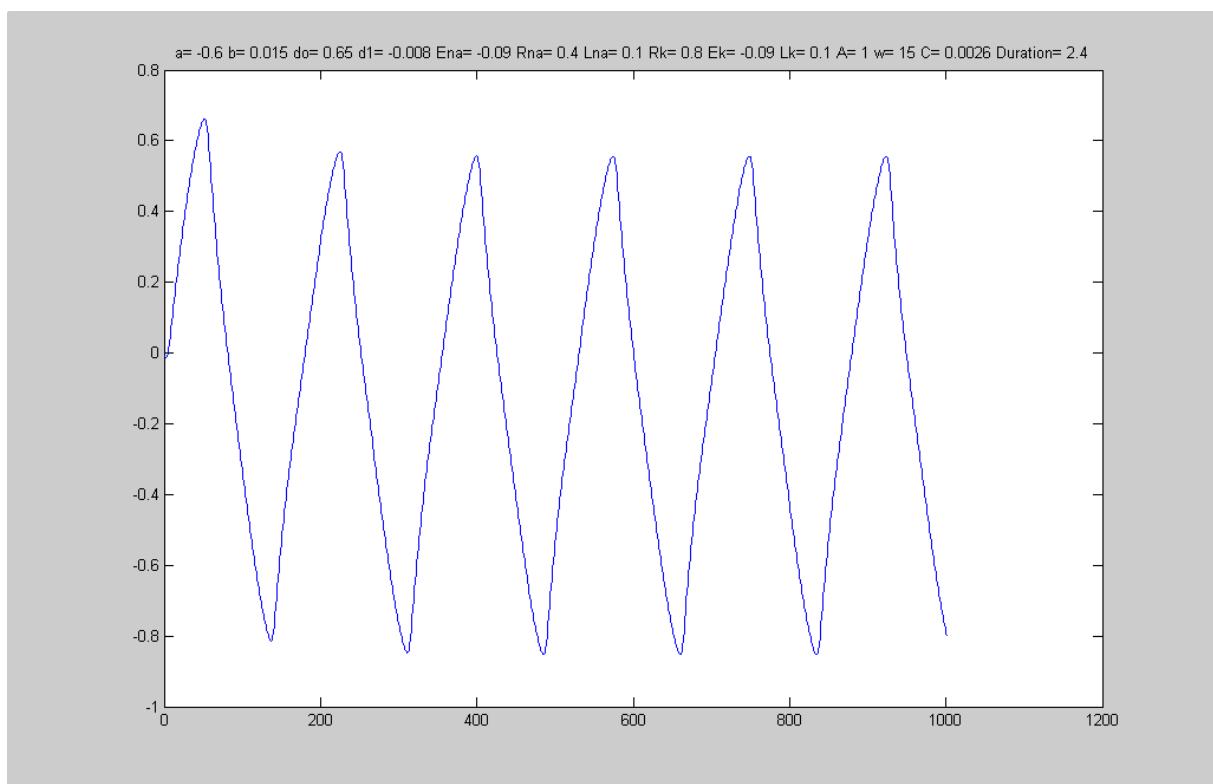
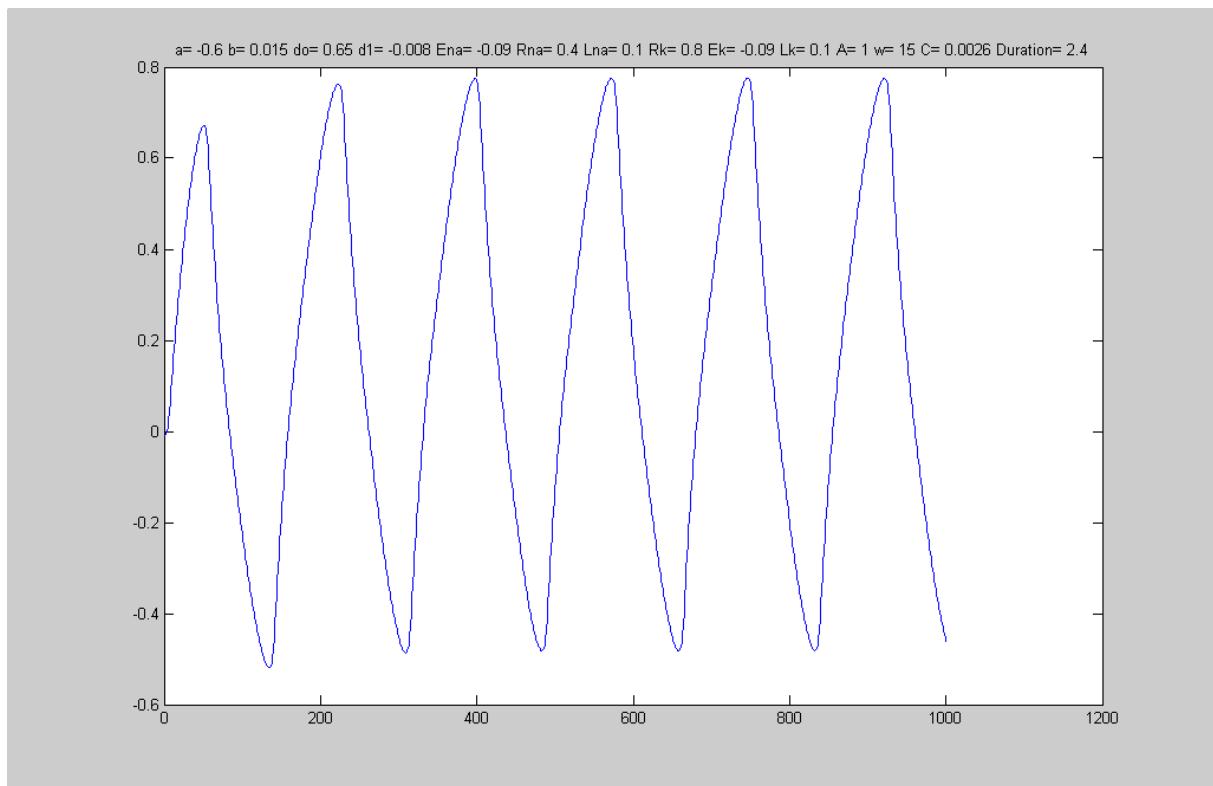
Figure:V(t)**Figure:Ina(t)**

Figure:Ik(t)**Figure:plan(V,Ina)**

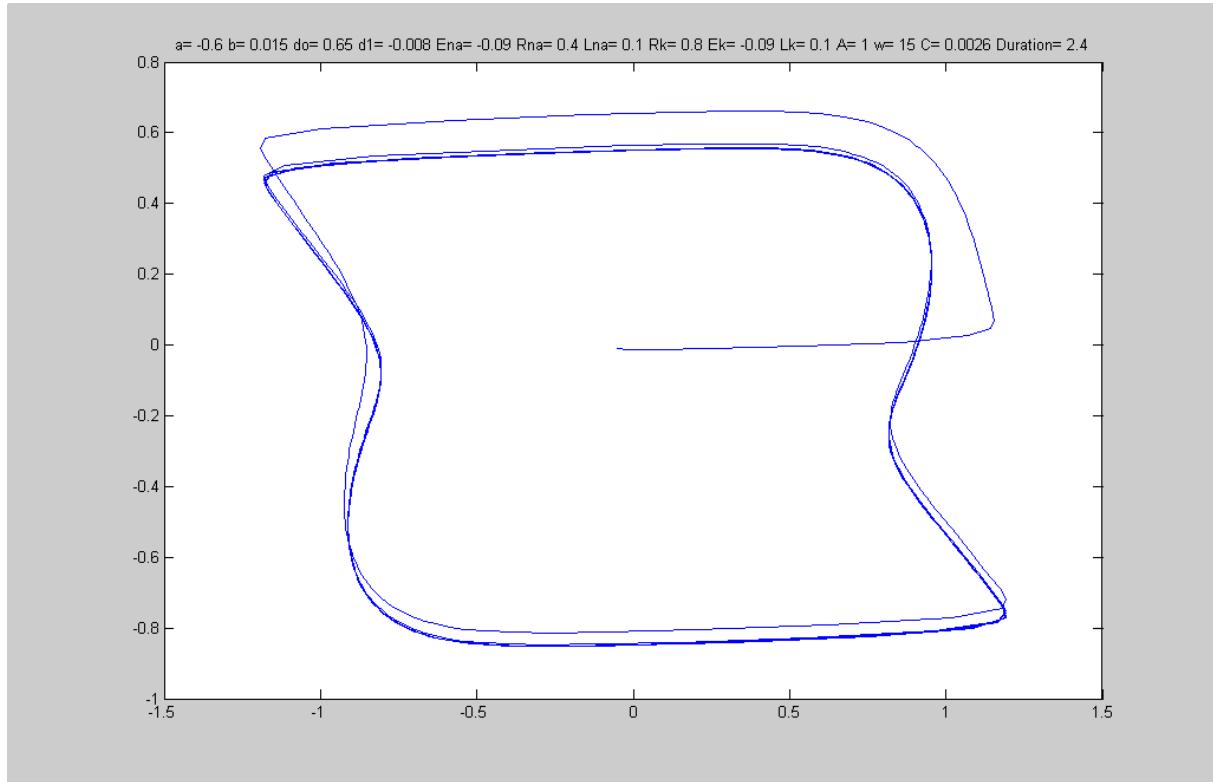


Figure: plan(V,Ik)

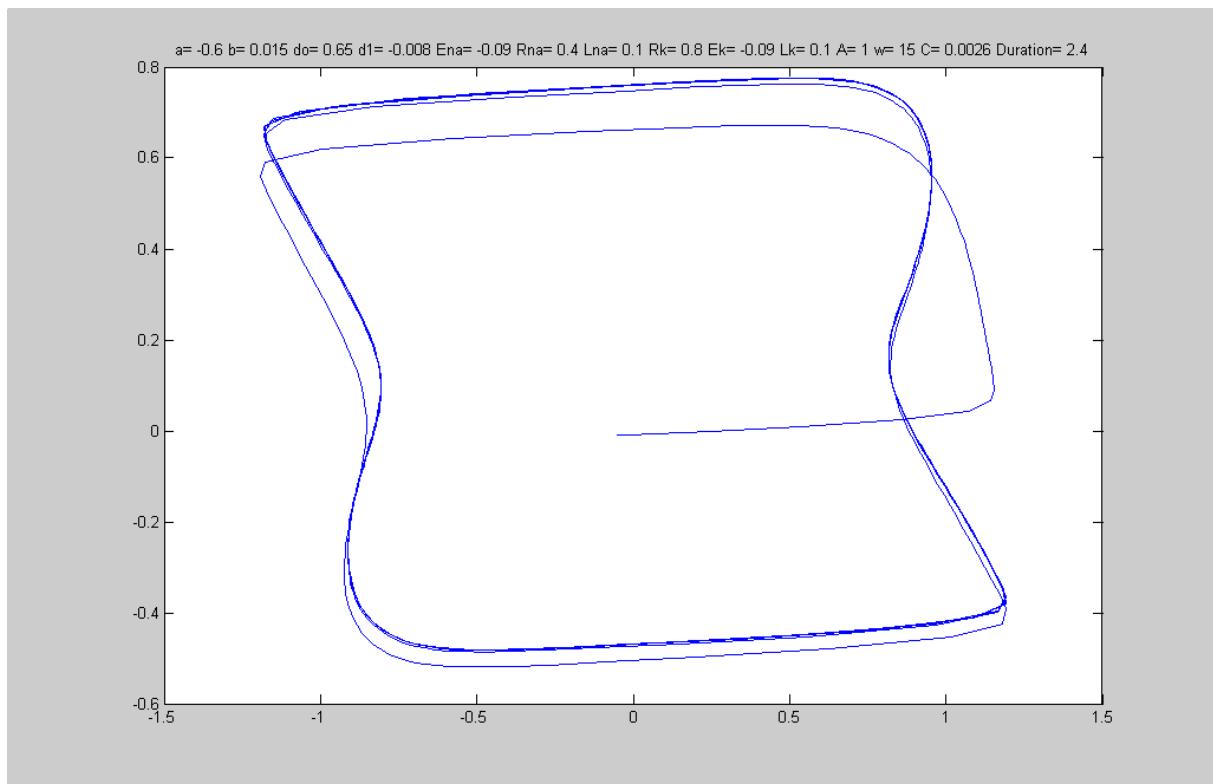
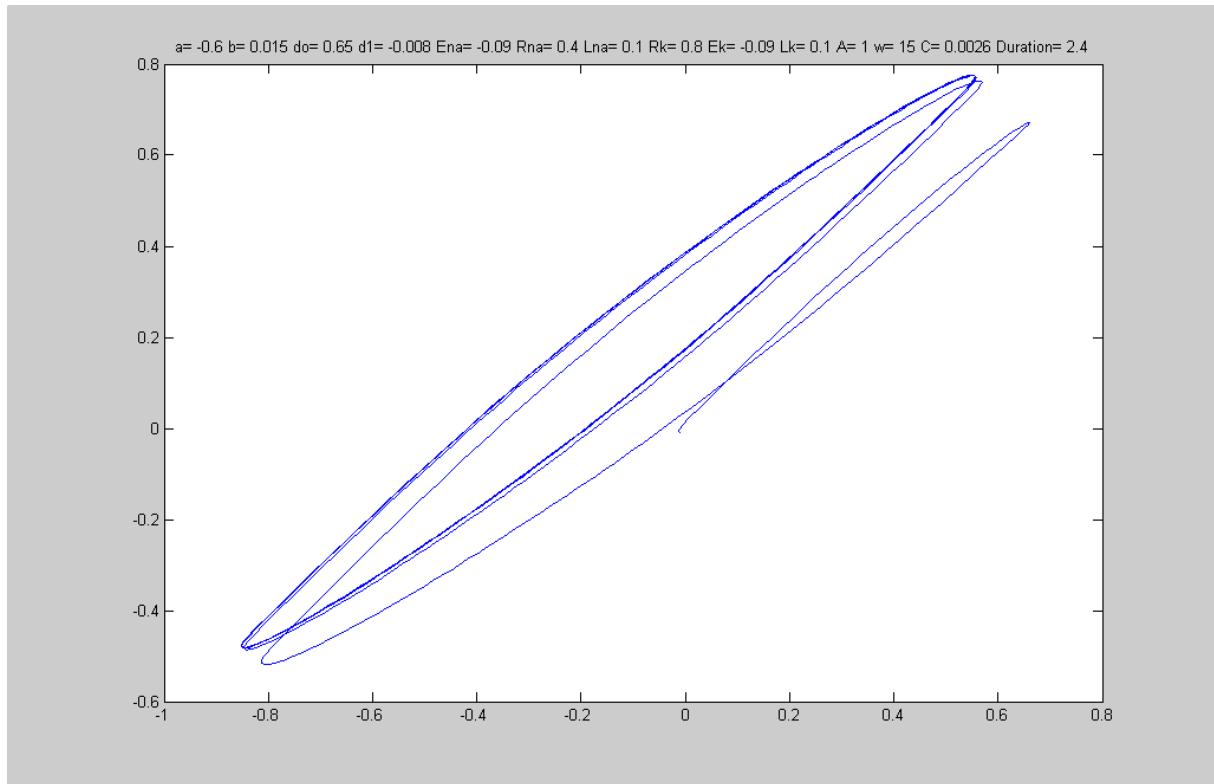
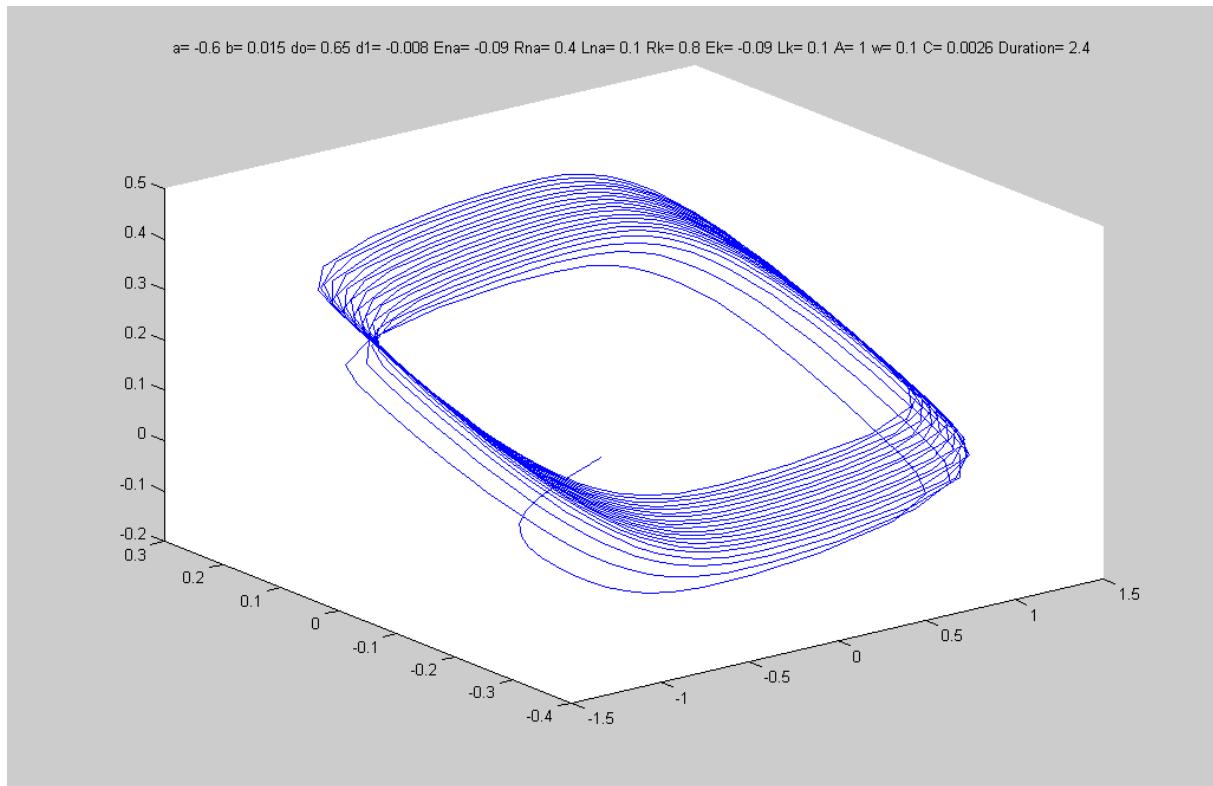


Figure:plan(I_a,I_k)

SERIE 3 VOLUME 5**1) w=0.1 A=1 the others parameters are fixed.****Figure:plan(V,Ina,Ik)****Figure:V(t)**

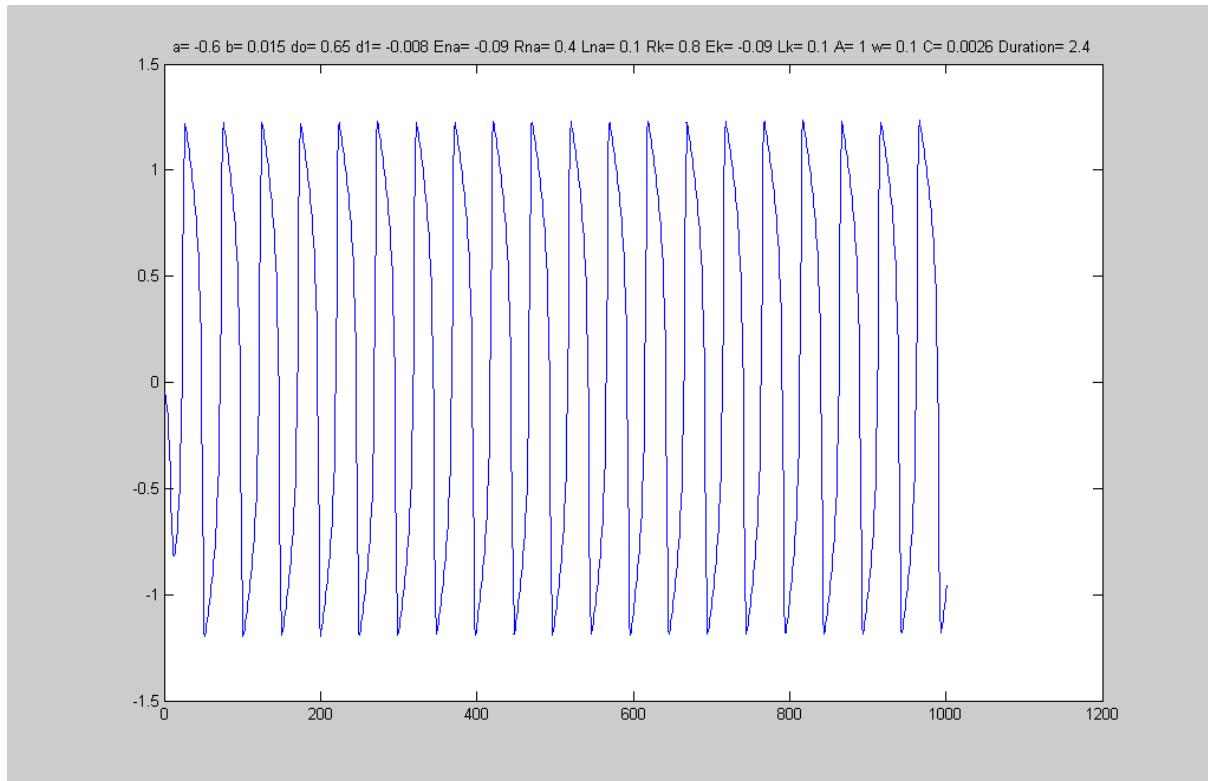


Figure:Ina(t)

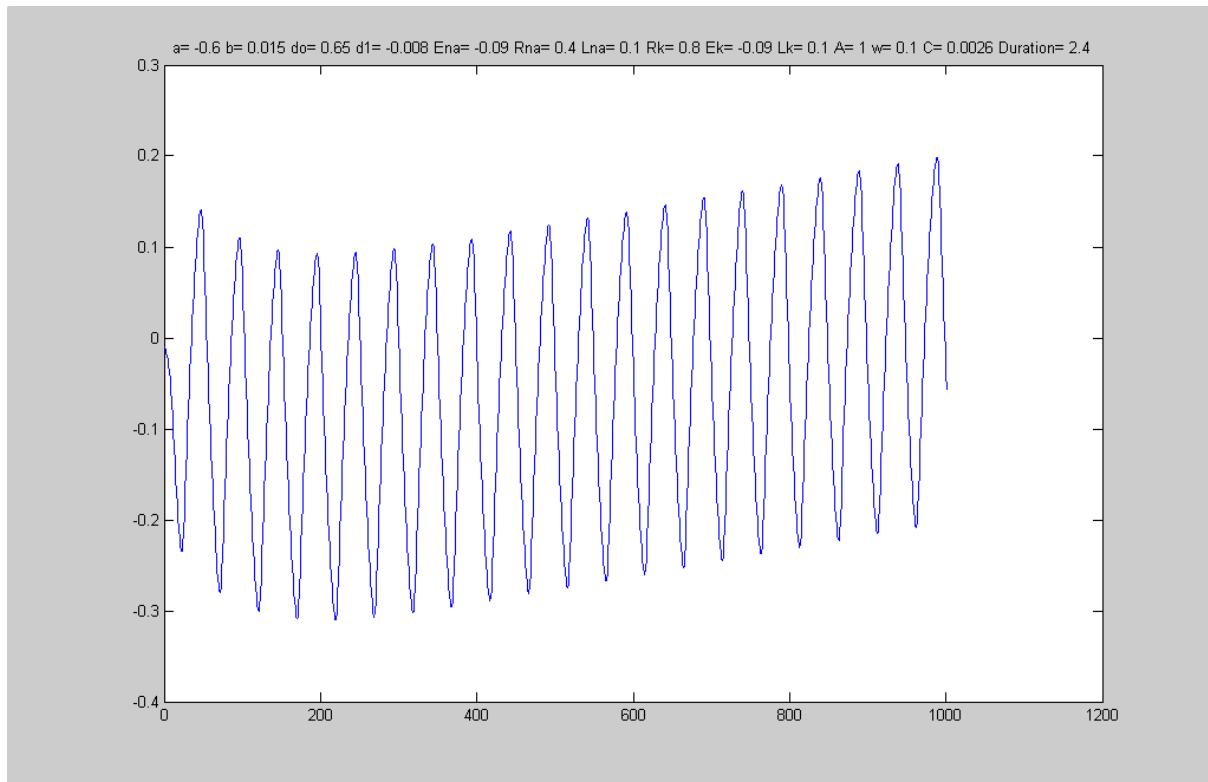


Figure:Ik(t)

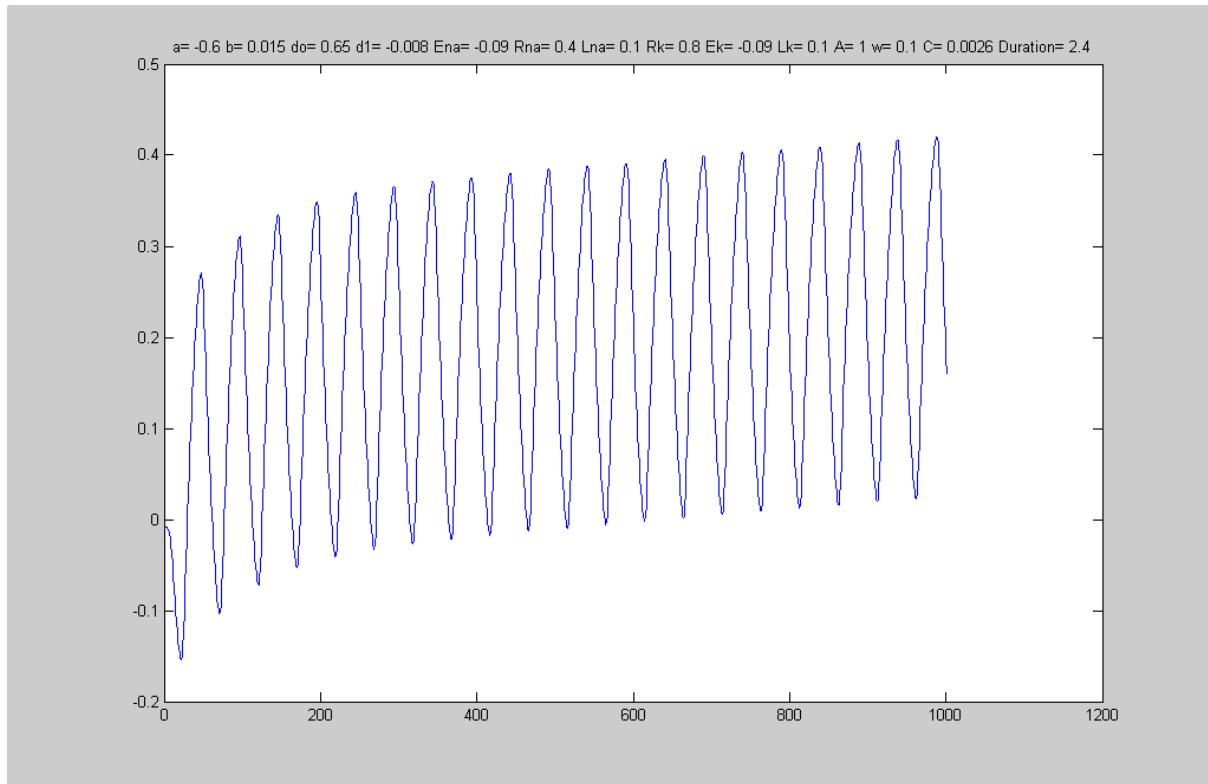


Figure:plan(V,Ina)

some think like cylindrical and dynamic of genomic AND.

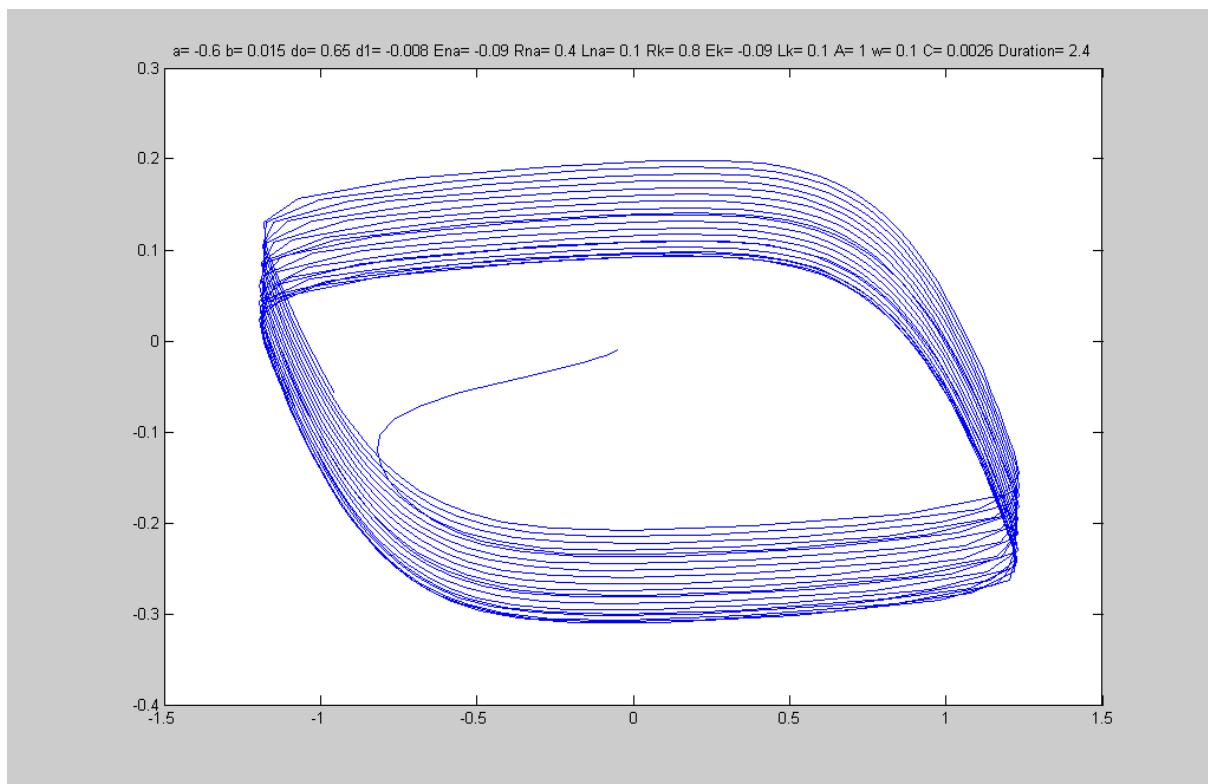


Figure:plan (V,Ik)

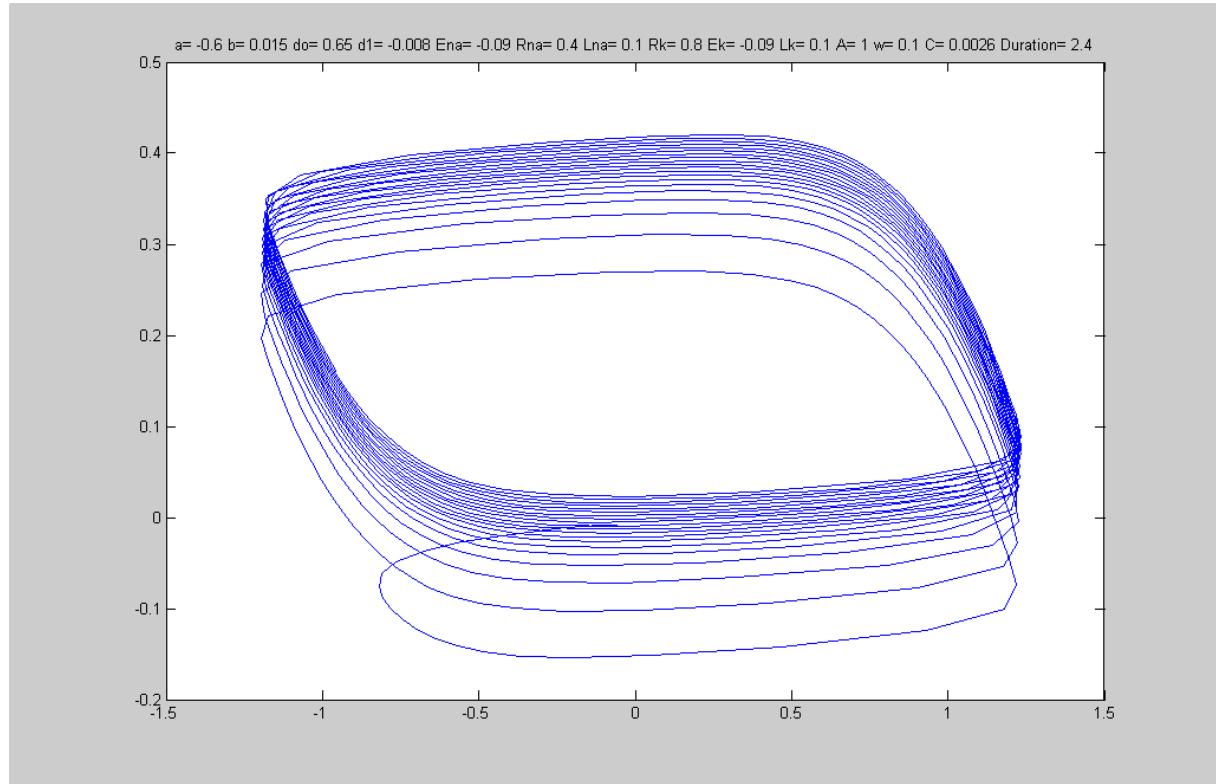
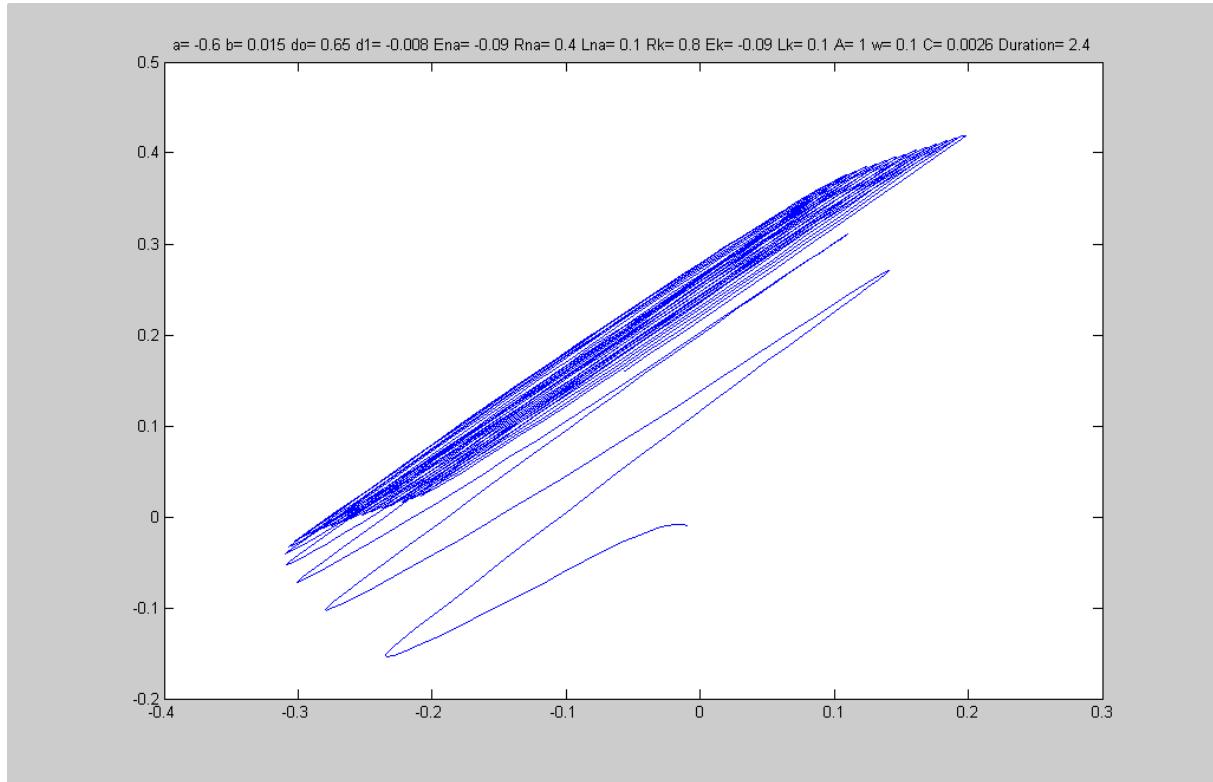


Figure:plan(Ia,Ik)



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SERIE 3 VOLUME 6**1)Investigation modele pacemakerVI1**

$a=-0.6; b=0.3; d_0=0.65; d_1=0.0005; E=90\text{mV}; R=0.6; L=50\text{mH};$

$C=9600\mu\text{F}; D=2400\text{ms}; N=1000; A=1 \text{ w}=150$ forced mode

Figure:plan (V,I1)

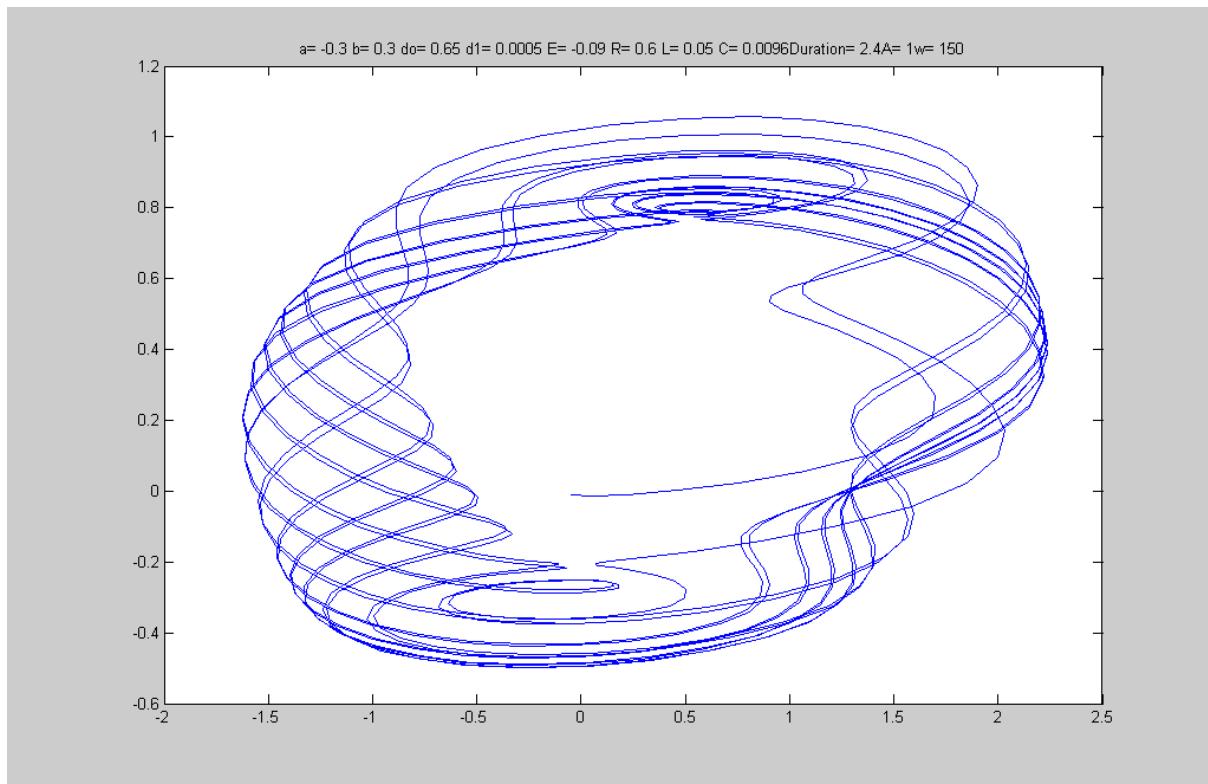


Figure:V(t)

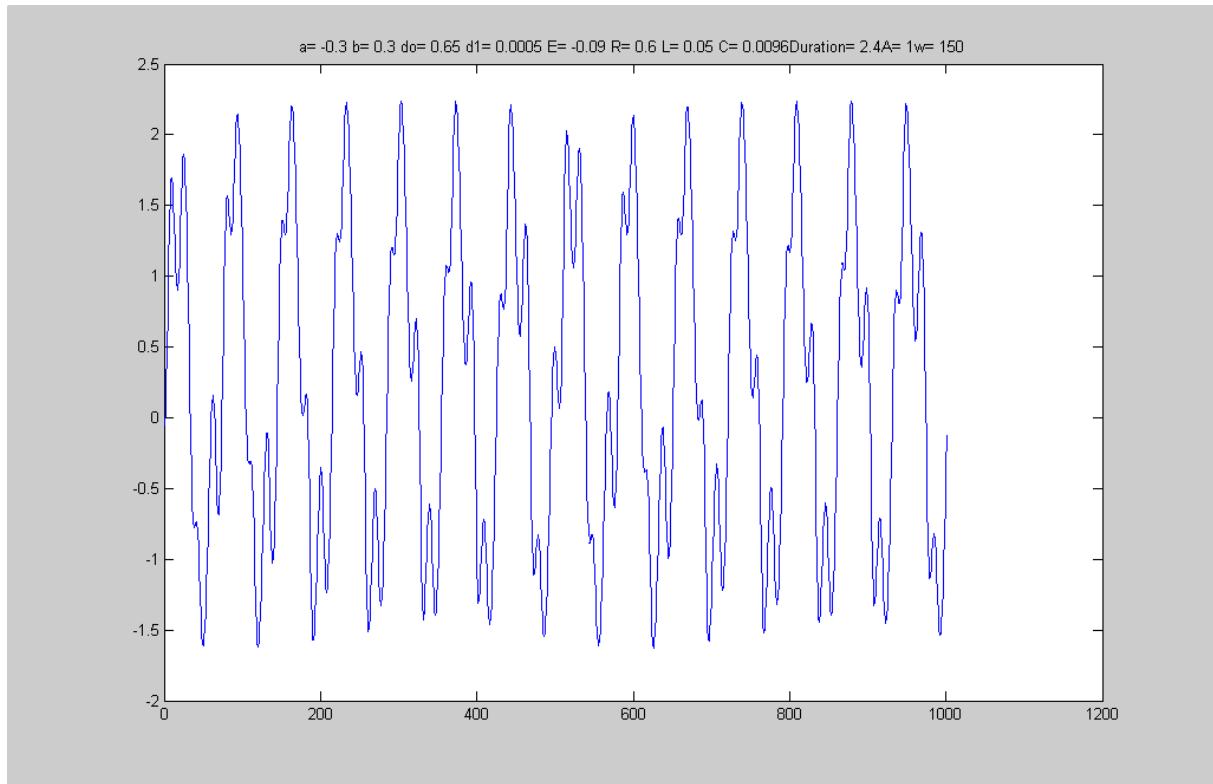
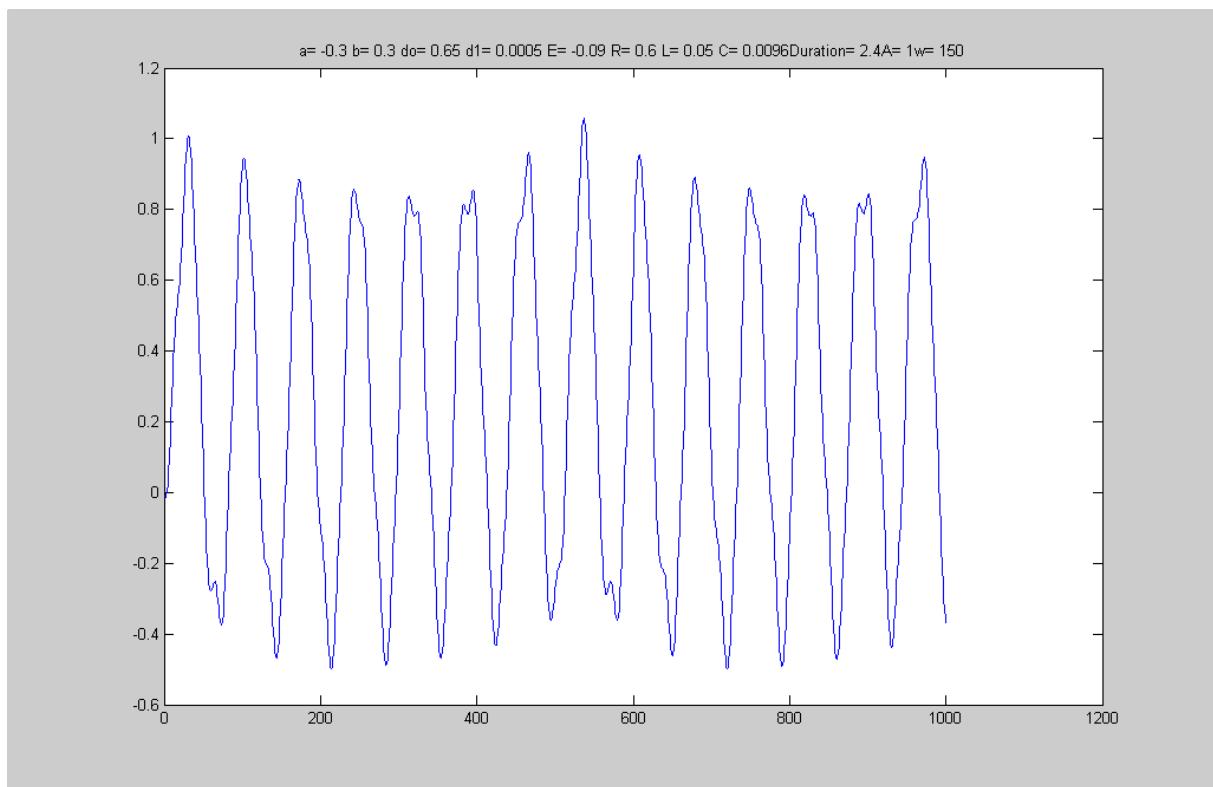


Figure:I1(t)



2) $w=0.1$ $A=1$ the other parameters are fixed.

Figure:plan(V,I1)

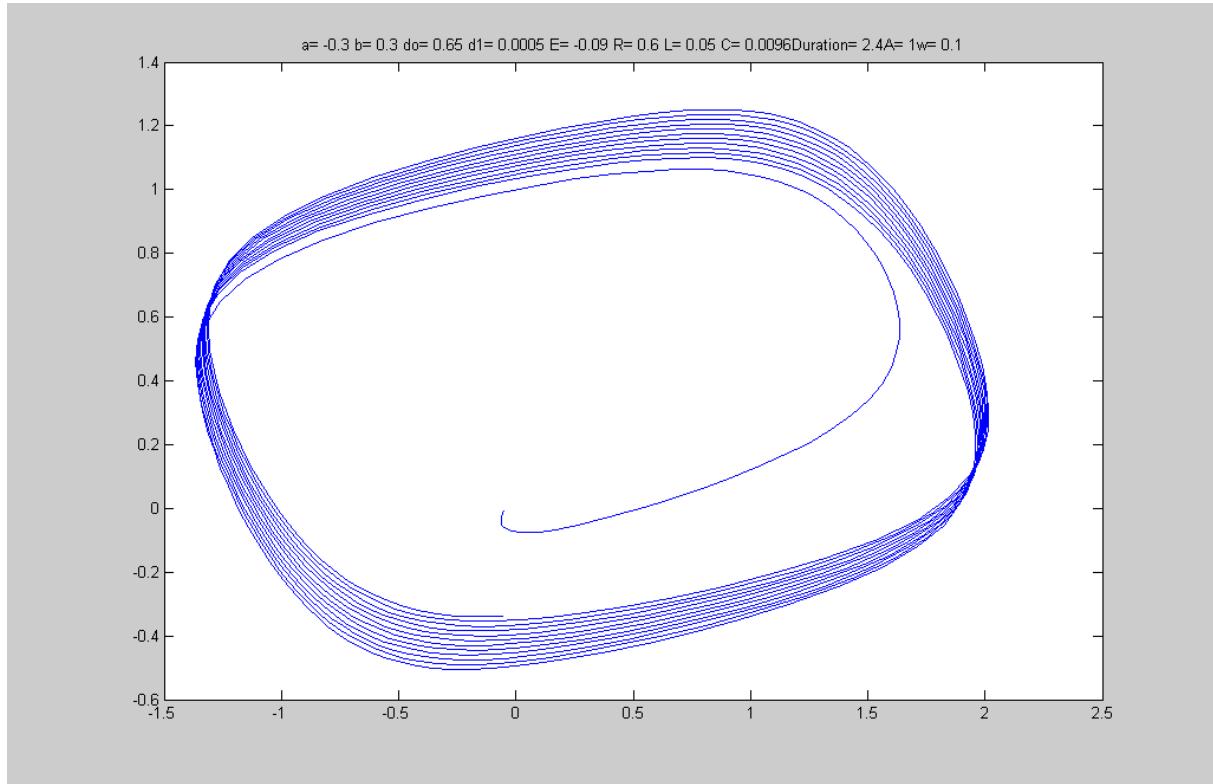


Figure:V(t)

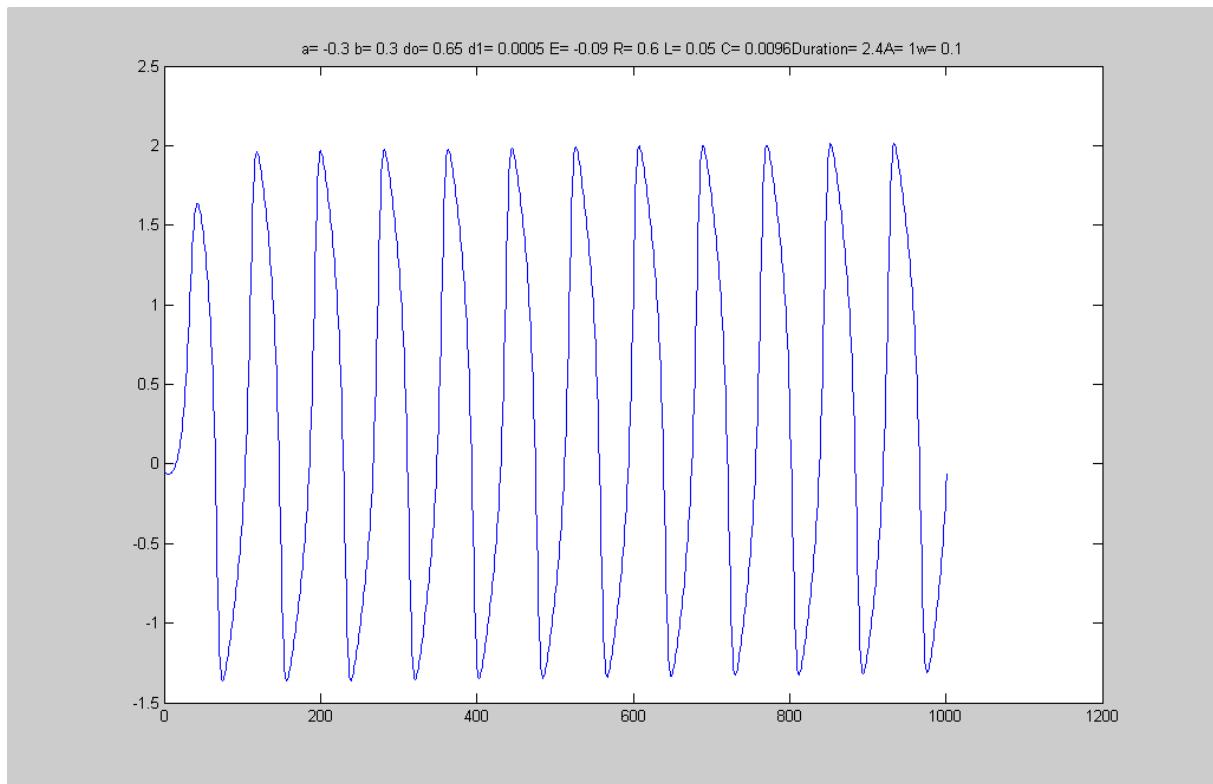
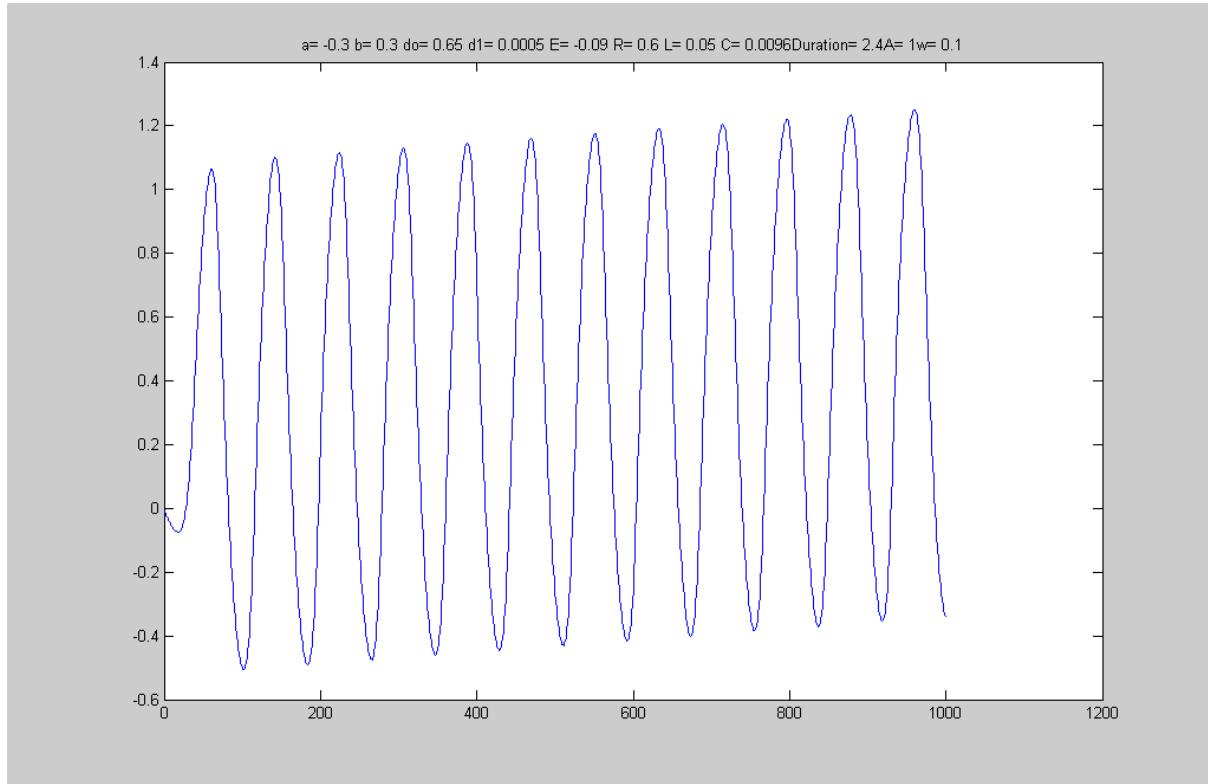


Figure:I1(t)



3)w=1;A=1 the other parameters are fixed.

Figure:plan(V,I1)

This case of chao observed can be called ,shoes,or,car,or a special care like porshe.

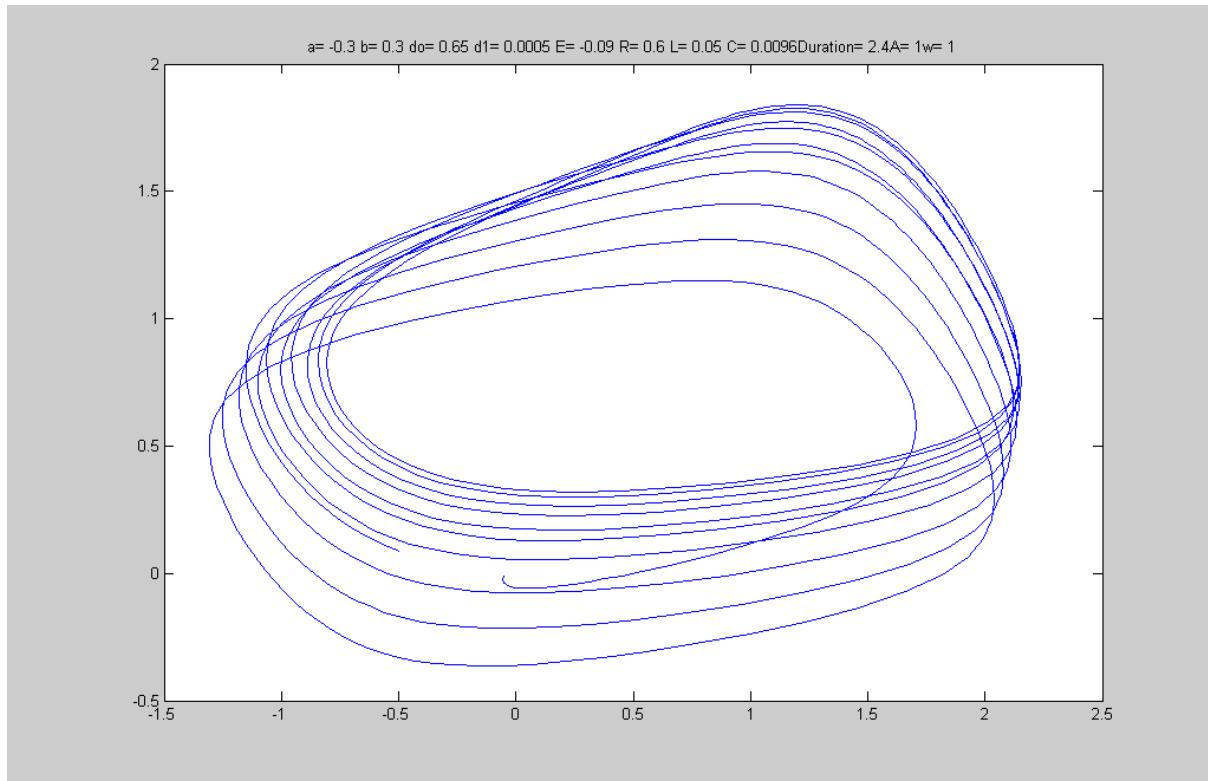


Figure:V(t)

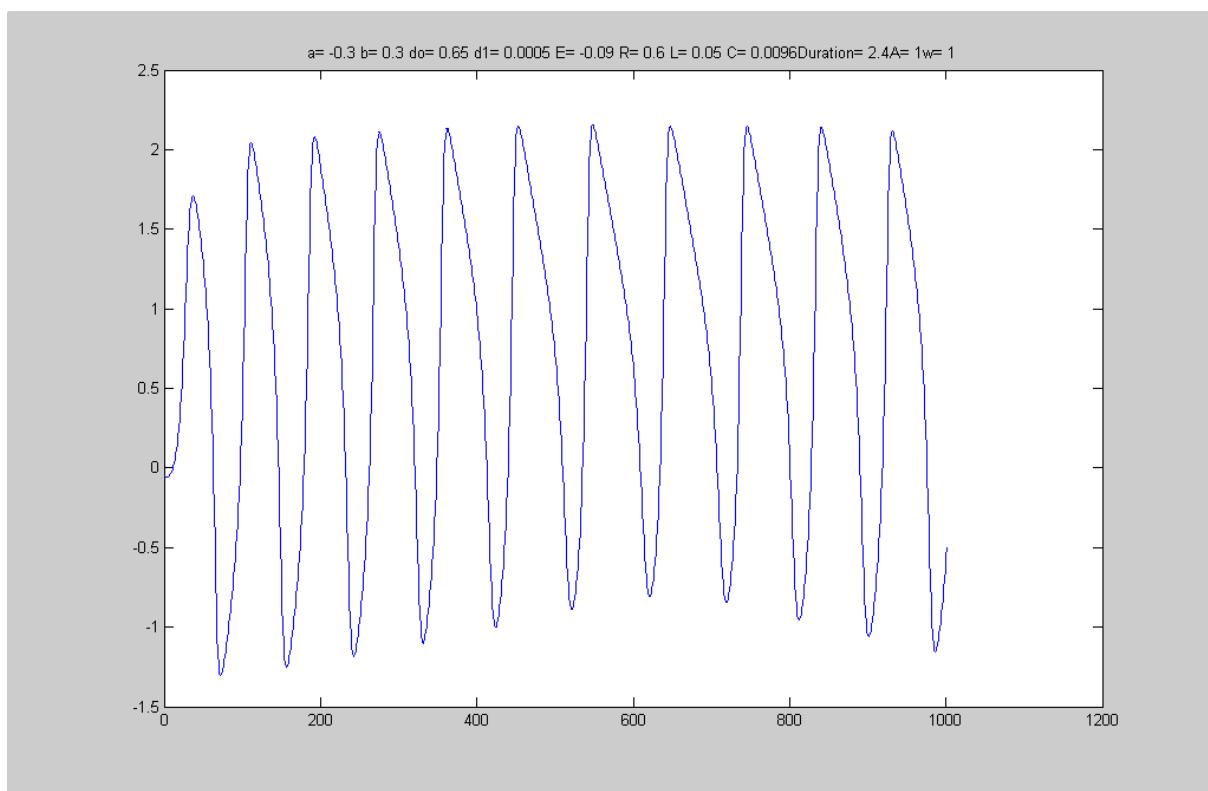
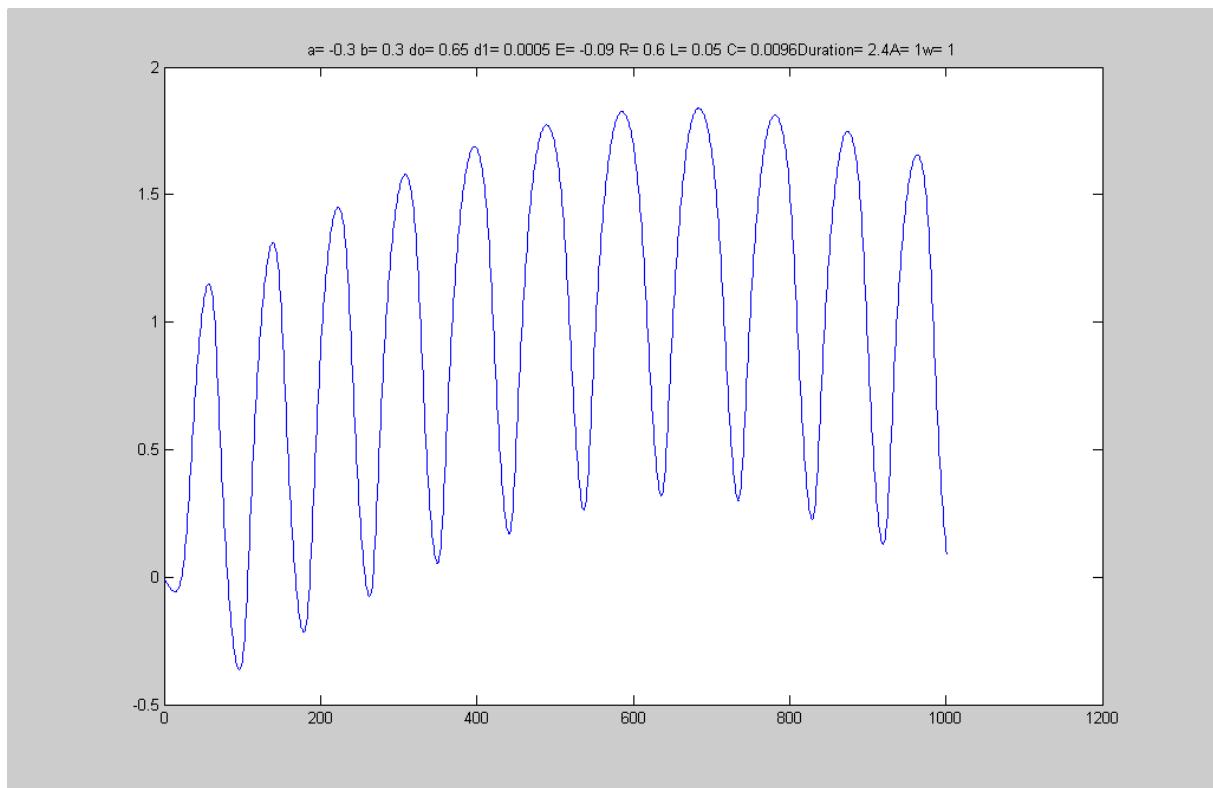


Figure:I1(t)

3) w=10 A=1 the other parameters are fixed.

Figure:plan (V,I1)

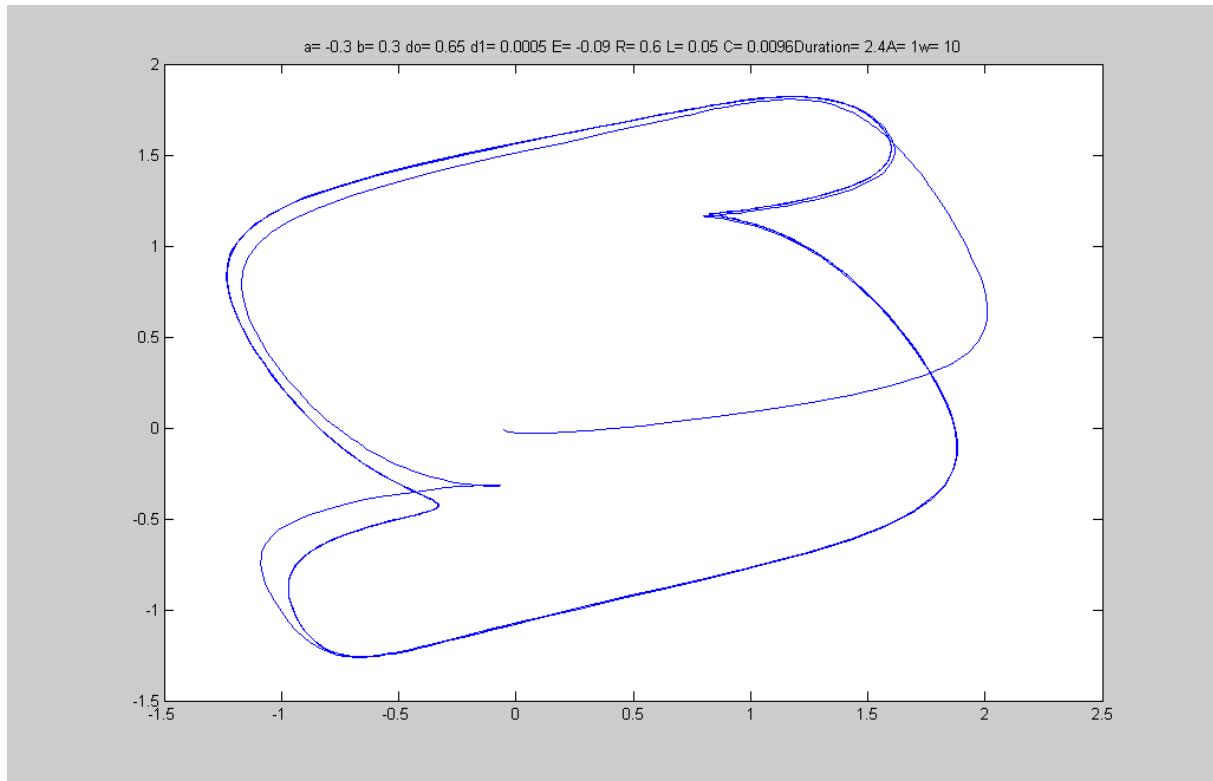


Figure: $V(t)$

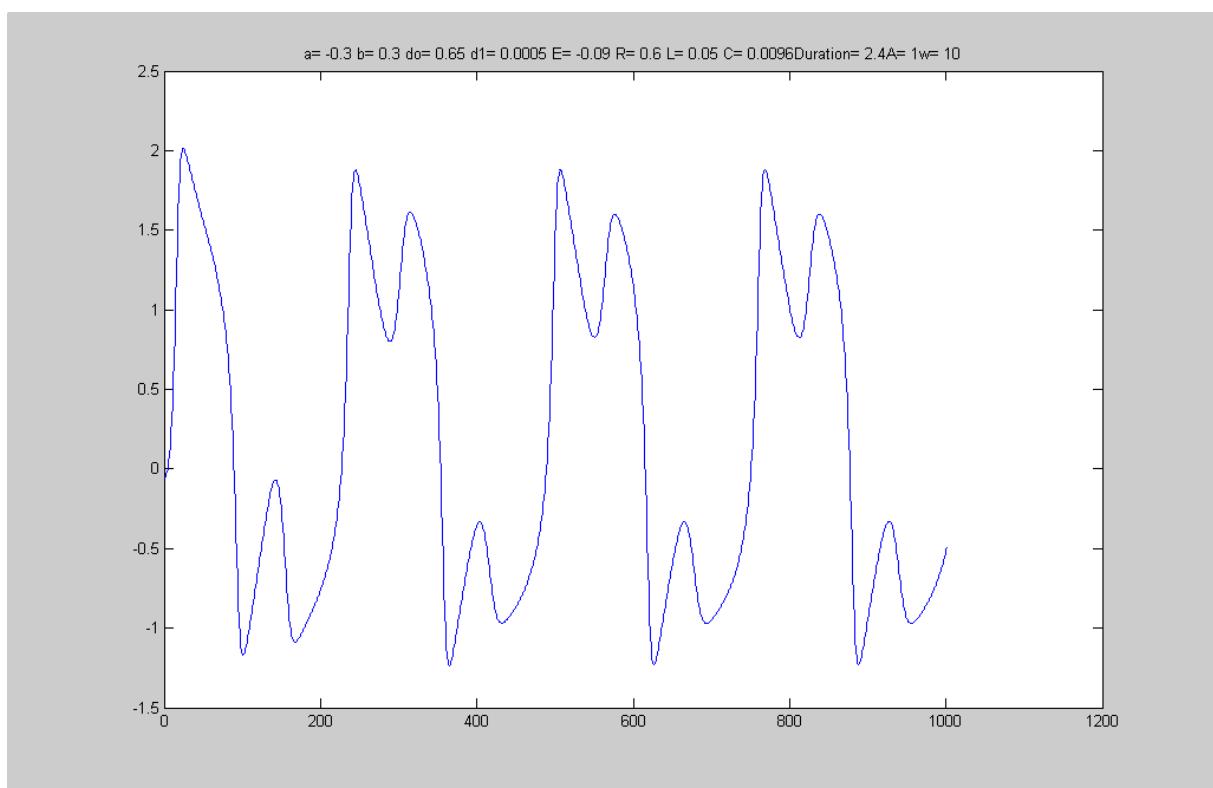
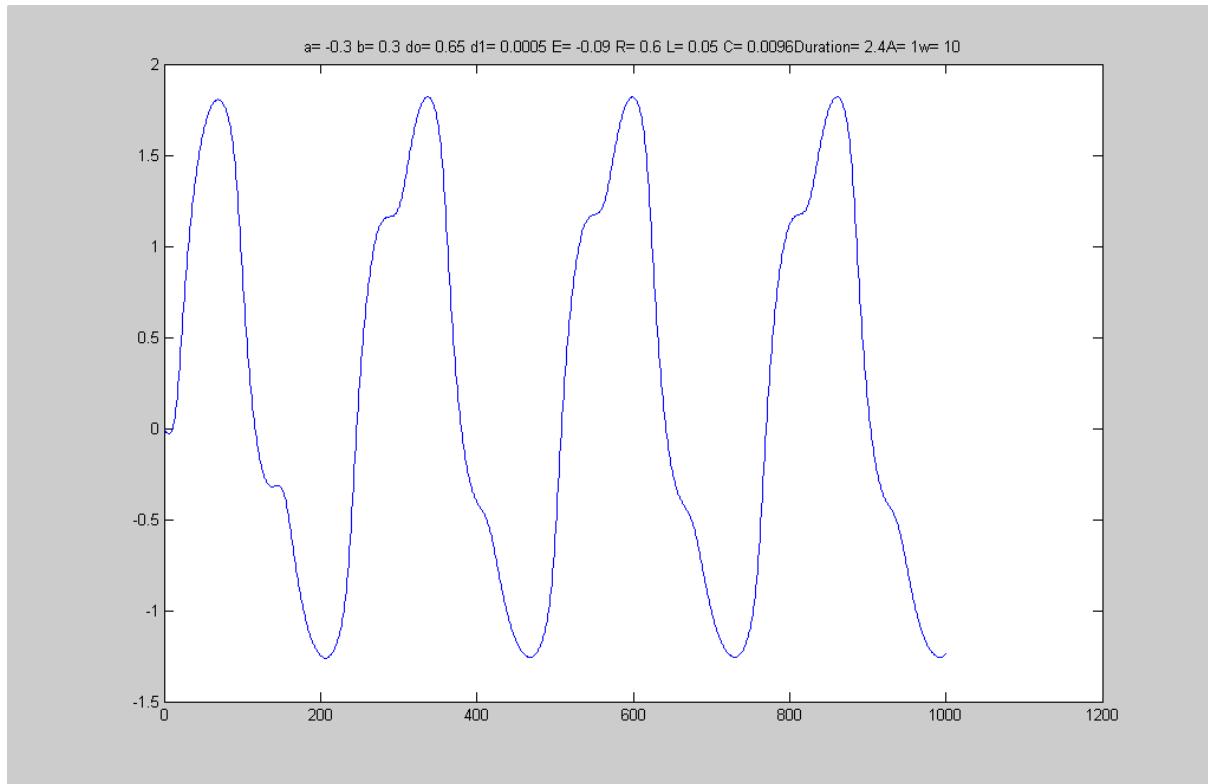


Figure:I1(t)

4)w=50 A=1

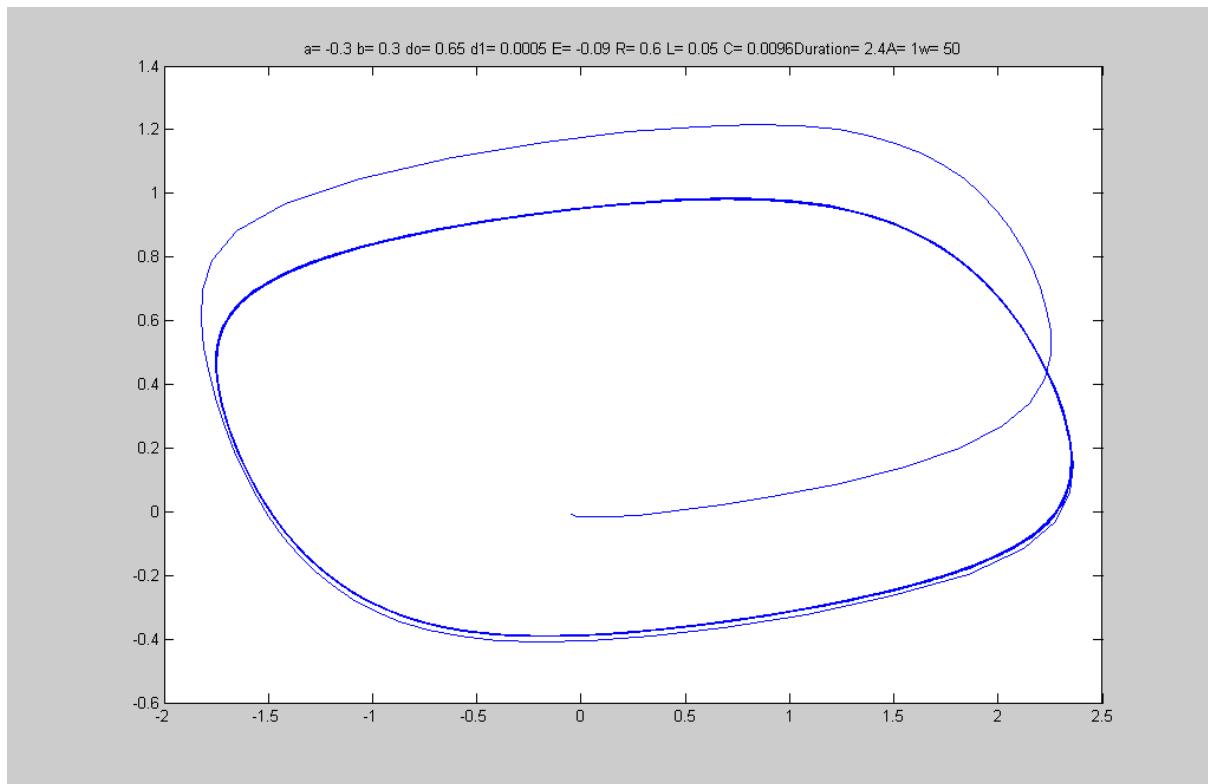
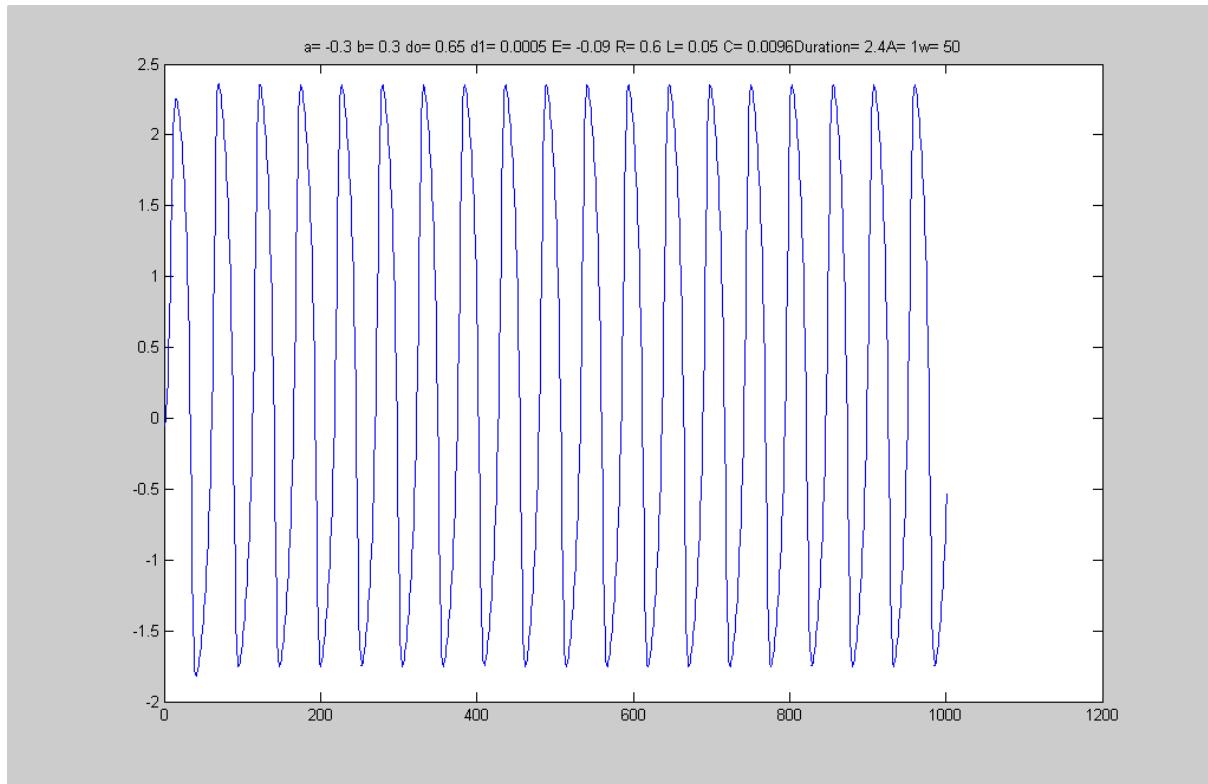
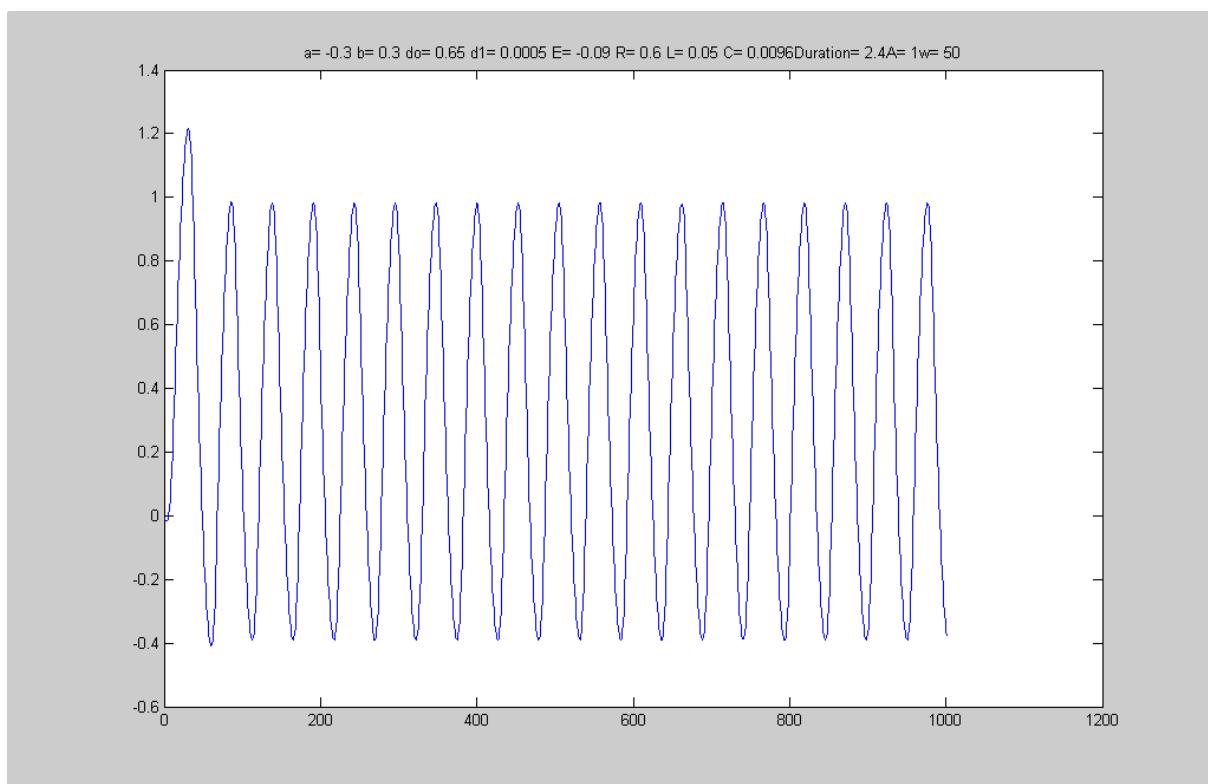
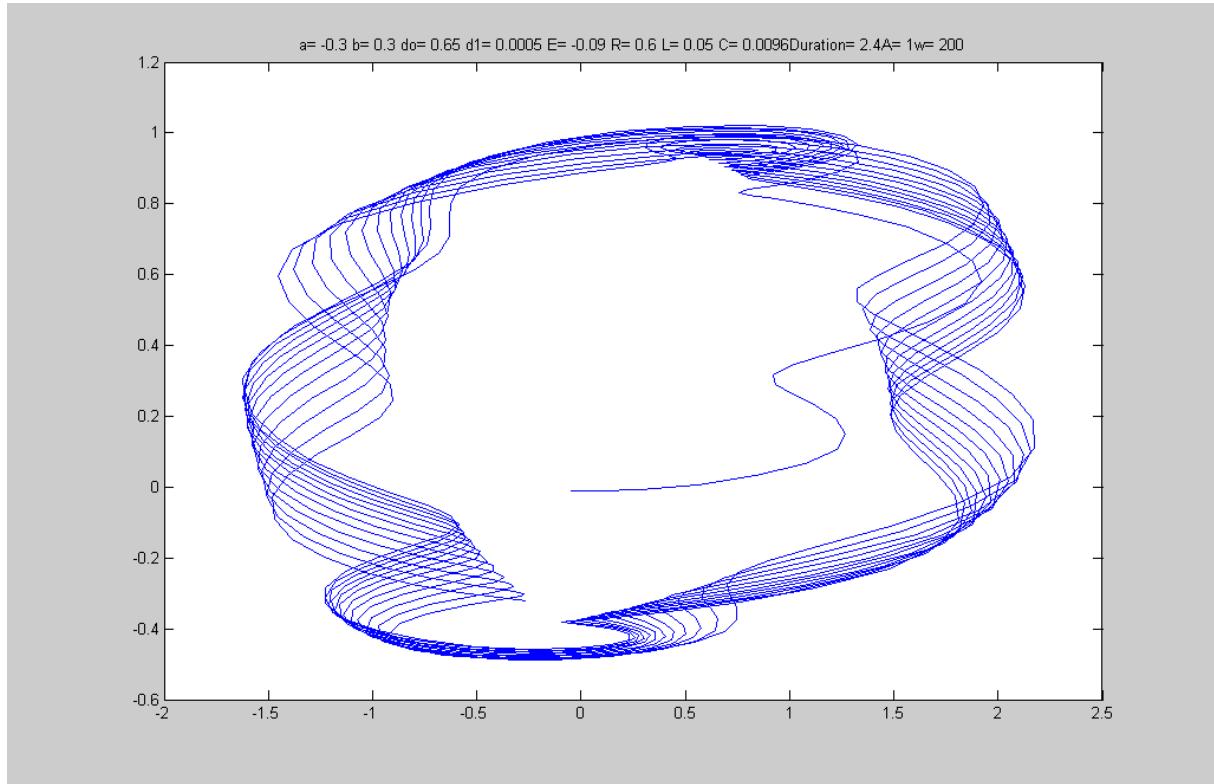
Figure:plan(V,I1)

Figure:V(t)**Figure:I1(t)**

**5)w=200 A=1 the other parameters are fixed
Figure:plan(V,I1) a ruban case**



Figure;V(t)

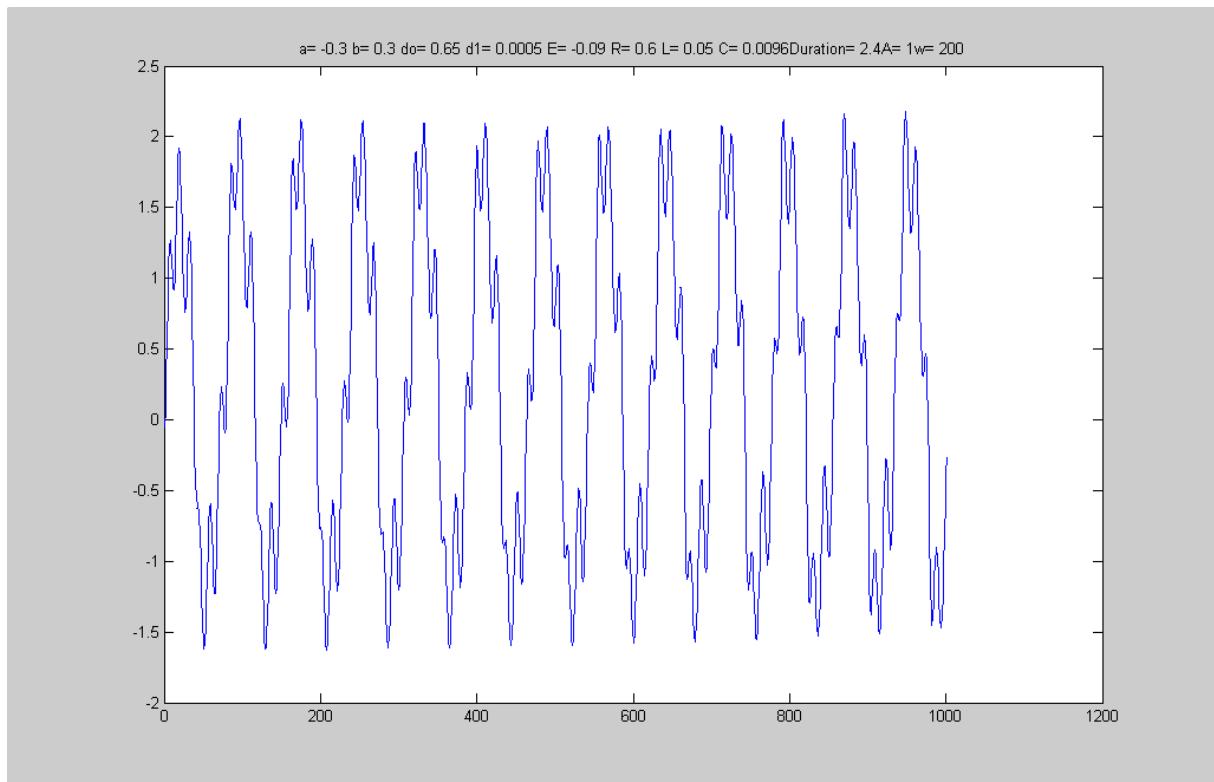
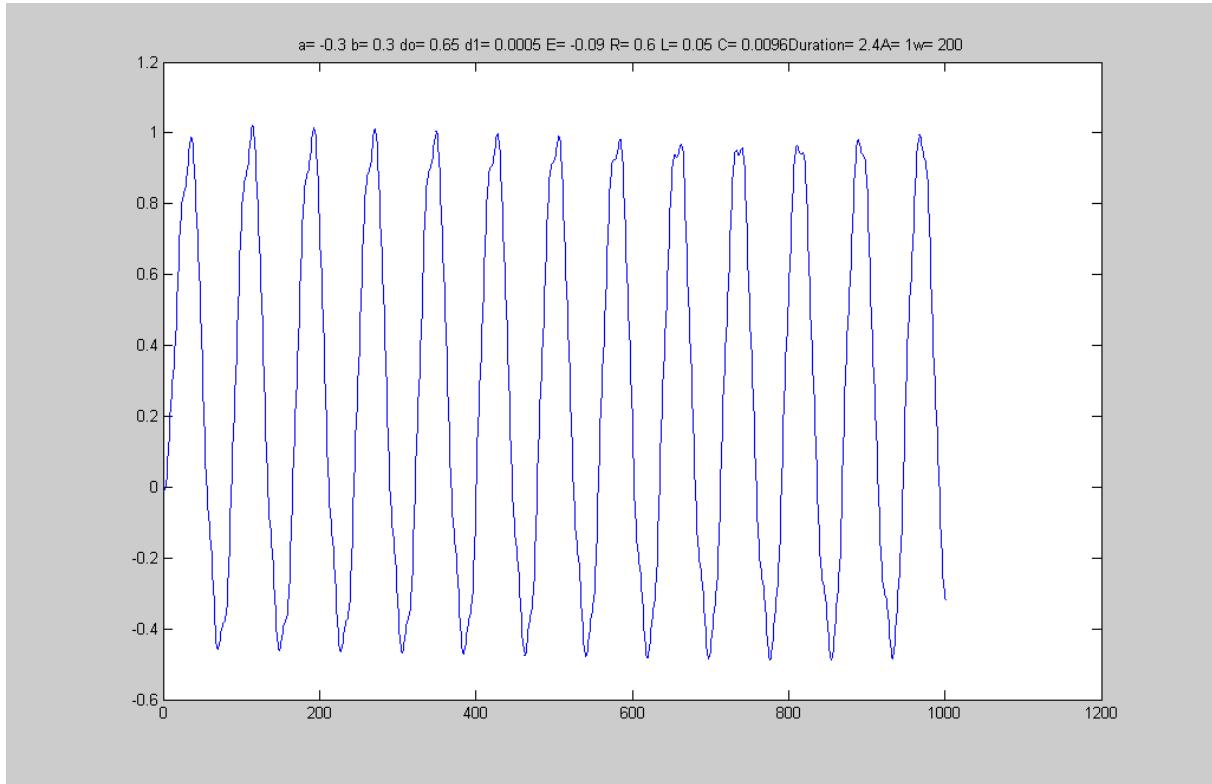


Figure: I1(t)

6) w=250 A=1 the other parameters are fixed.

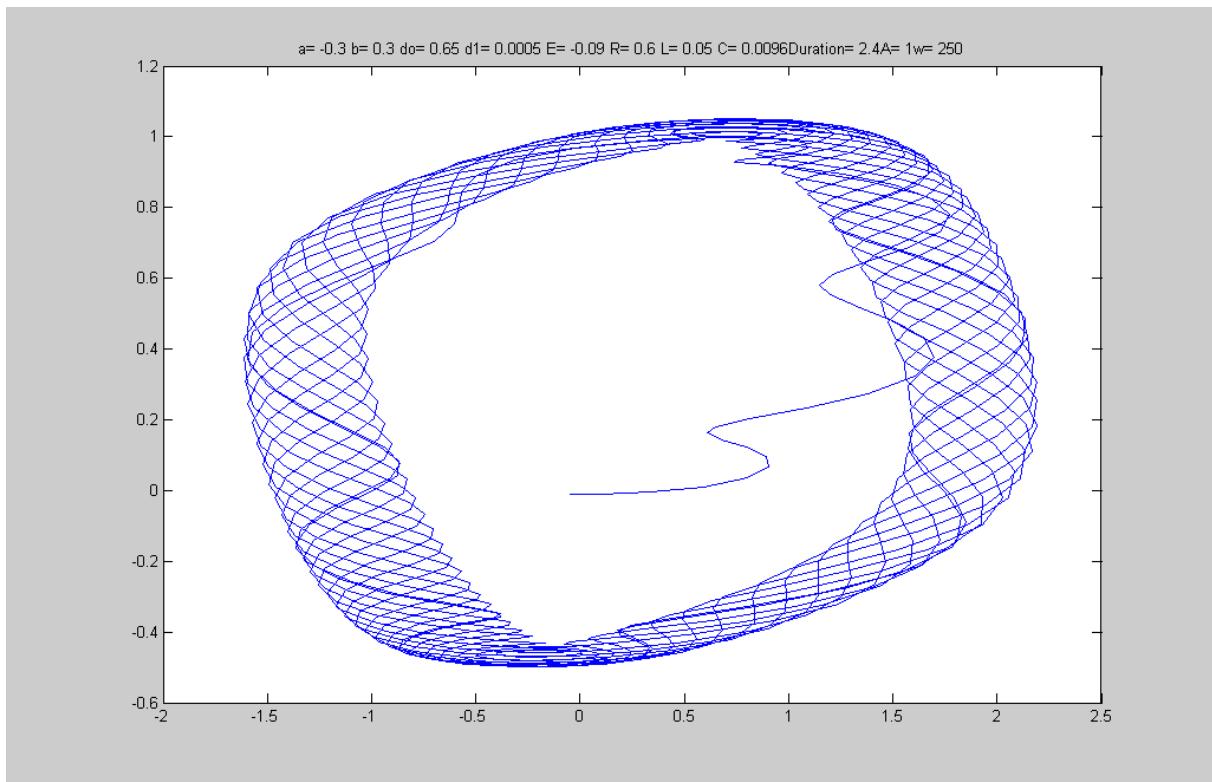
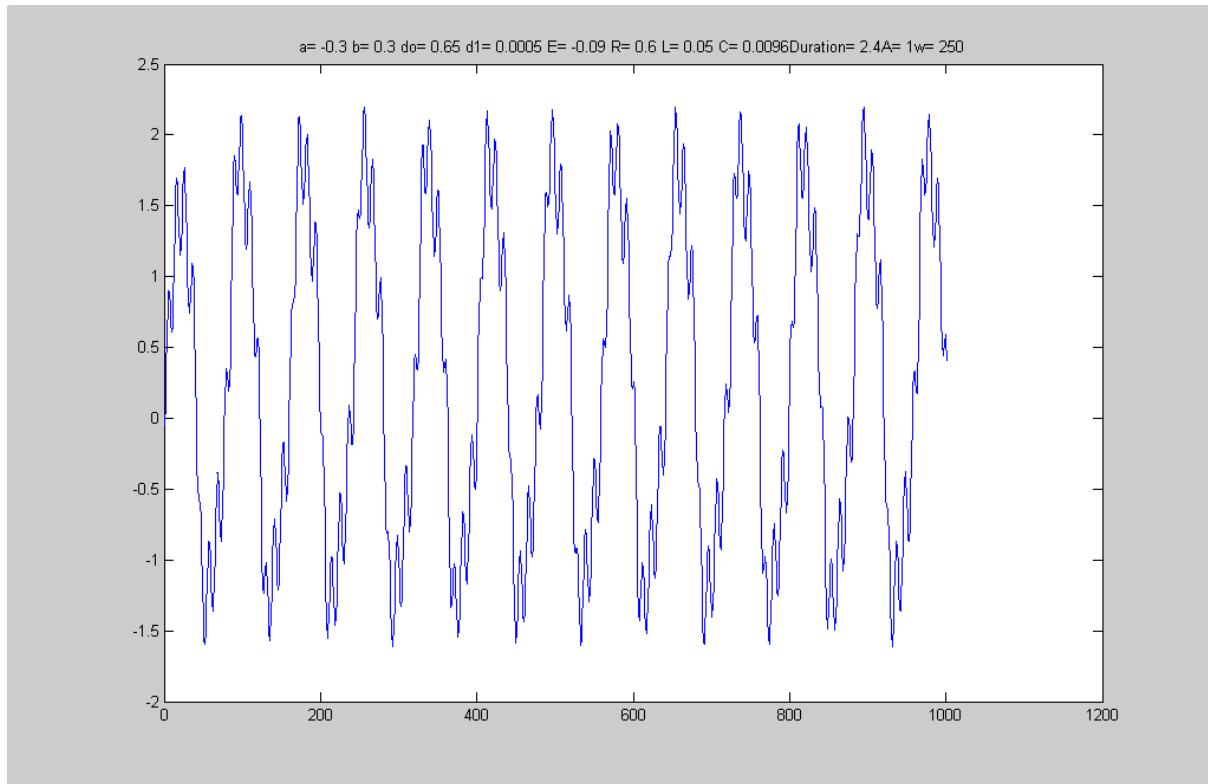
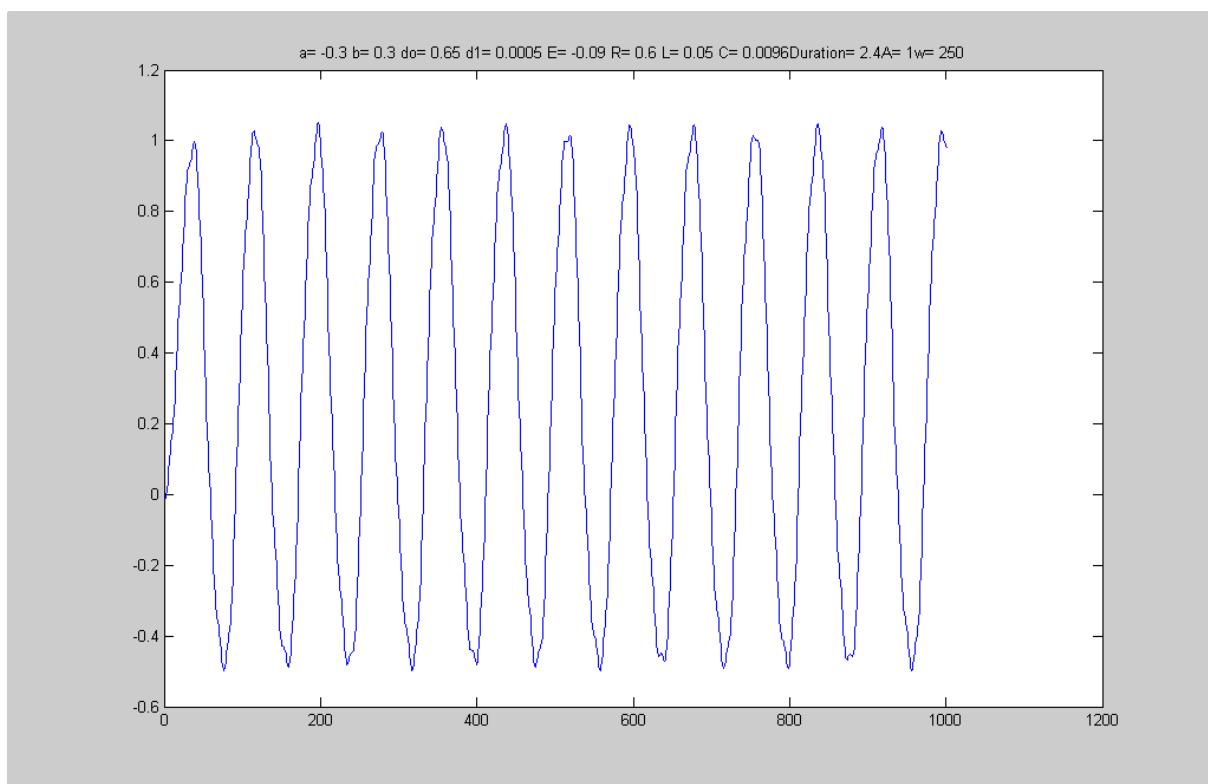
Figure:plan(V,I1)

Figure:V(t)**Figure:I1(t)**

SERIE 3 VOLUME 7

1)investigation modele pacemaker VINAIK
 $a=-0.3; b=0.3; d_0=0.65; d_1=-0.0005; E_{Na}=-90\text{mV}; L_{Na}=50\text{mH}$
 $R_{Na}=0.6; D=2400\text{ms}; N=1000; R_k=0.6; L_k=50\text{mH}$
 $W=0.1 A=1$

Figure:plan(V,I_{Na},I_k)

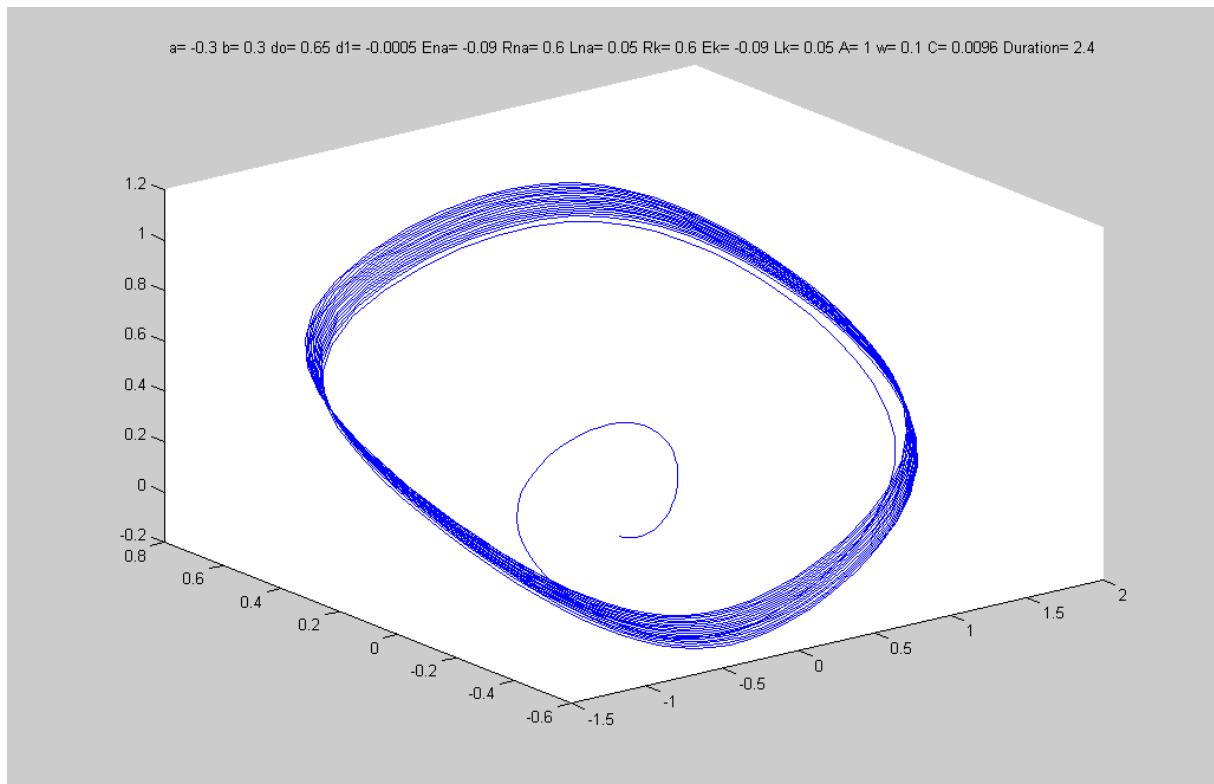


Figure: V(t)

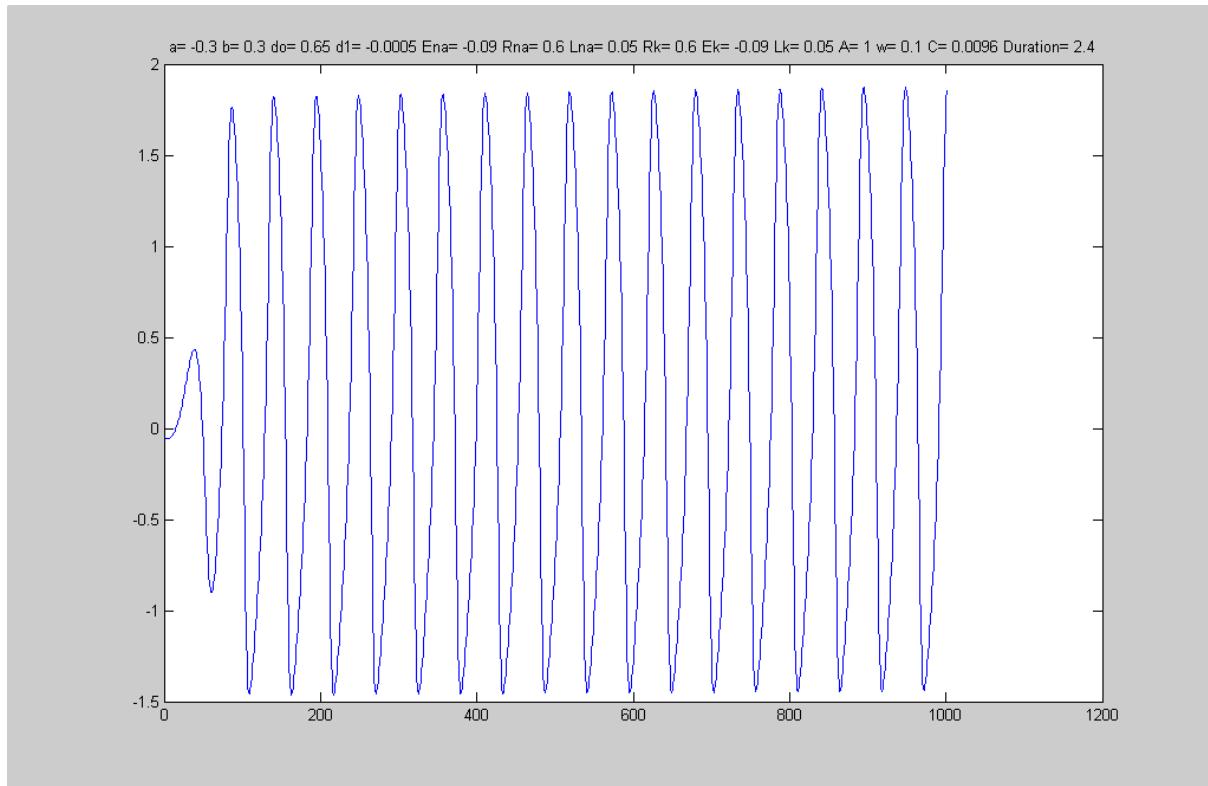


Figure:Ina(t)

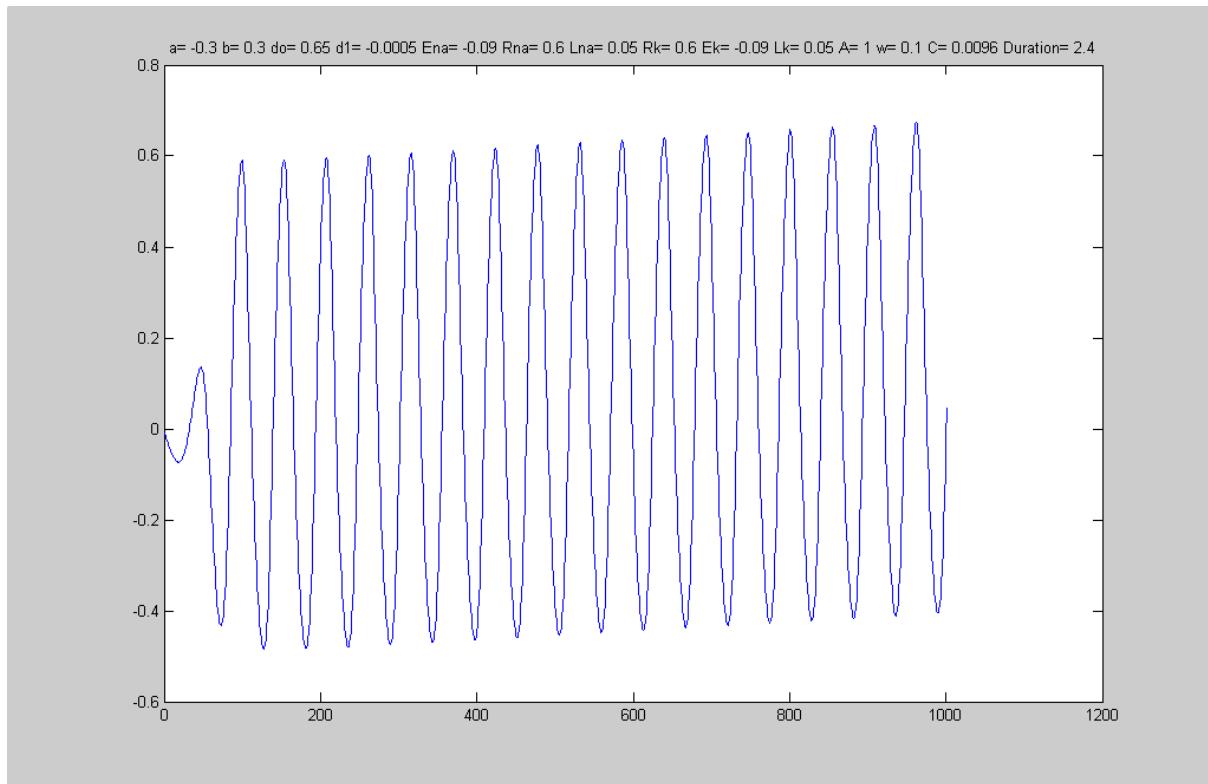


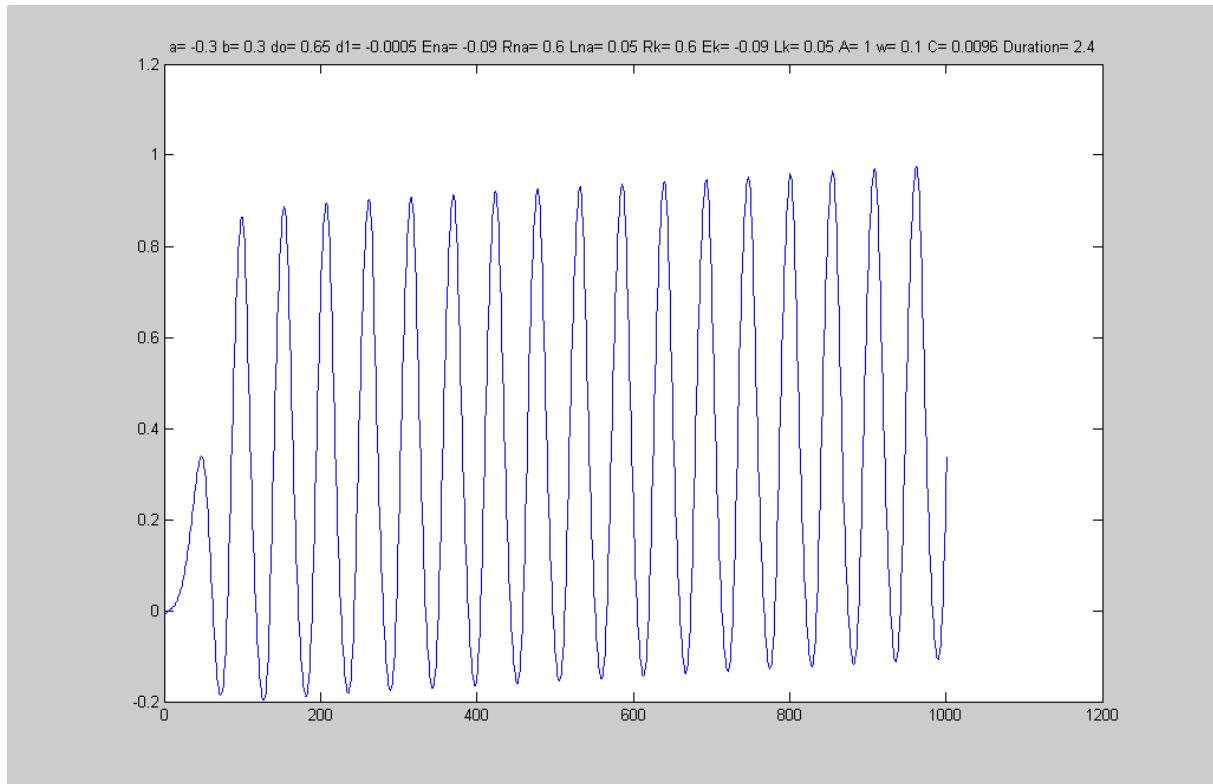
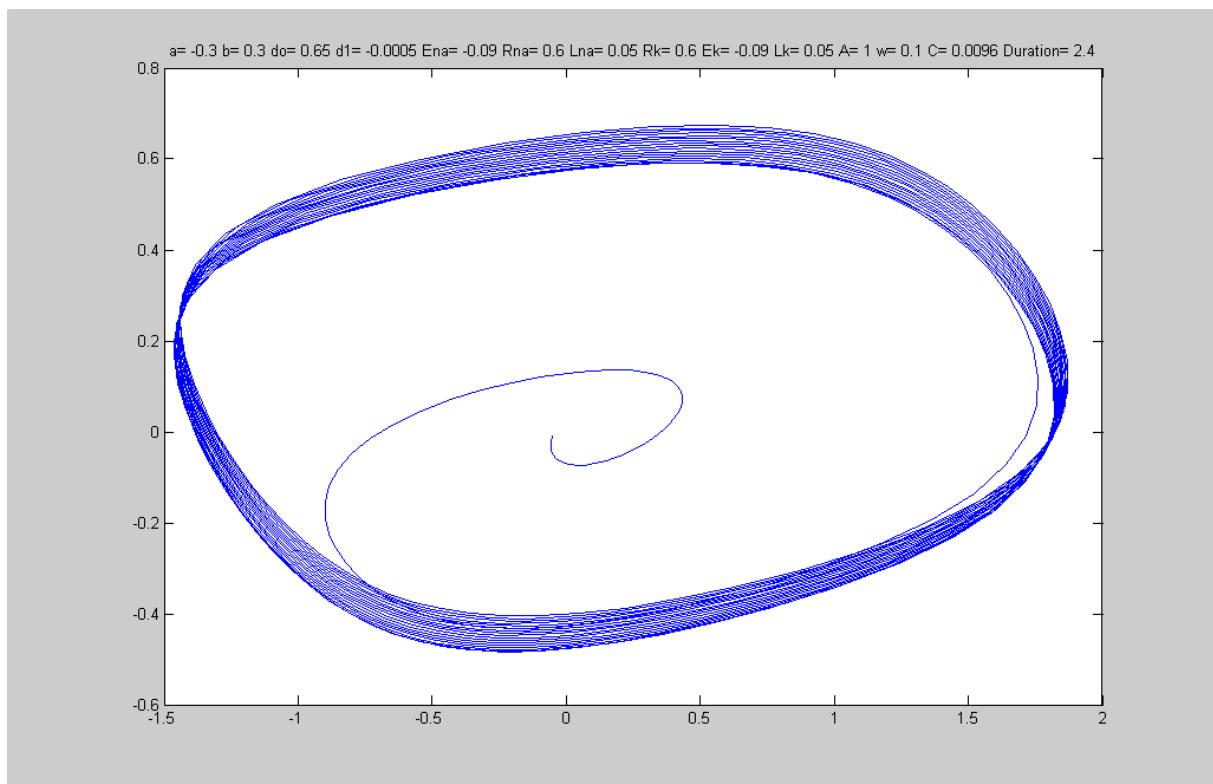
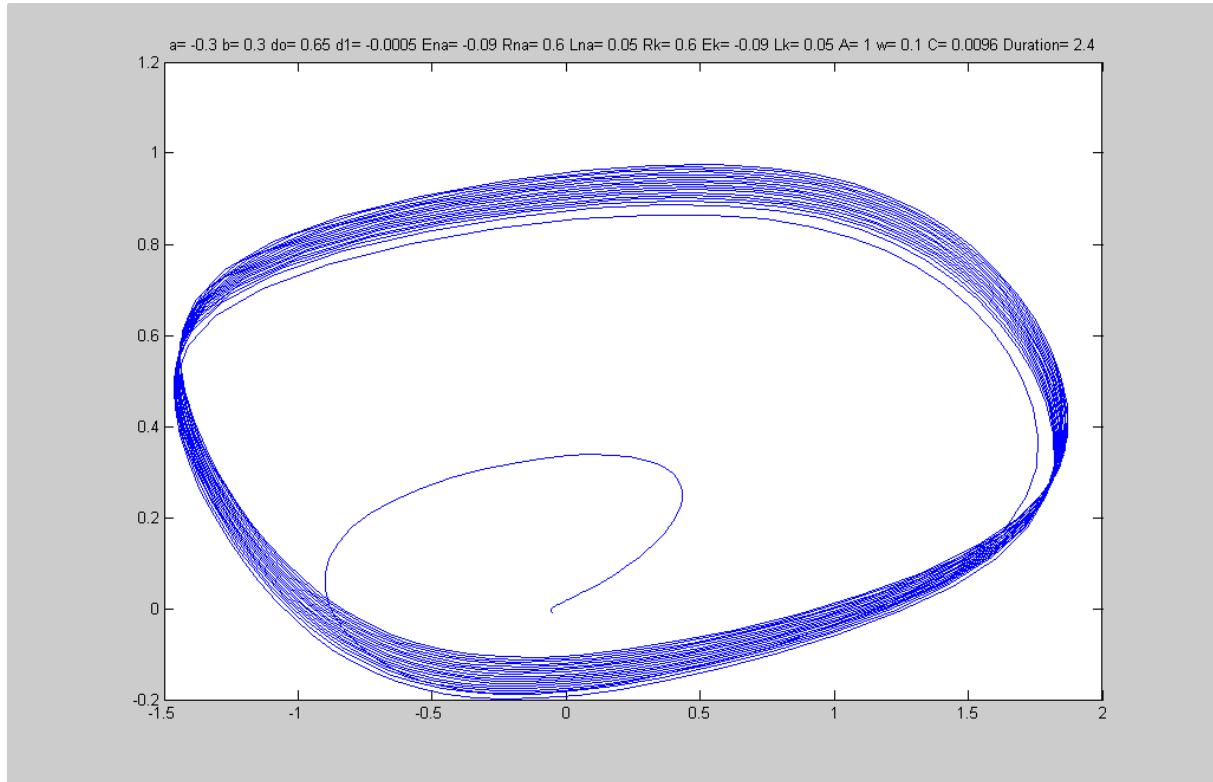
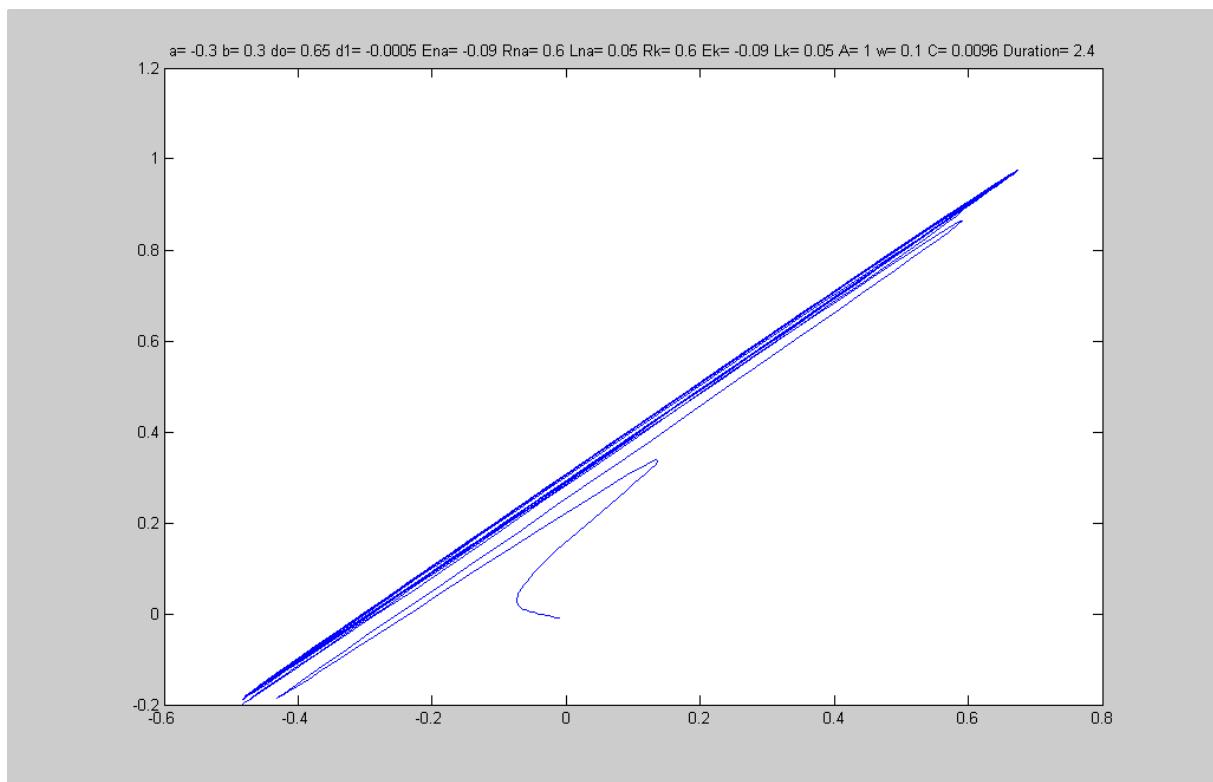
Figure:Ik(t)**Figure:plan(V,I_{in})**

Figure:plan (V,Ik)**Figure:plan(Ia,Ik)**

2) $w=10$ $A=1$ the other parameters are fixed.

Figure:plan(V,Ina,Ik) spiral case of chao

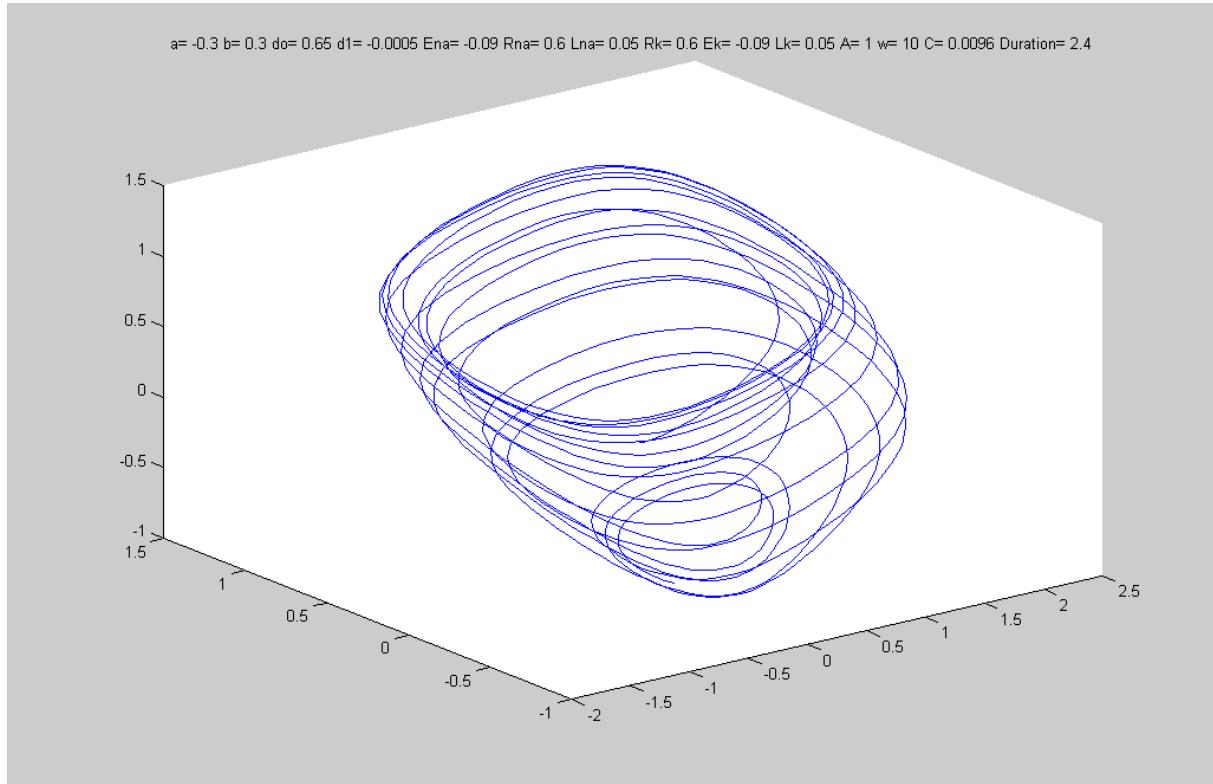


Figure:V(t)

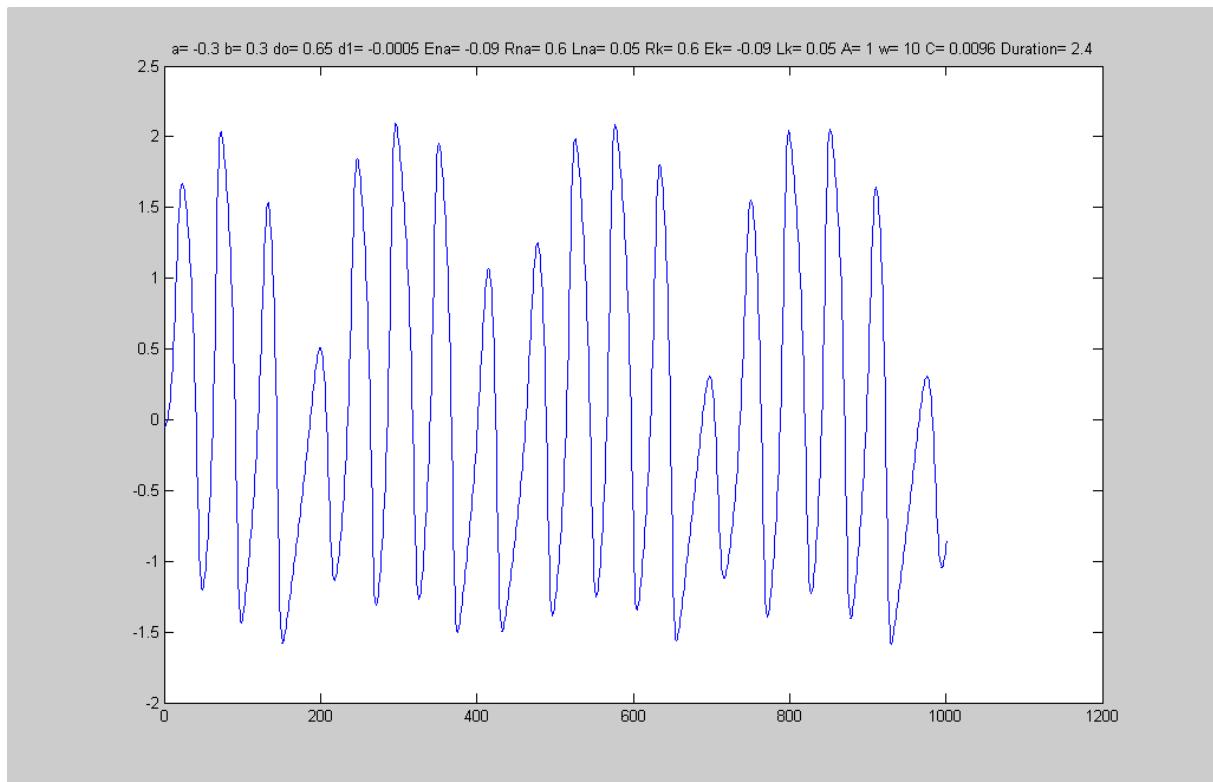
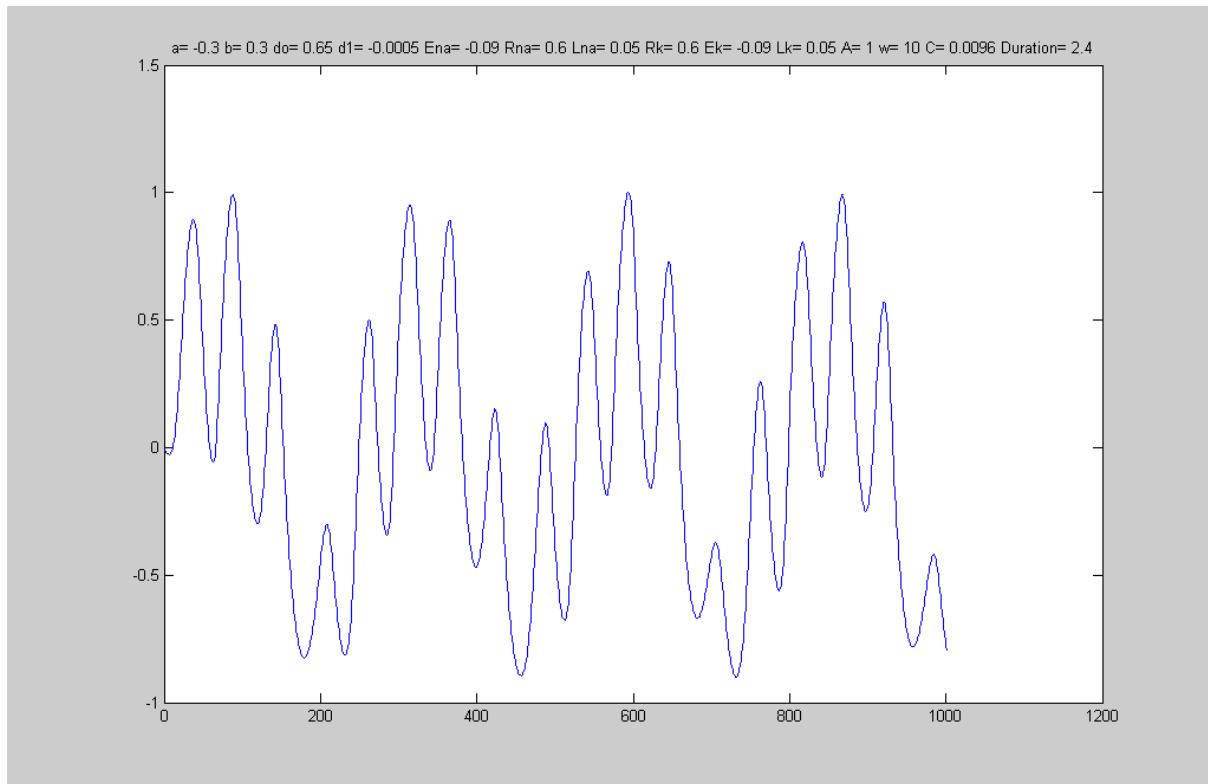


Figure: Ina(t)**Figure;plan (V,Ina)**

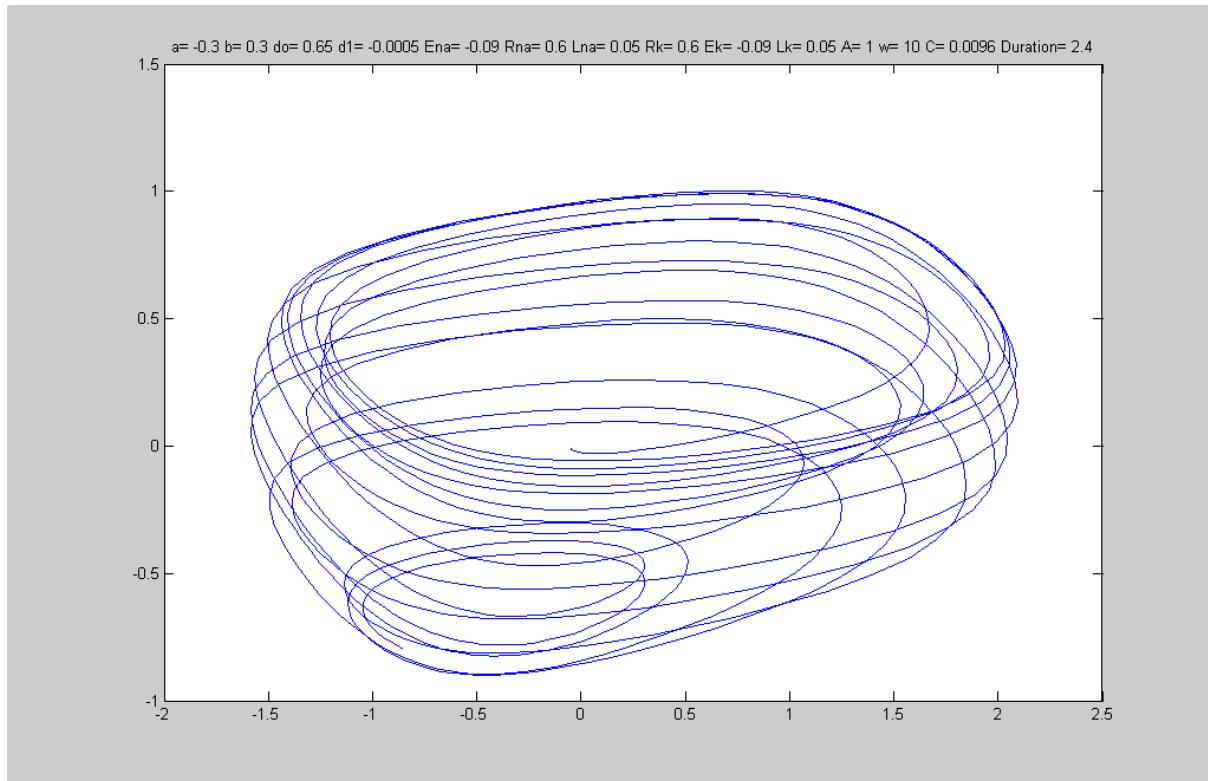


Figure:plan (V,Ik) a boat chao,(airplane,car porshe surface)

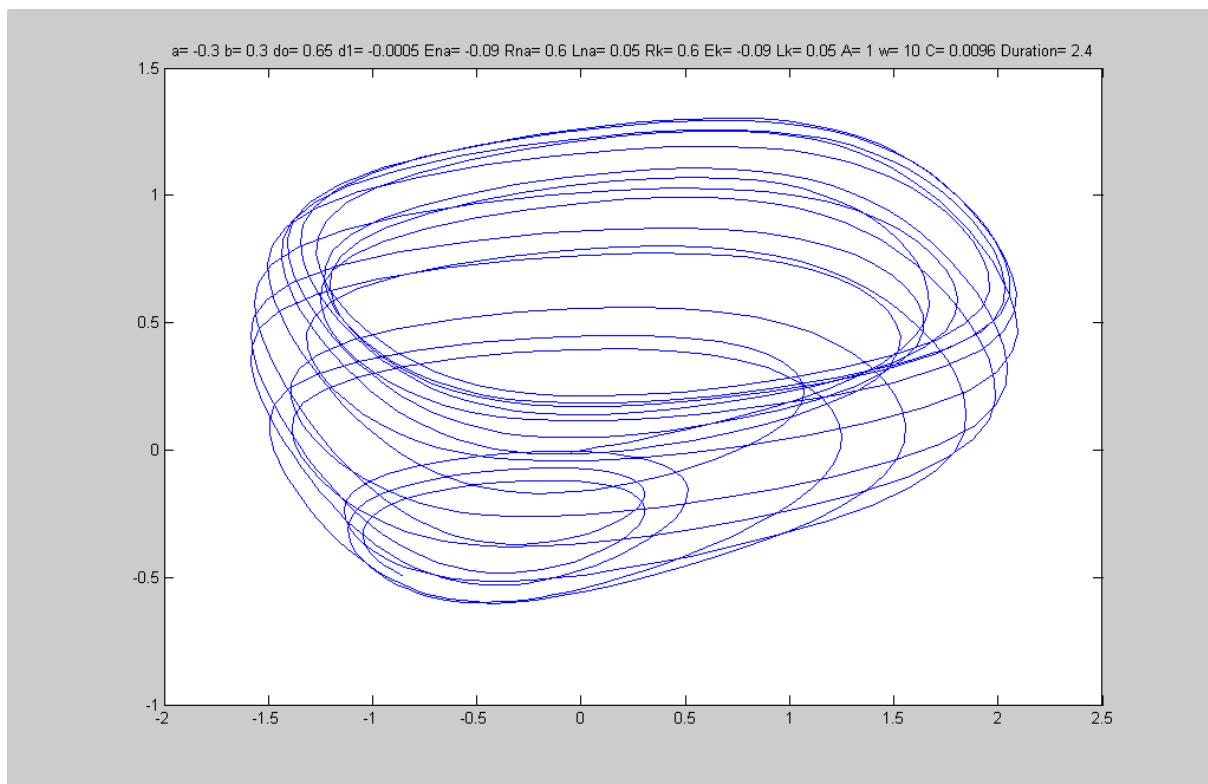
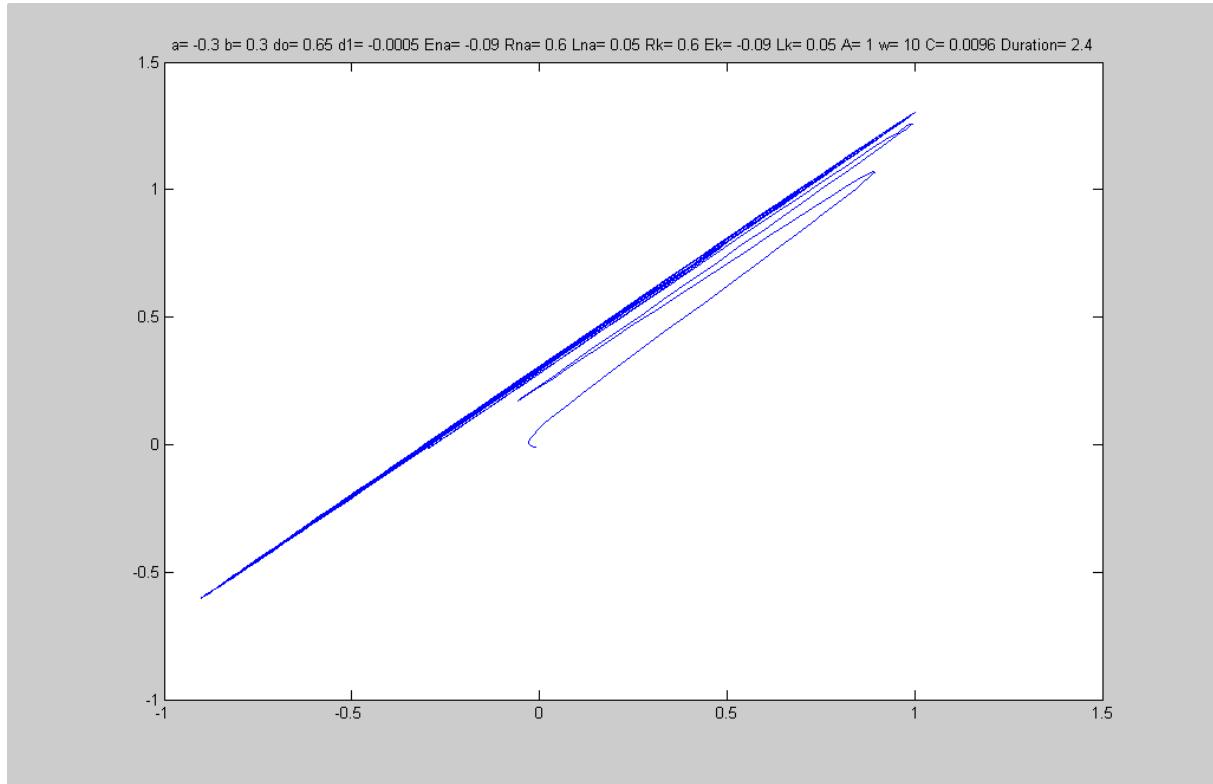


Figure:plan(I_a,I_k)



4) $w=50$ $A=1$ the other parameters are fixed.

Figure;plan (V,I_a,I_k)

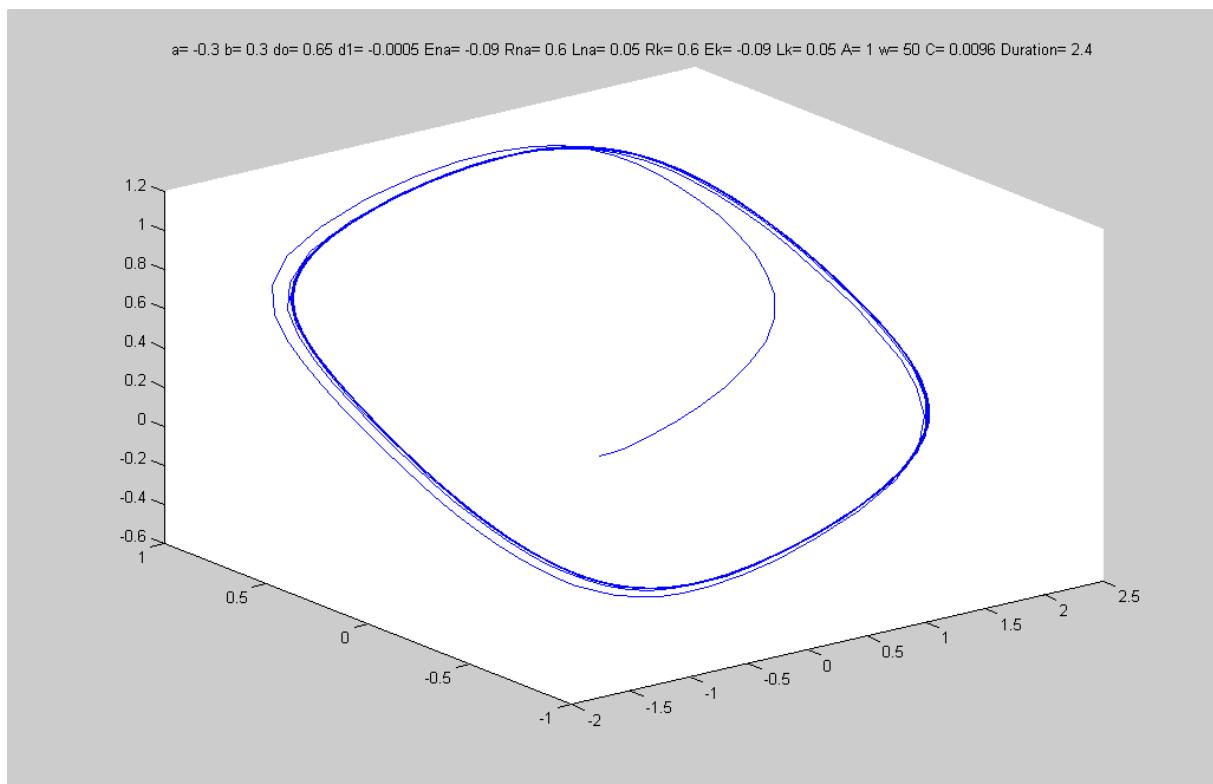
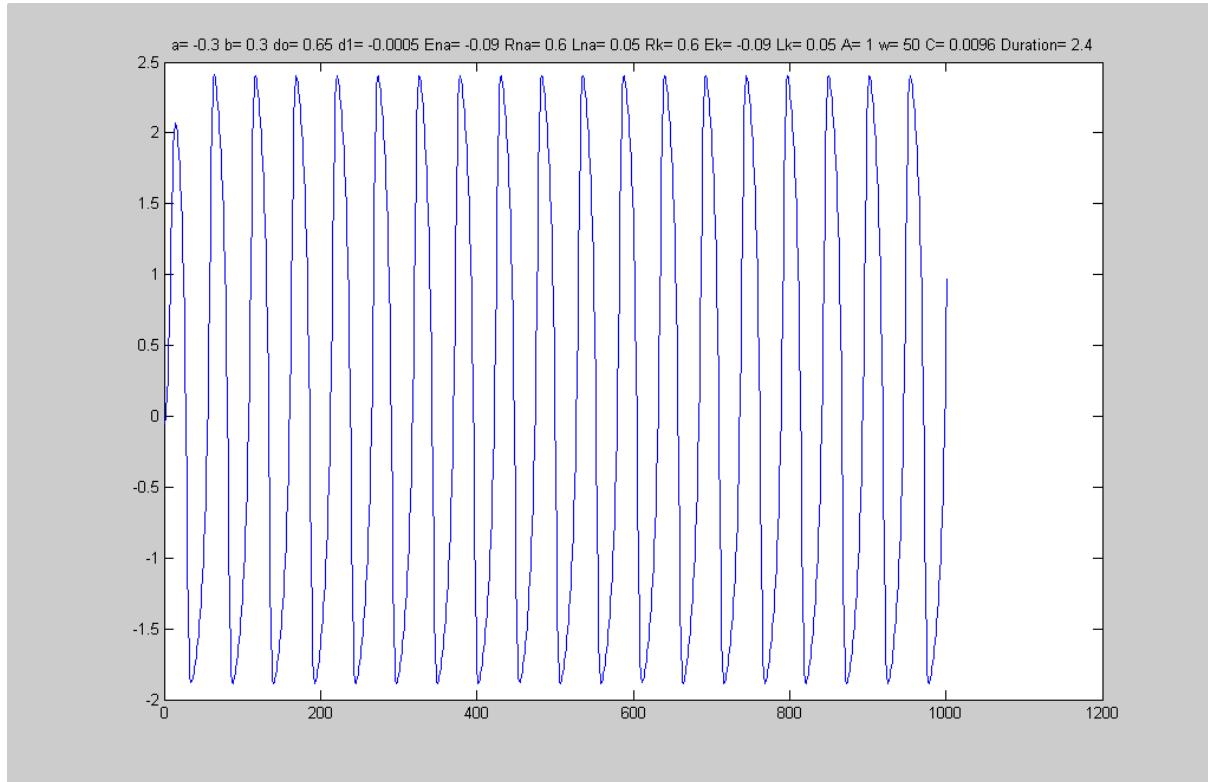
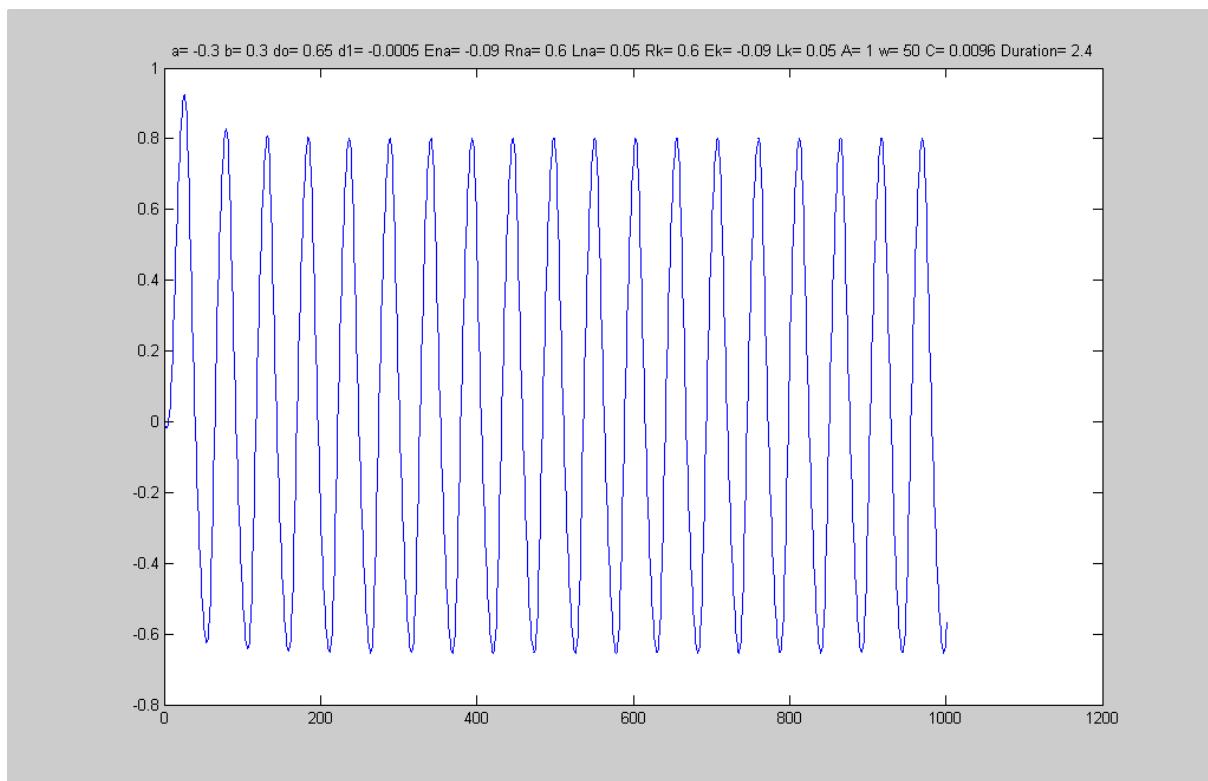
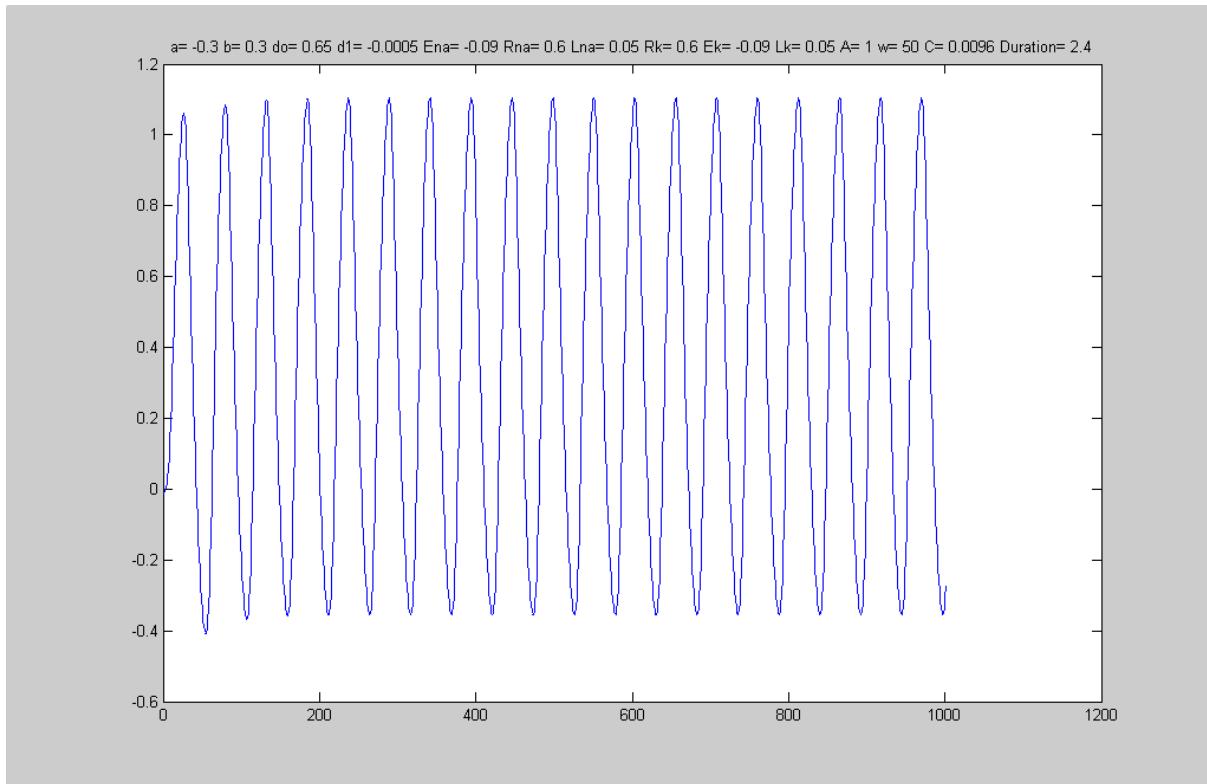
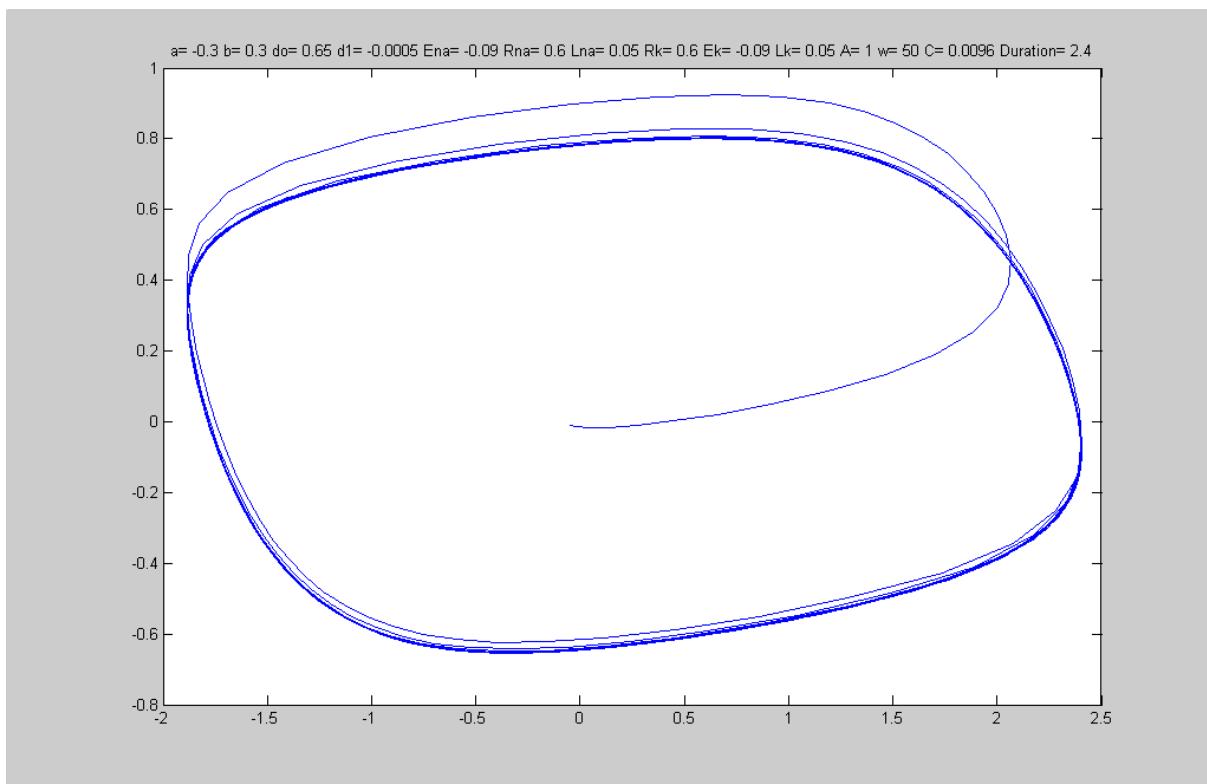
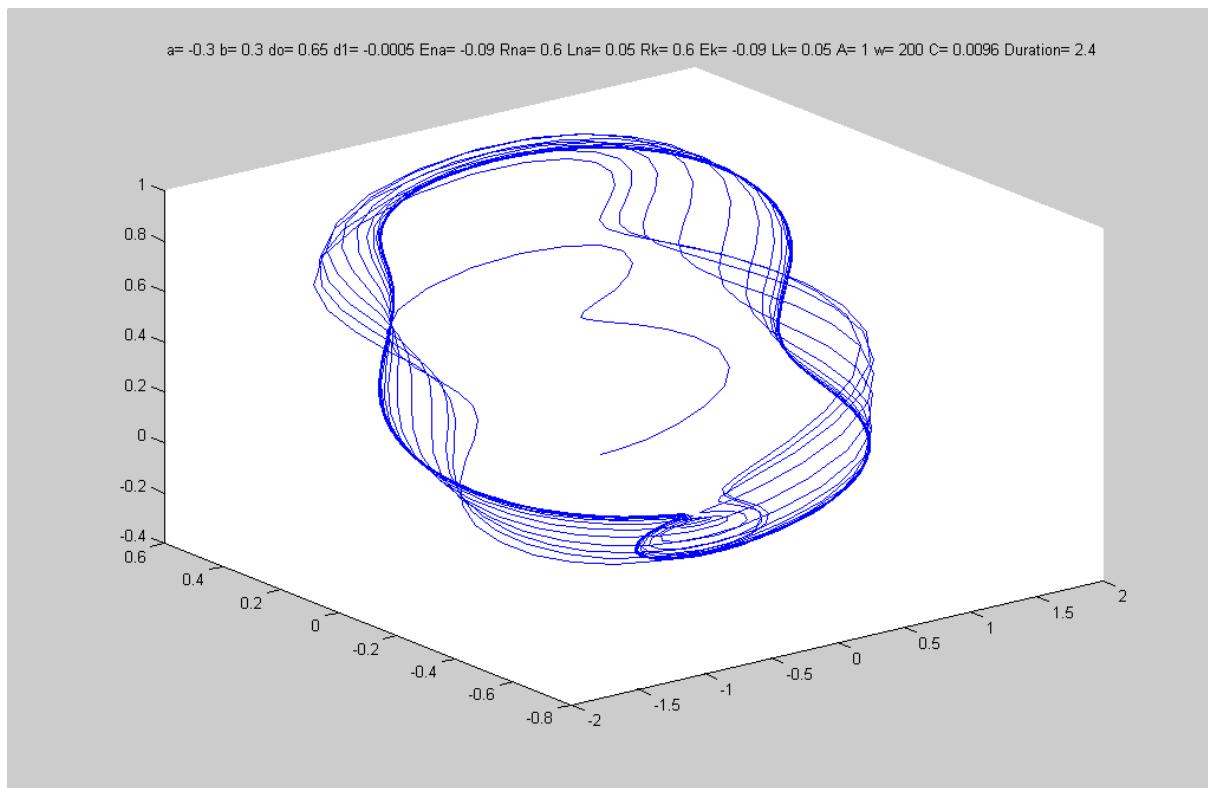


Figure:V(t)**Figure:I_{Na}(t)**

Figure;Ik(t)**Figure;plan (V,Ina)**

5) $w=200$ $A=1$ other parameters are fixed.

Figure:plan (V,I_a,I_k)



Figure;V(t)

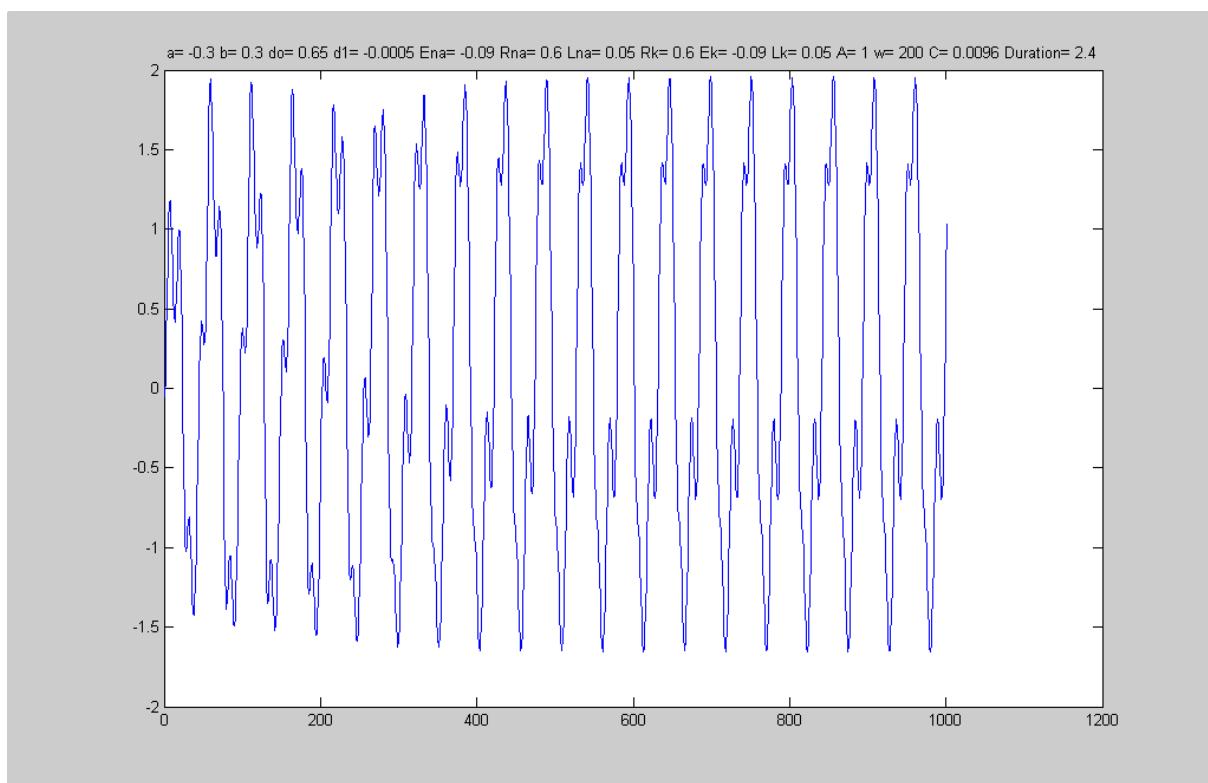
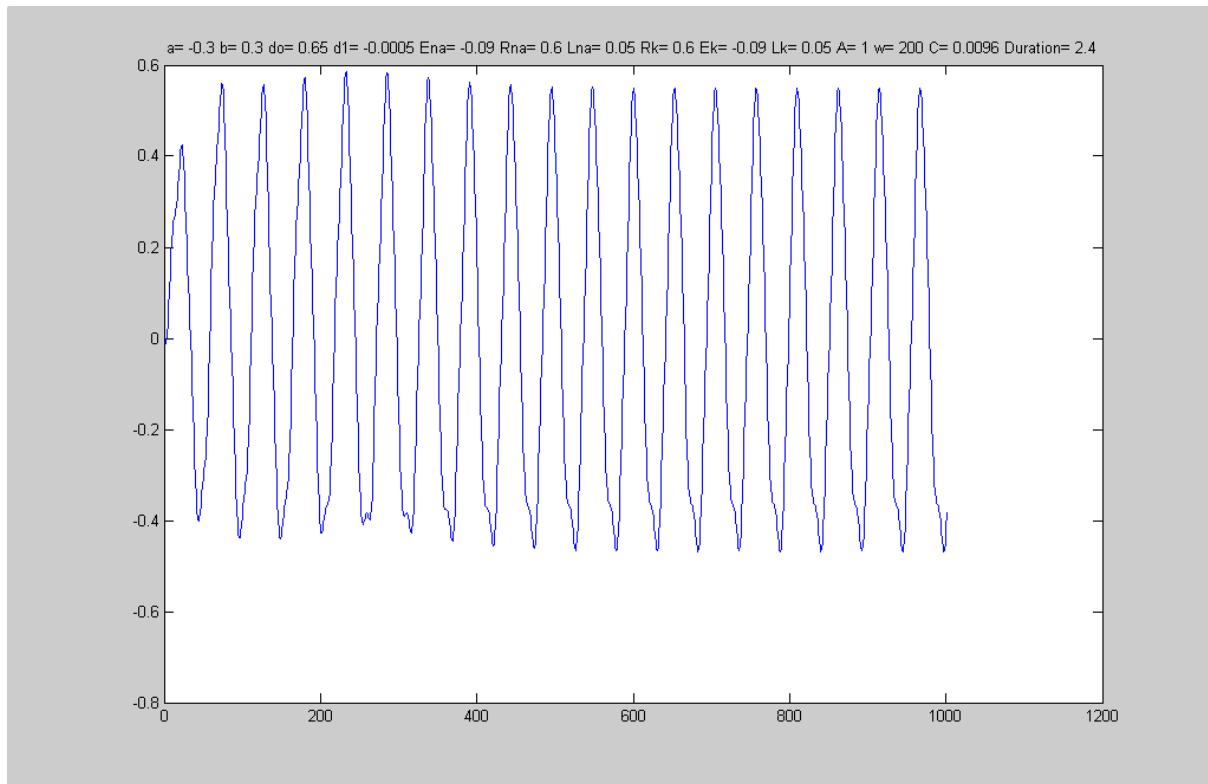


Figure:Ina(t)**Figure:plan(V,Ina)**

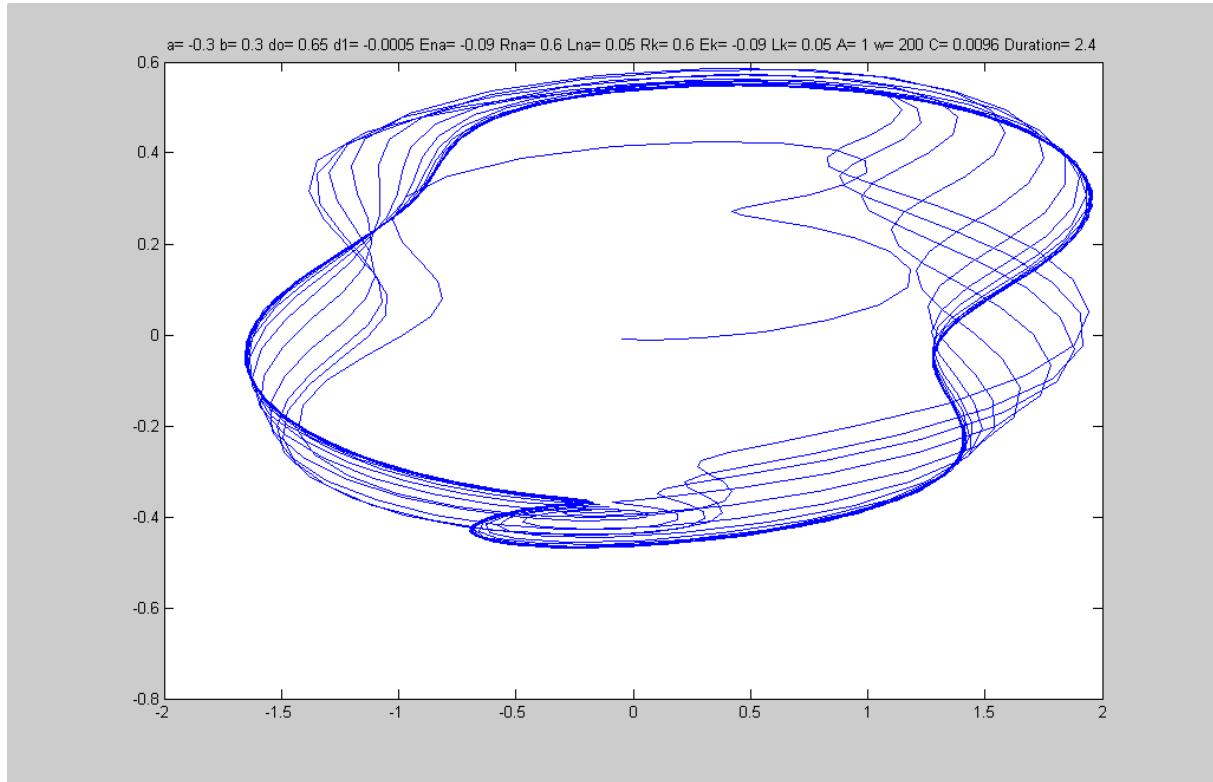


Figure:plan(V,Ik)

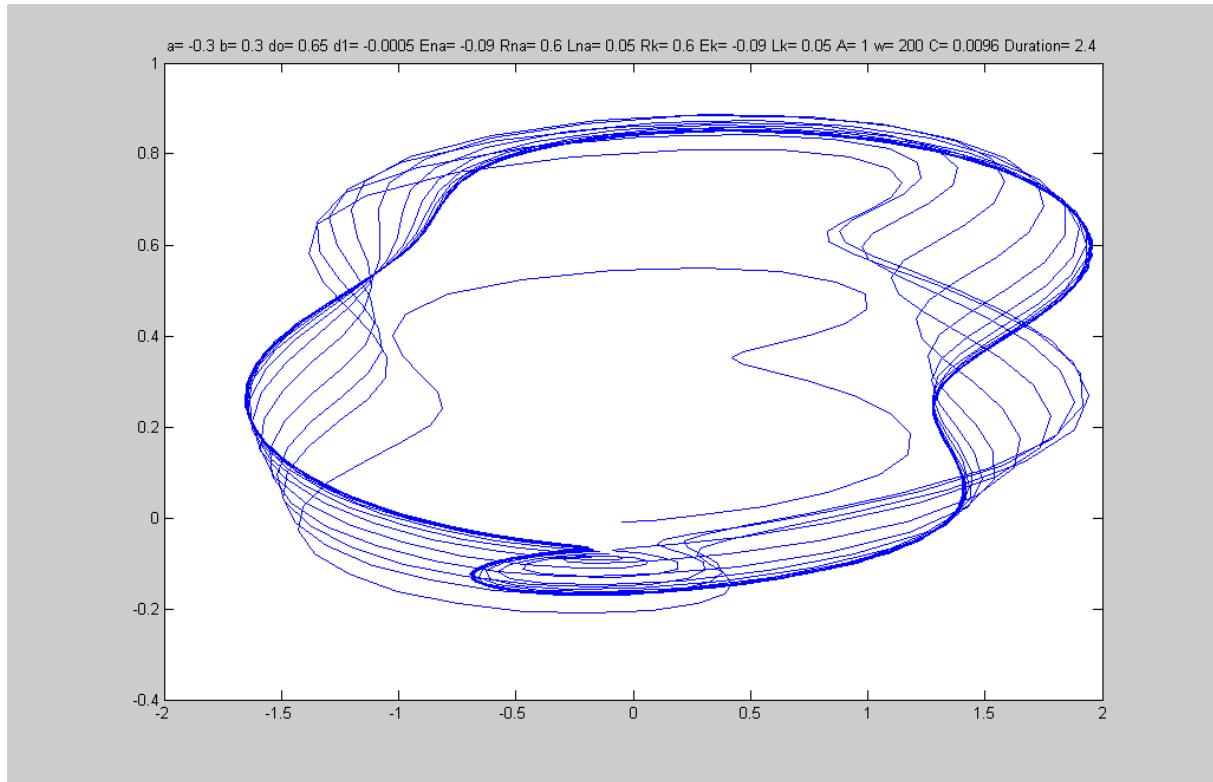
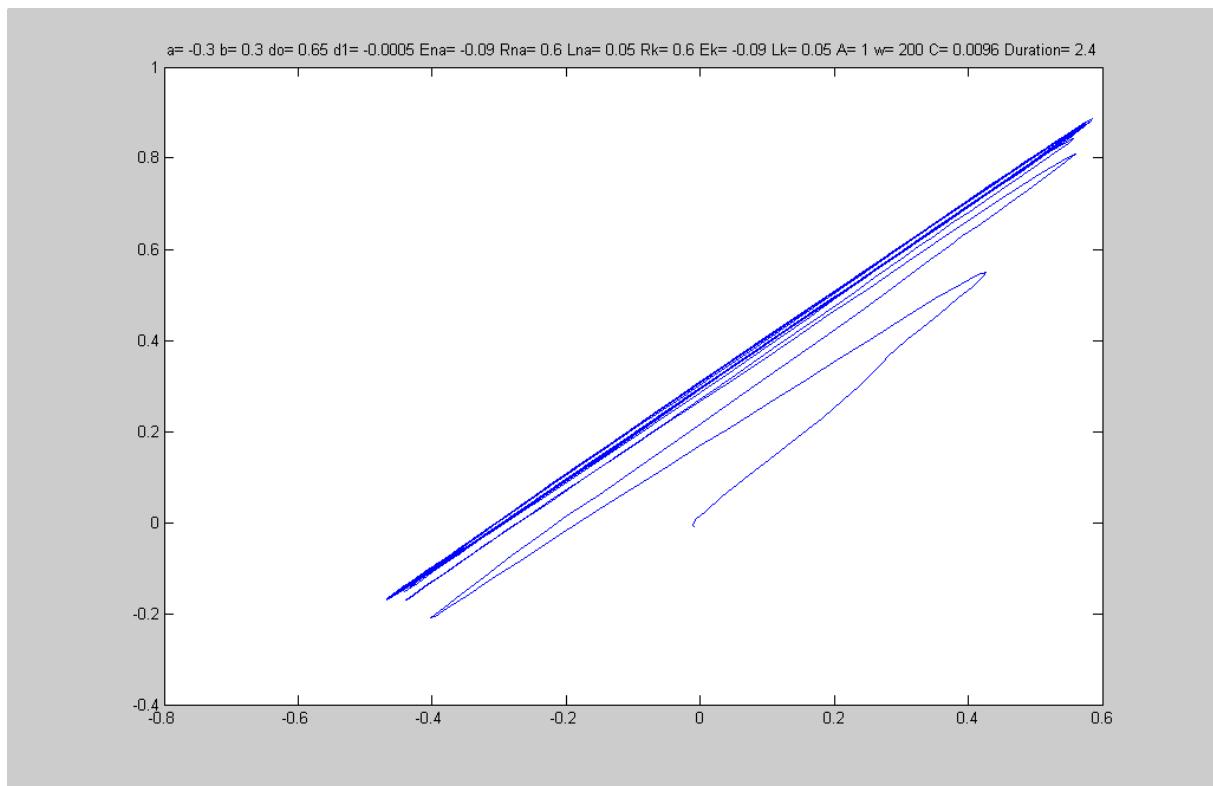
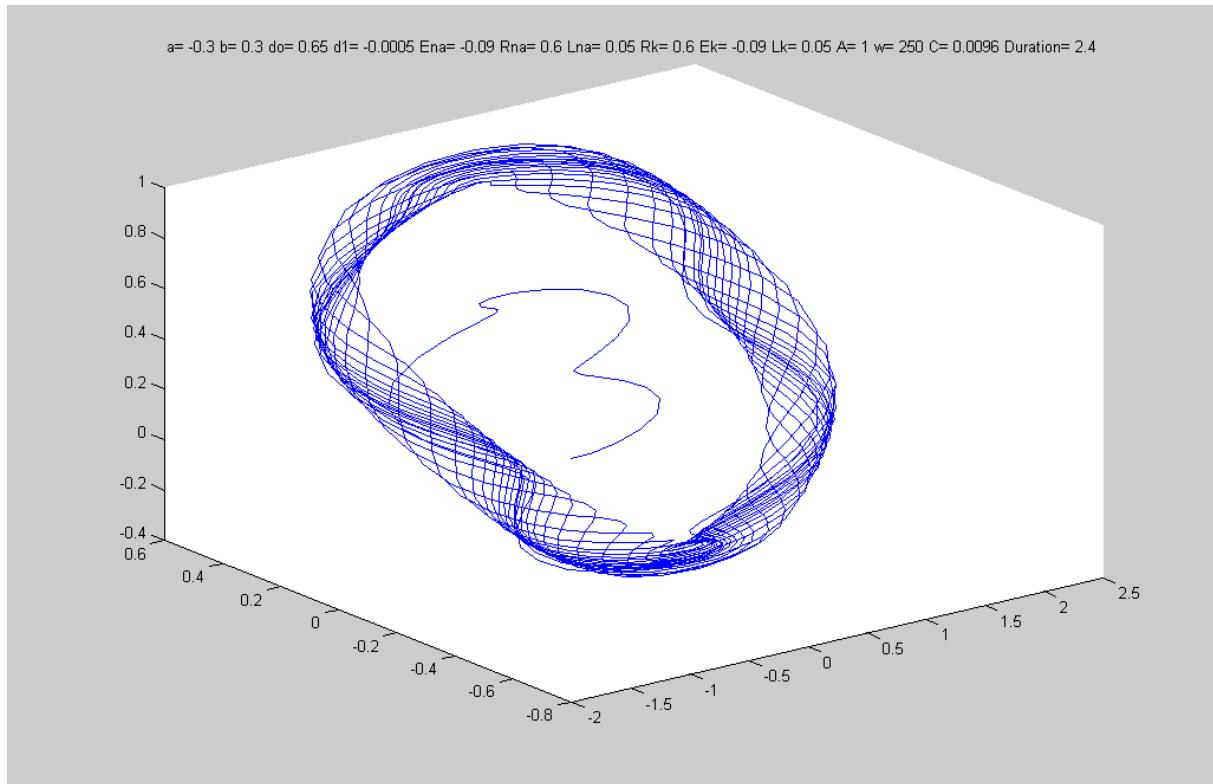


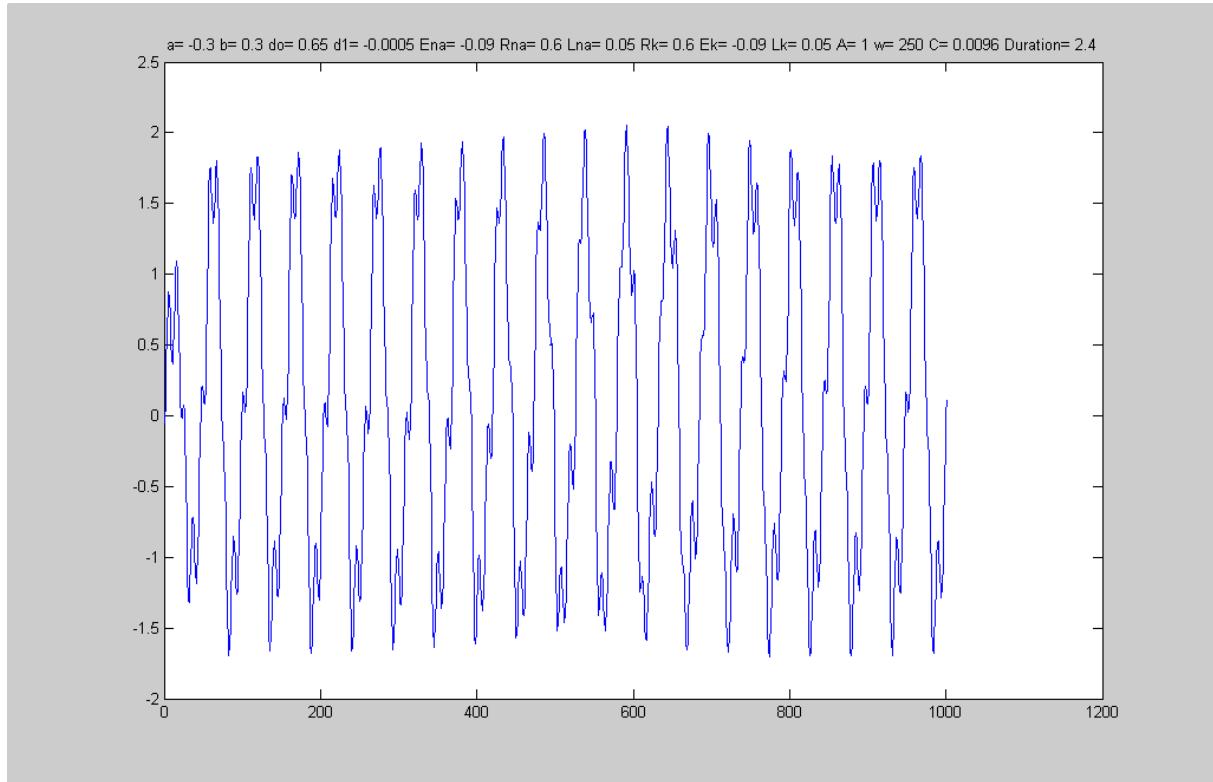
Figure : plan (Ina,Ik)

SERIE 3 VOLUME 8

1)Investigation modele pacemaker VINAIK –case torus
 $a=-0.3; b=0.3; d_0=0.65; d_1=0.0005; E_{Na}=90mV; R_{Na}=0.6;$
 $L_{Na}=50mH; R_k=0.6; E_k=-90mV; L_k=50mh;$
 $W=250 A=1; C=9600\mu F$
Figure:plan(V,Ina,Ik)



Figure;V(t)



Figure;Ina(t)

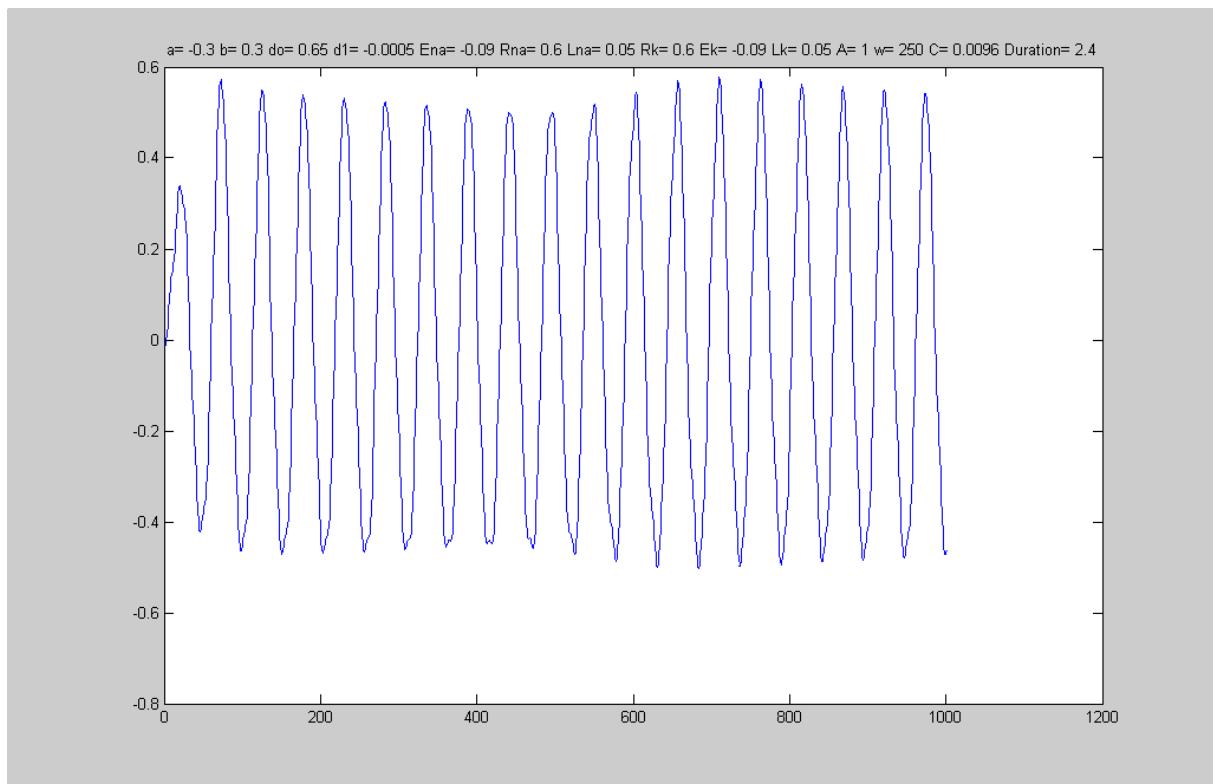
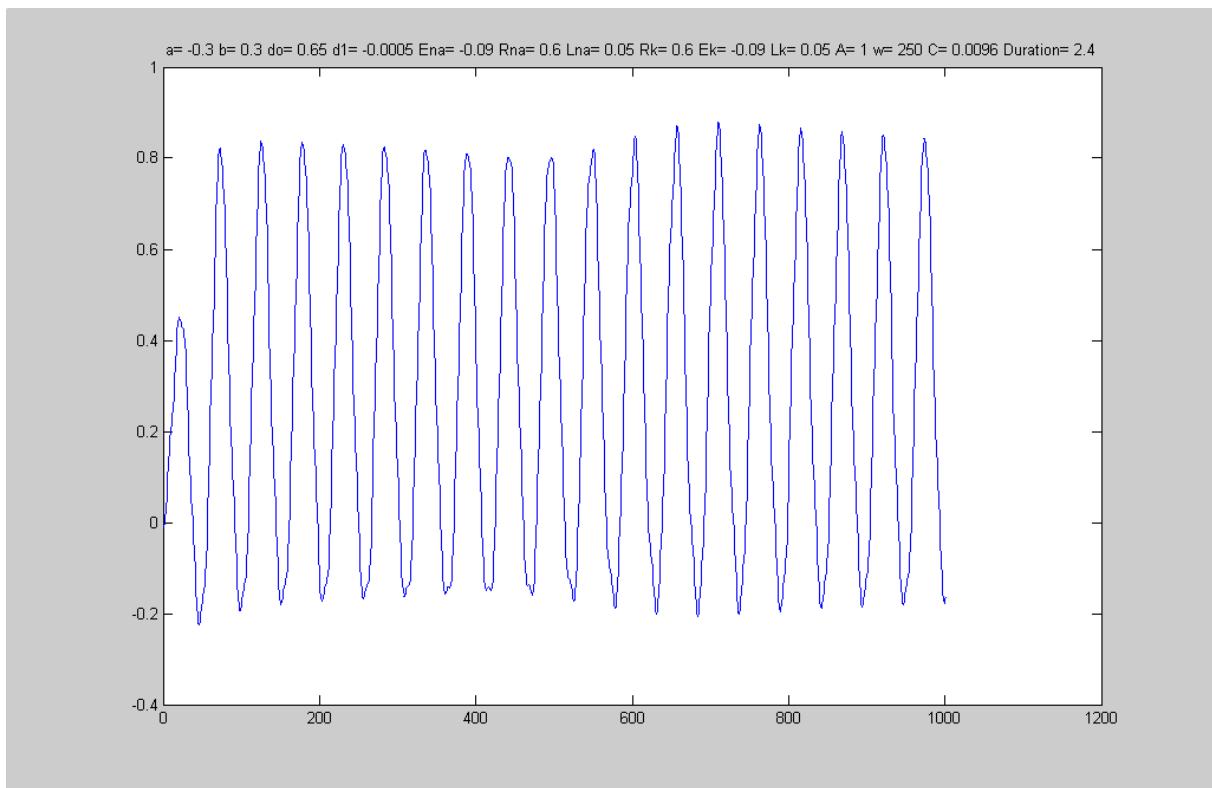
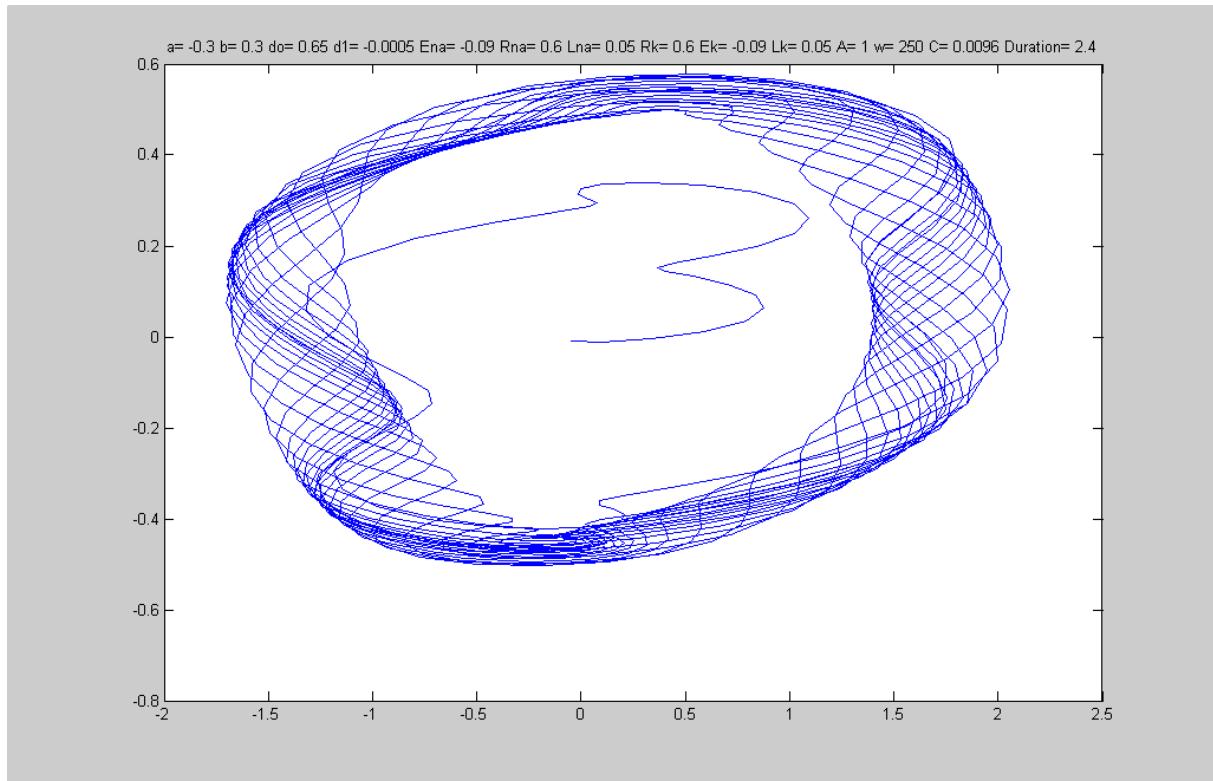
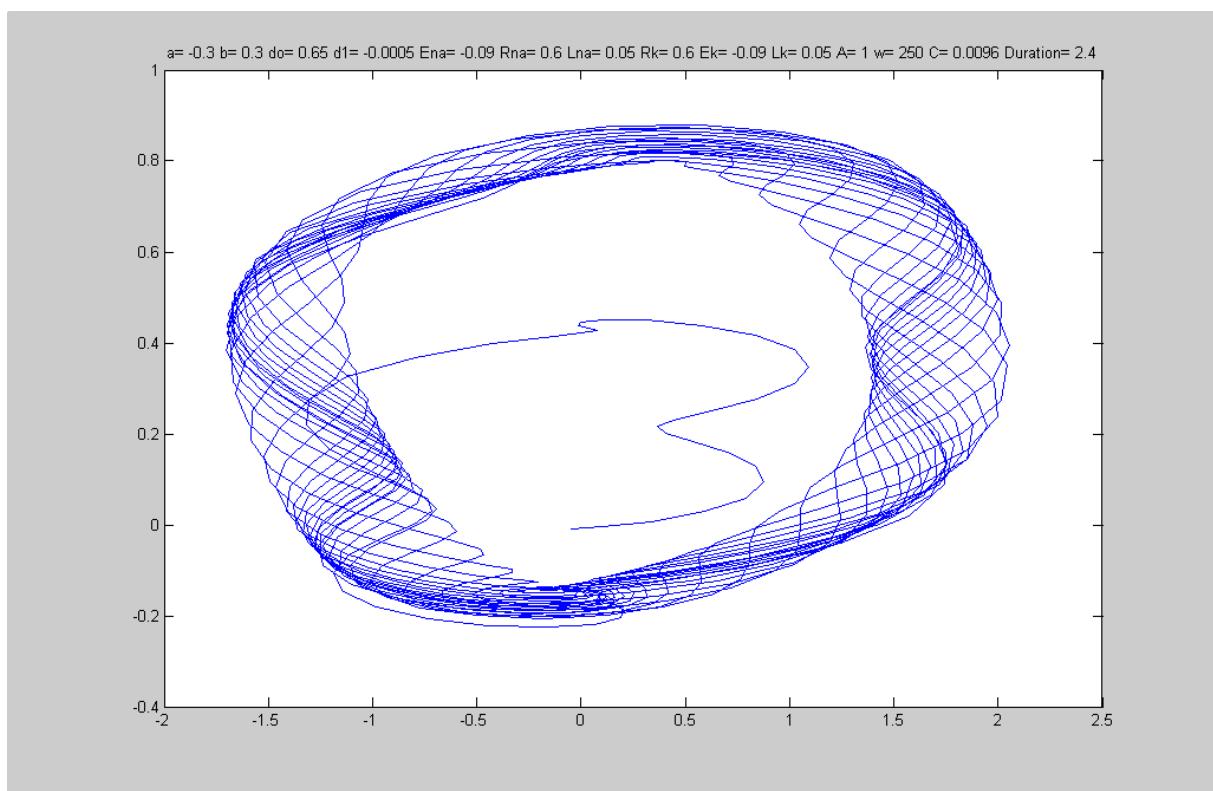
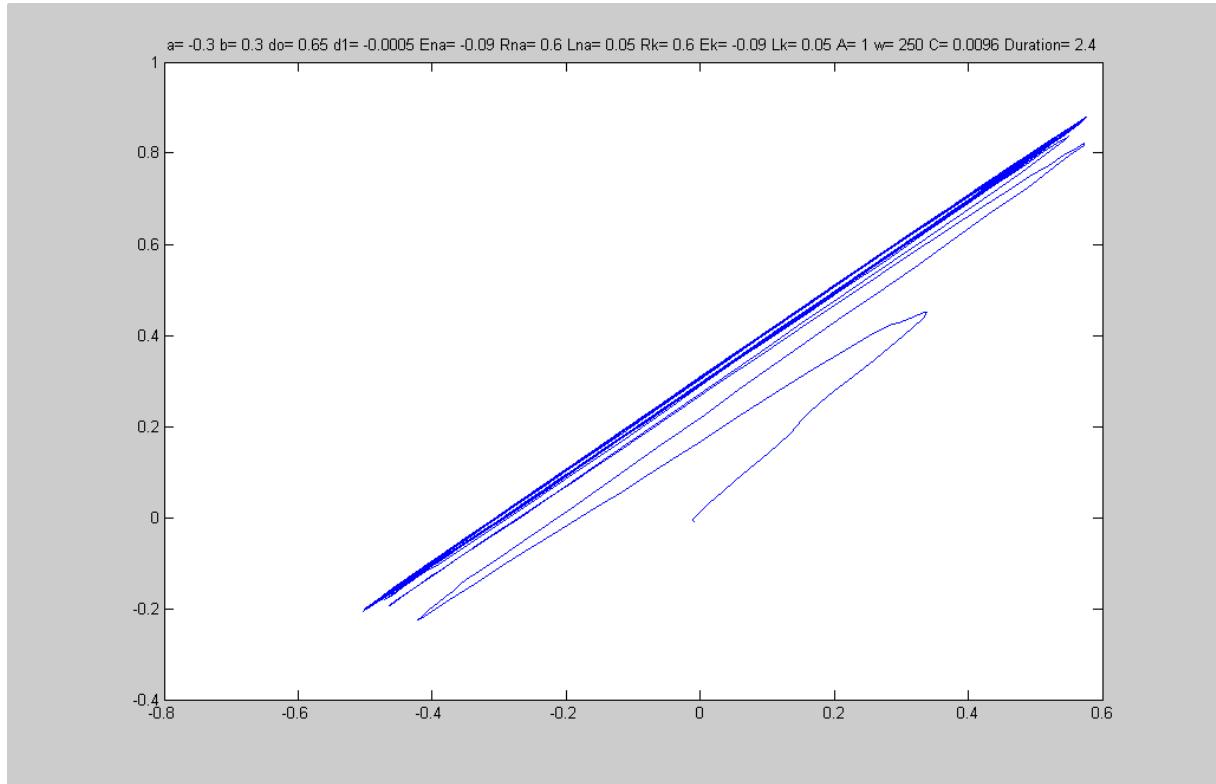


Figure:Ik(t)**Figure:plan(V,Ina)**



Figure;plan(V,Ik)

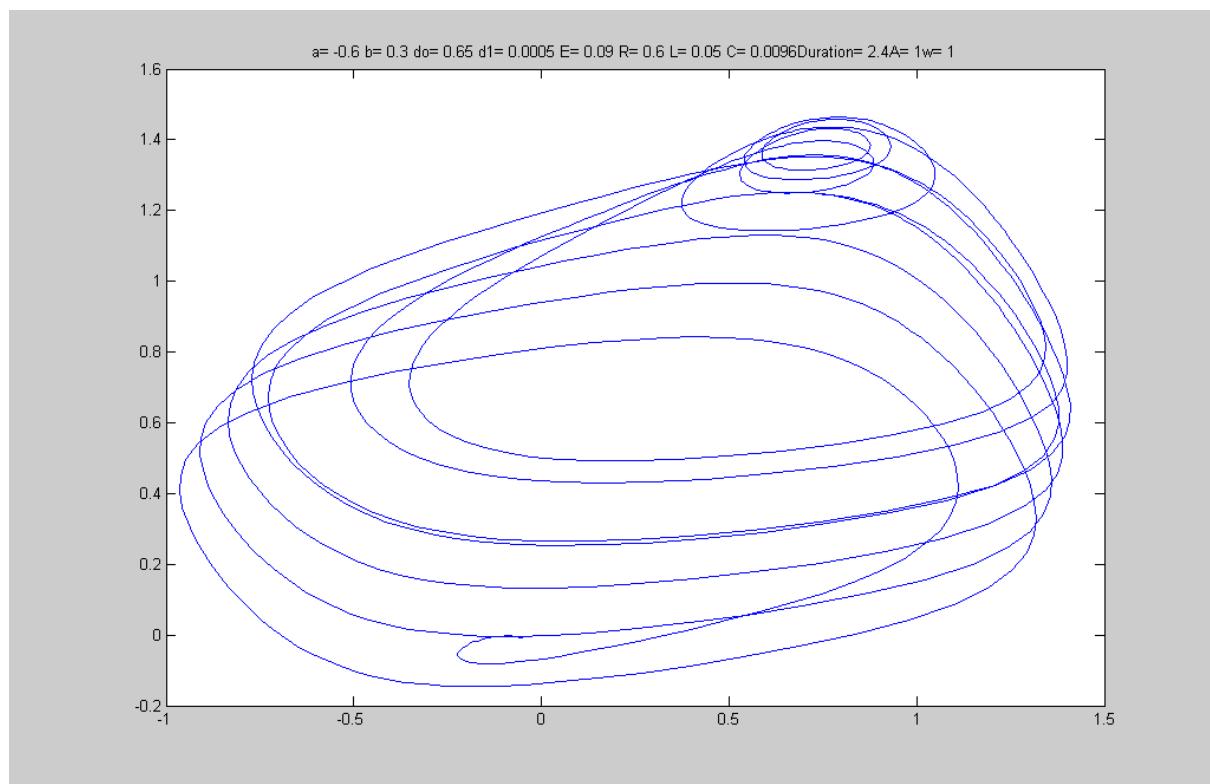


Figure;plan(I_a,I_k)

SERIE 3 VOLUME 9

1)investigation of modele pacemaker VI1 in chao cases like
shoes or car porshe,in dimension 2.We observe that the ratio,
amplitude A and frequency w is 1, $w/A=1$
 $a=-0.6;b=0.3;do=0.65;d1=0.0005;E=90mV;R=0.6;L=50mH$
 $C=9600\mu F;D=2400ms;A=1;w=1$

Figure:plan (V,I1) porsche-shoes-car investigation



figure;V(t)

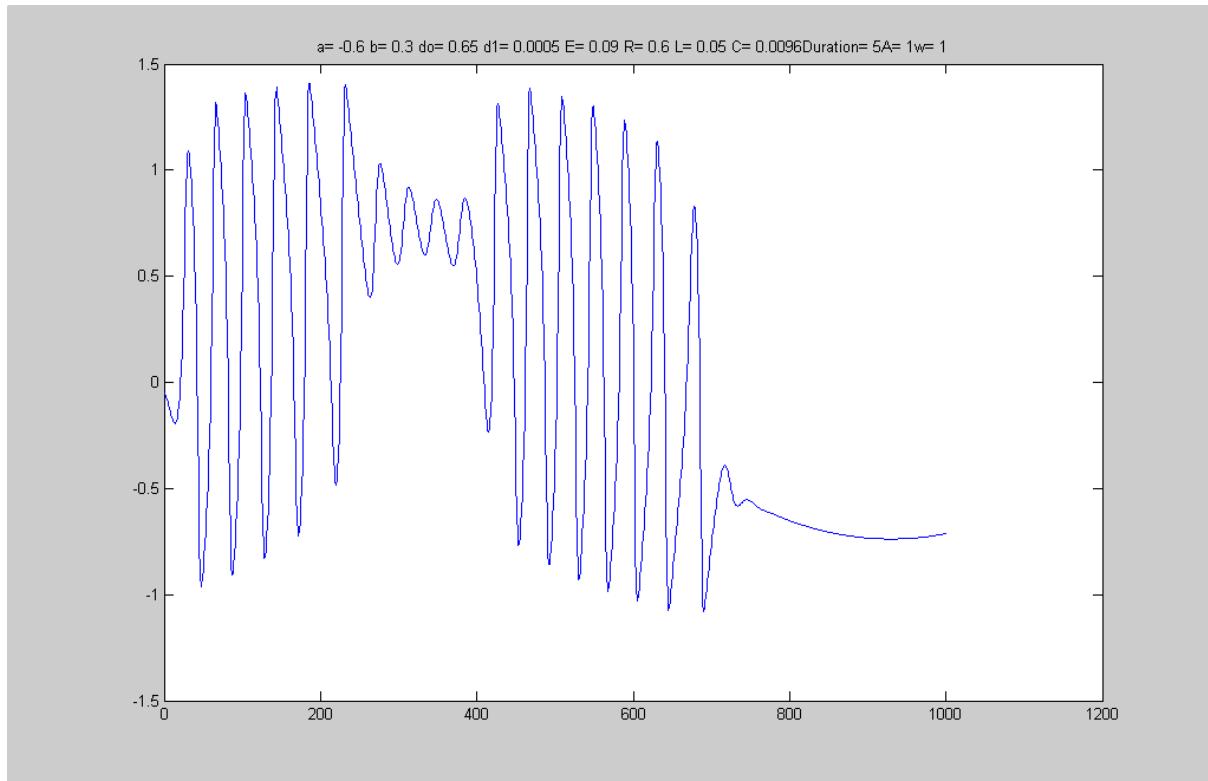


Figure:I1(t)

2) investigation ratio=1 A/w=1

A=2 w=2

**Figure:plan(V,I1) case canard chao or airplane figure
Chao,airplane surface.**

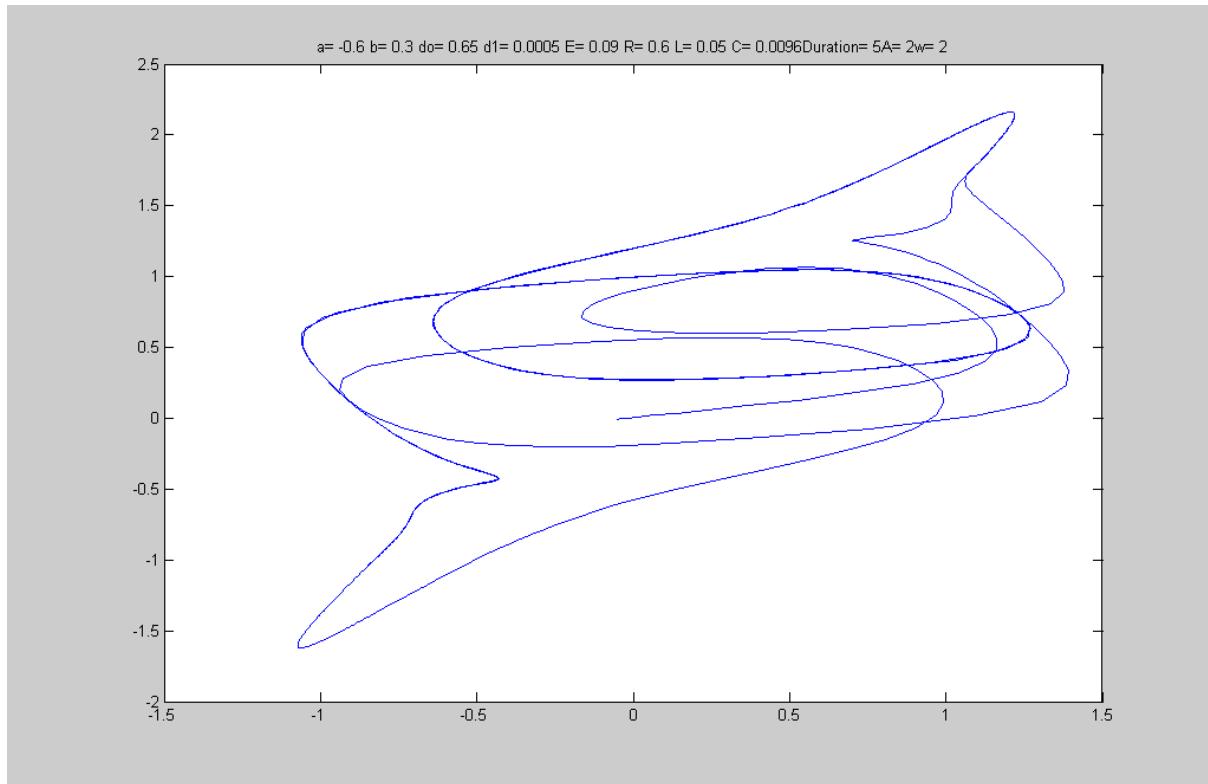


Figure: V(t)

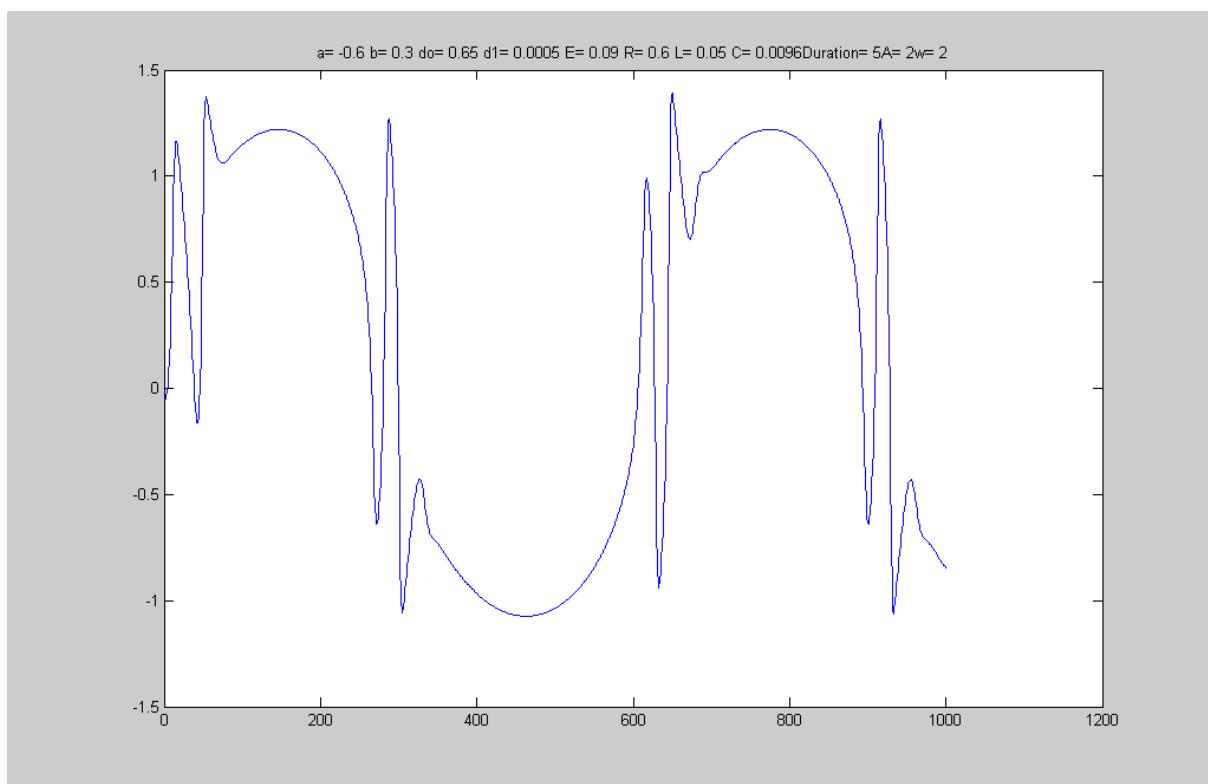
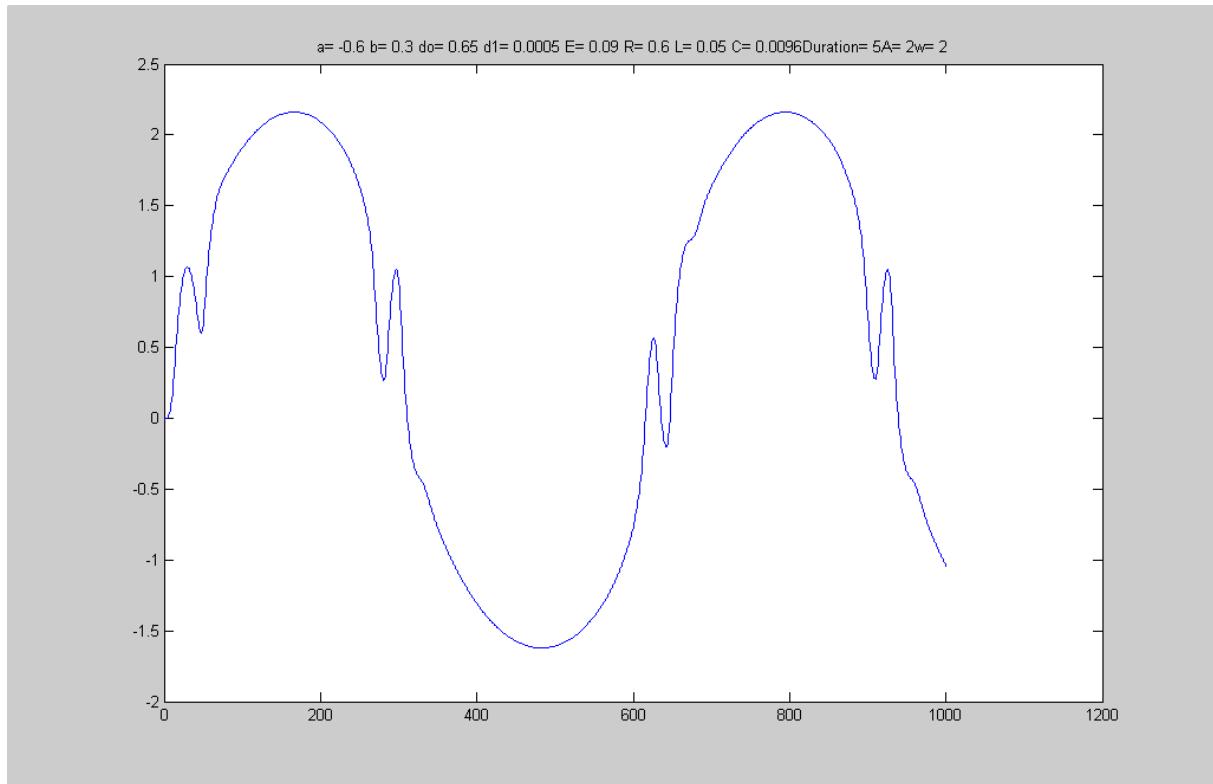
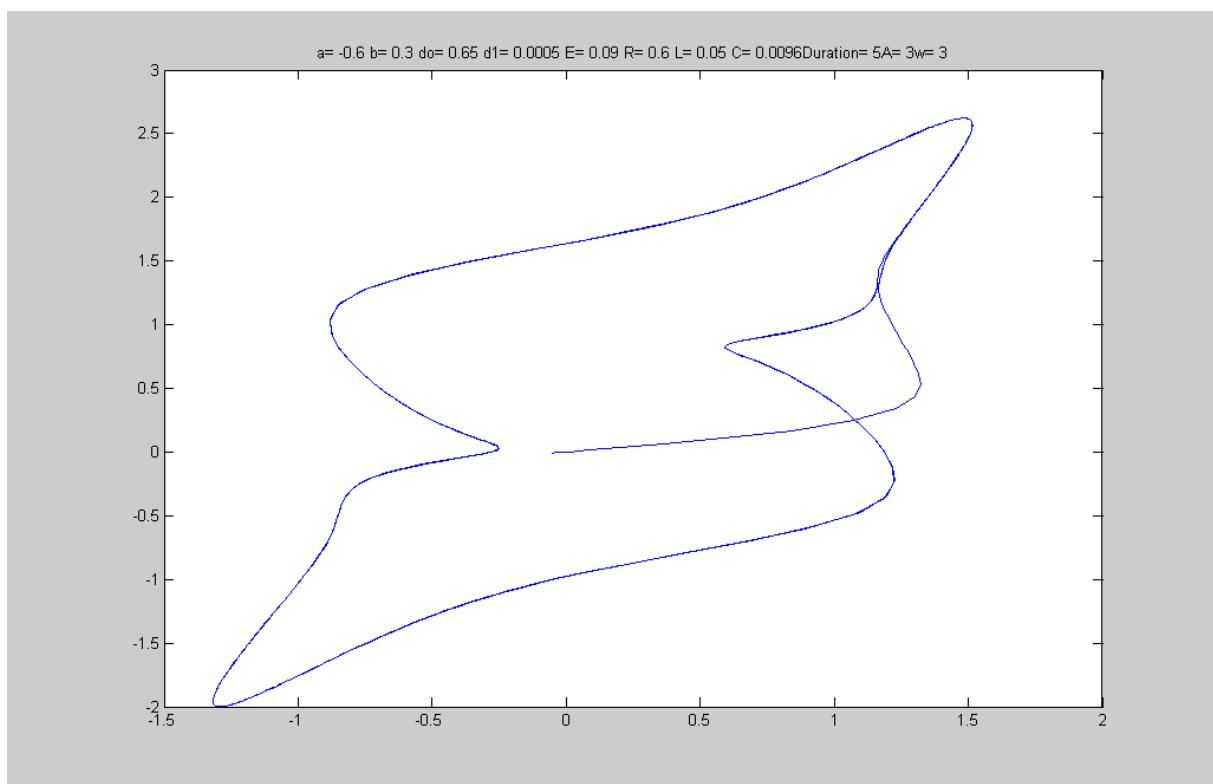
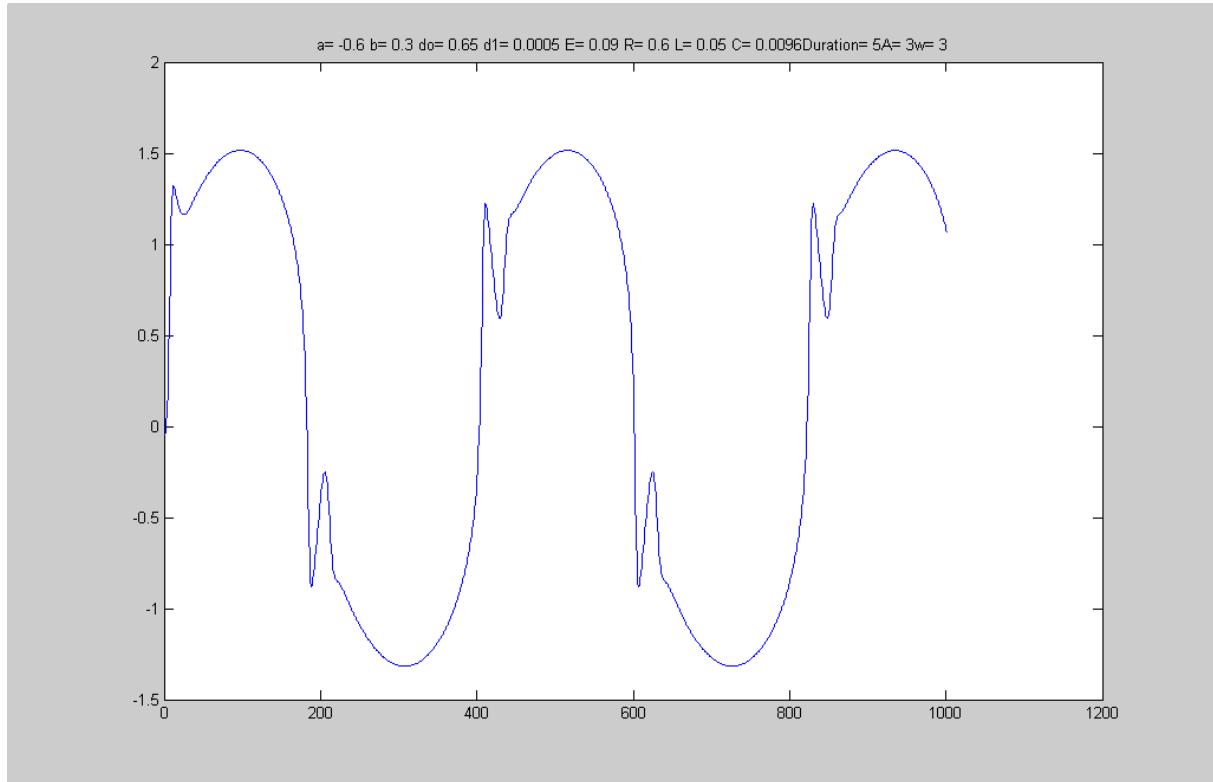
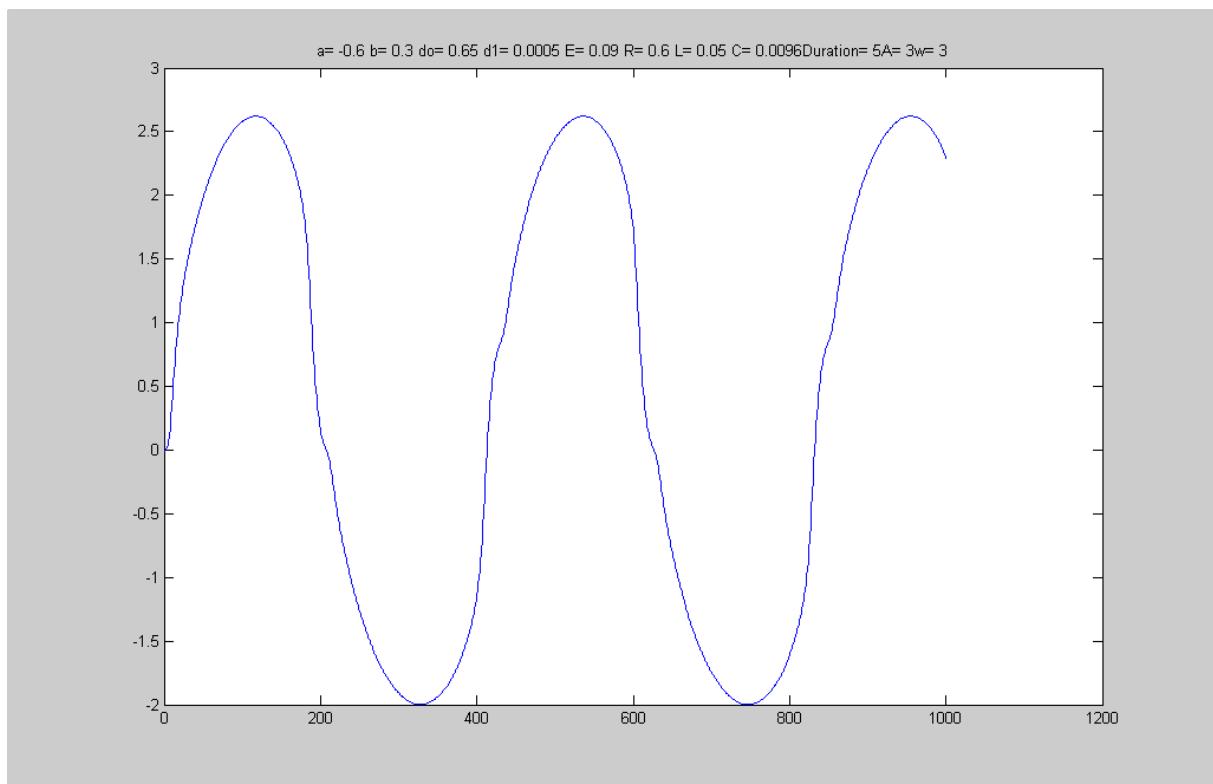


Figure: I1(t)

3) A=3 w=3 airplane surface



Figure;V(t)**Figure:I1(t)**

4) w=4 A=4

Figure;plan (V,I1)

sensation of volume on dimension 2

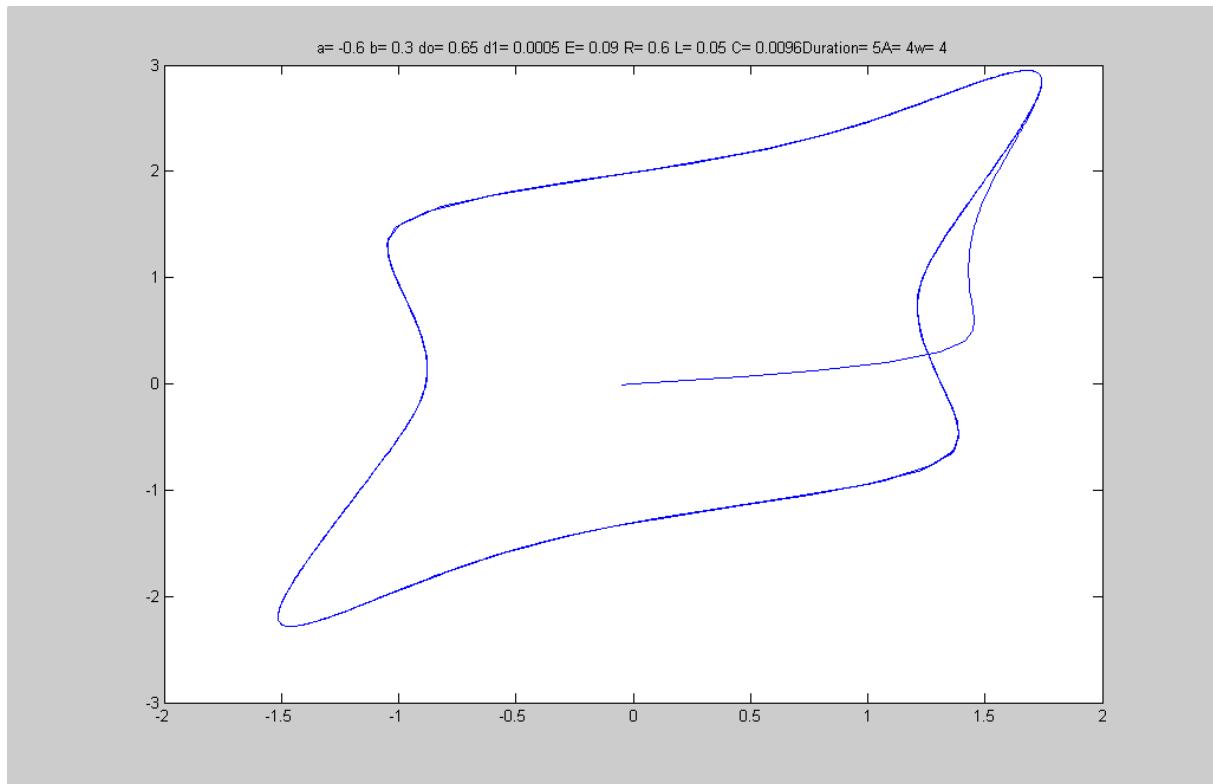


Figure:V(t)

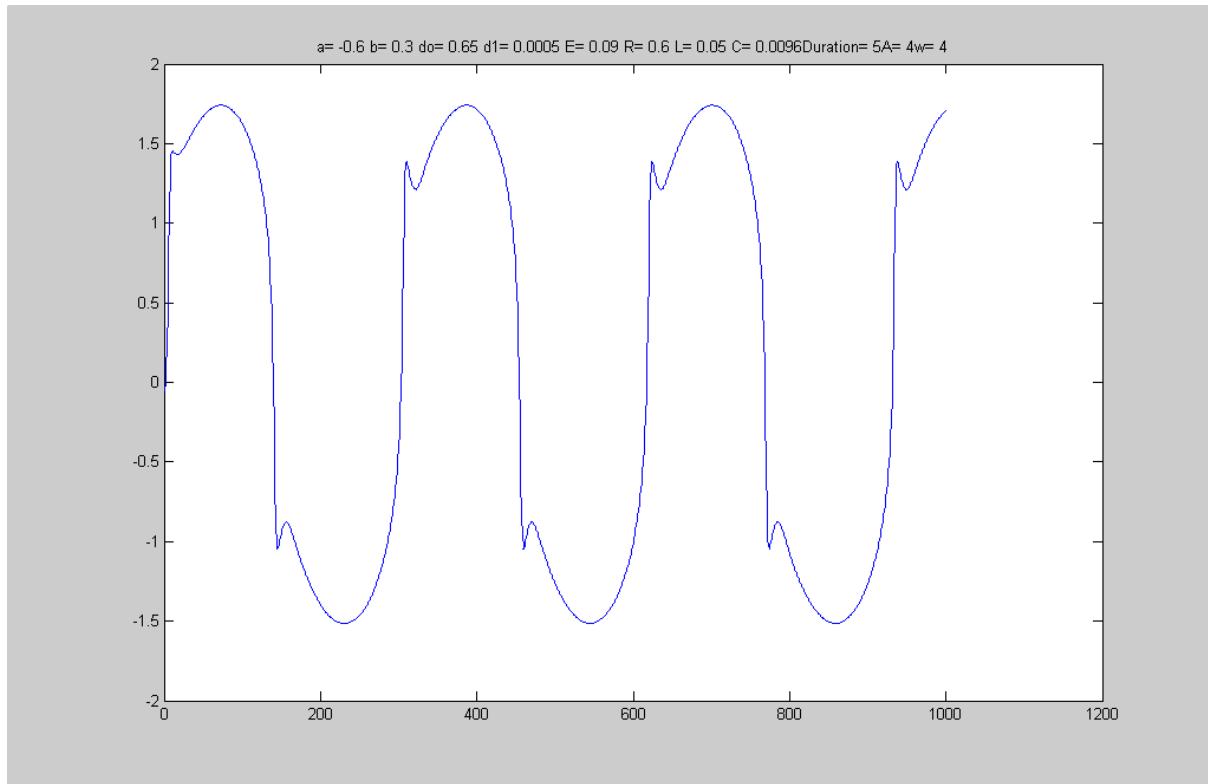
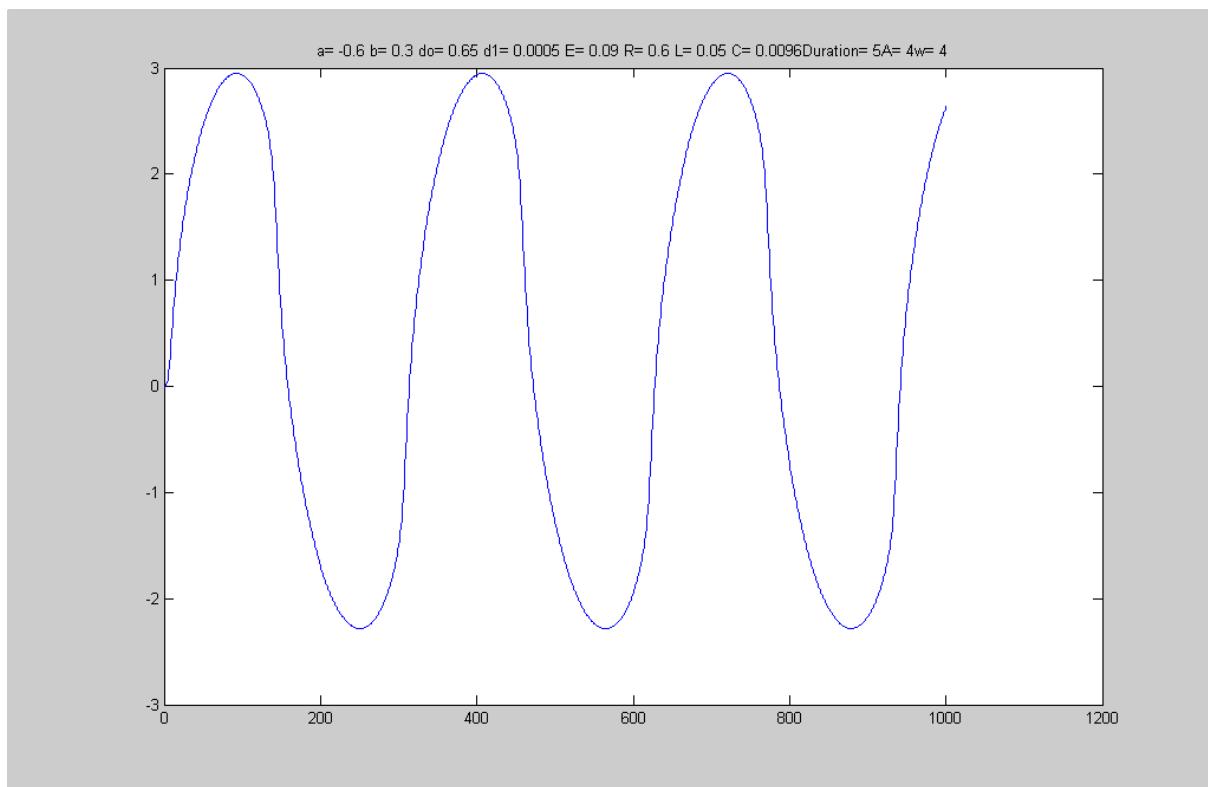
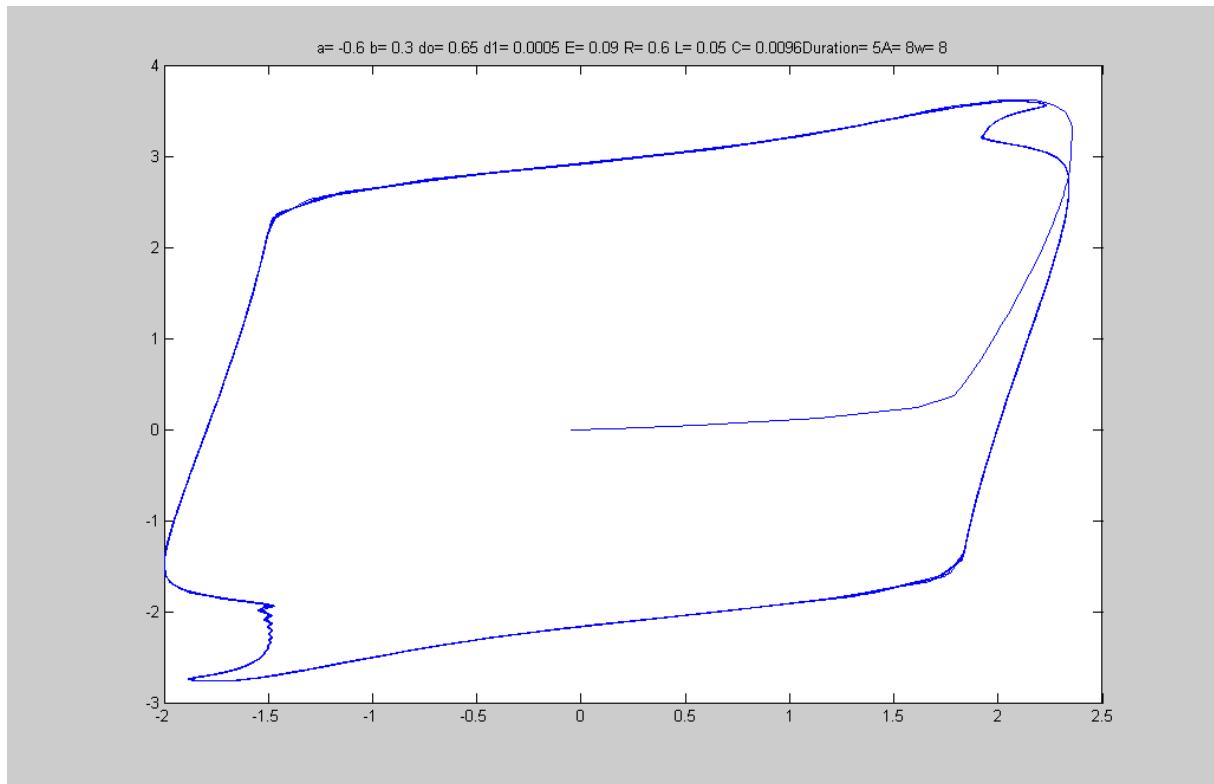


Figure:I1(t)



5) w=8 A=8

Figure:plan(V,I1)



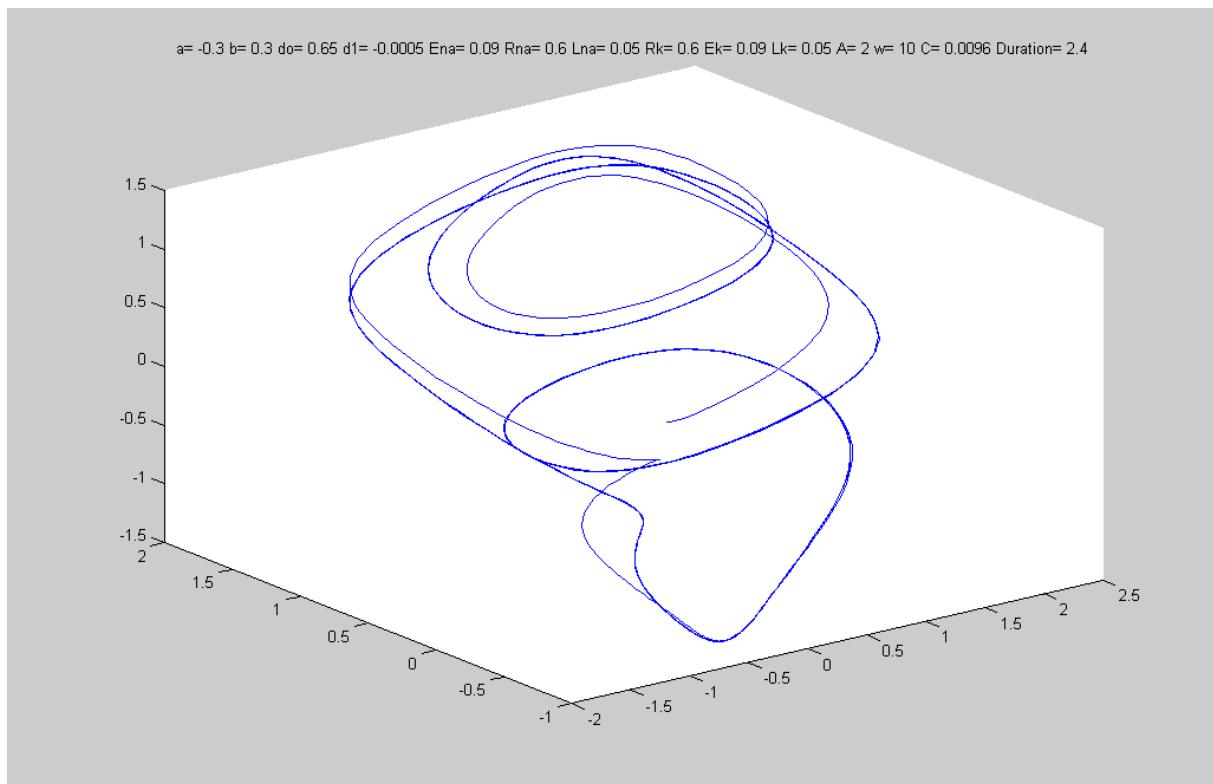
SERIE 3 VOLUME 10

1)investigation modele pacemaker VINAIK
 $a=-0.3; b=0.3; d_0=0.65; d_1=0.0005; E_{Na}=-90mV; L=50mH;$
 $R_{Na}=0.6; D=2400ms; N=1000; R_k=0.6; L_k=50mH$

$$C=9600\mu F$$

1) $w=10 A=2$ ($w=10 A=1$ ratio=10)

figure:plan(V,I_{Na},I_k)



Figure;V(t)

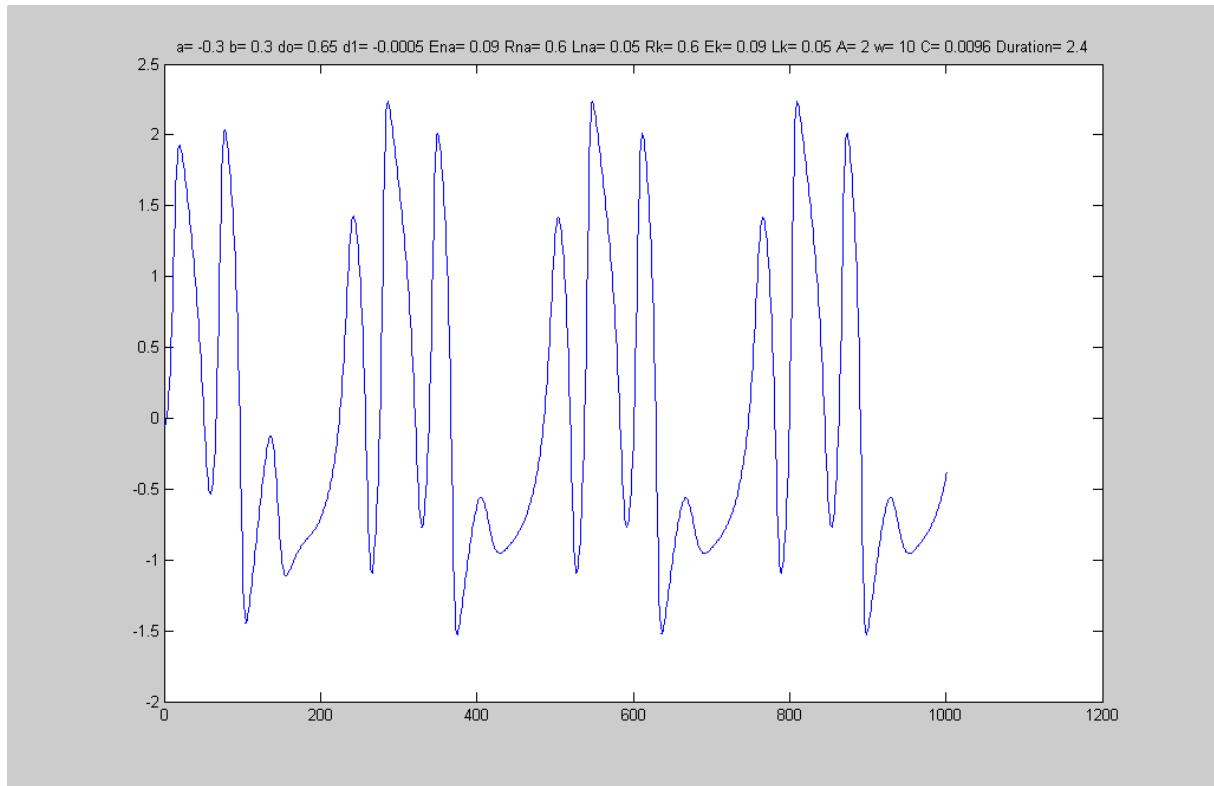
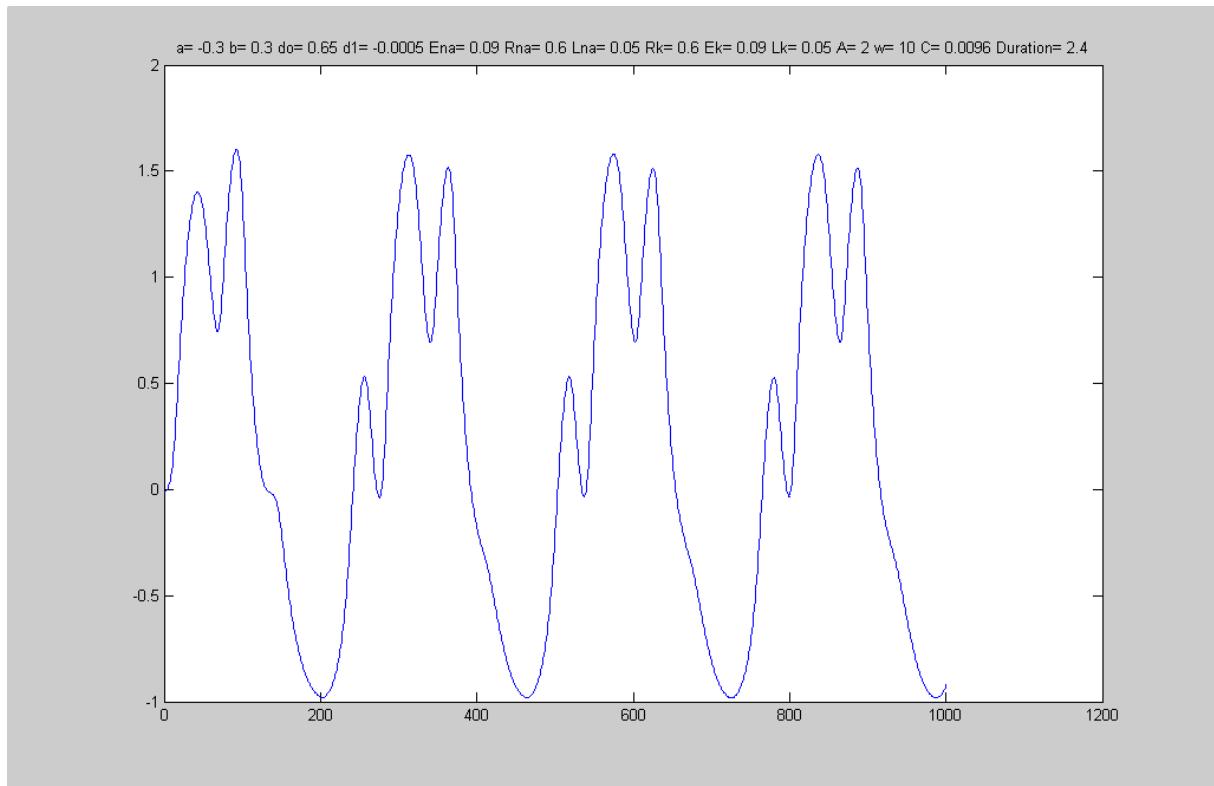
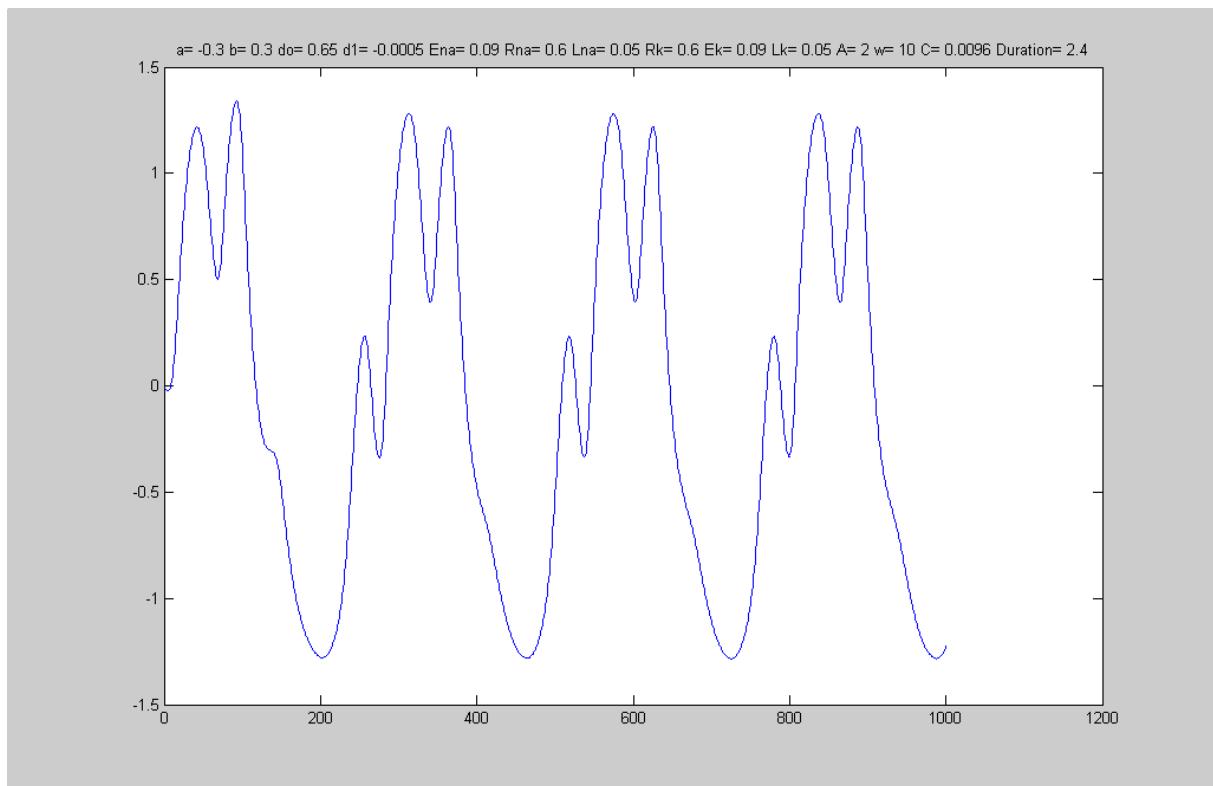


Figure:Ina(t)



Figure;Ik(t)**Figure:plan(V,Ina)**

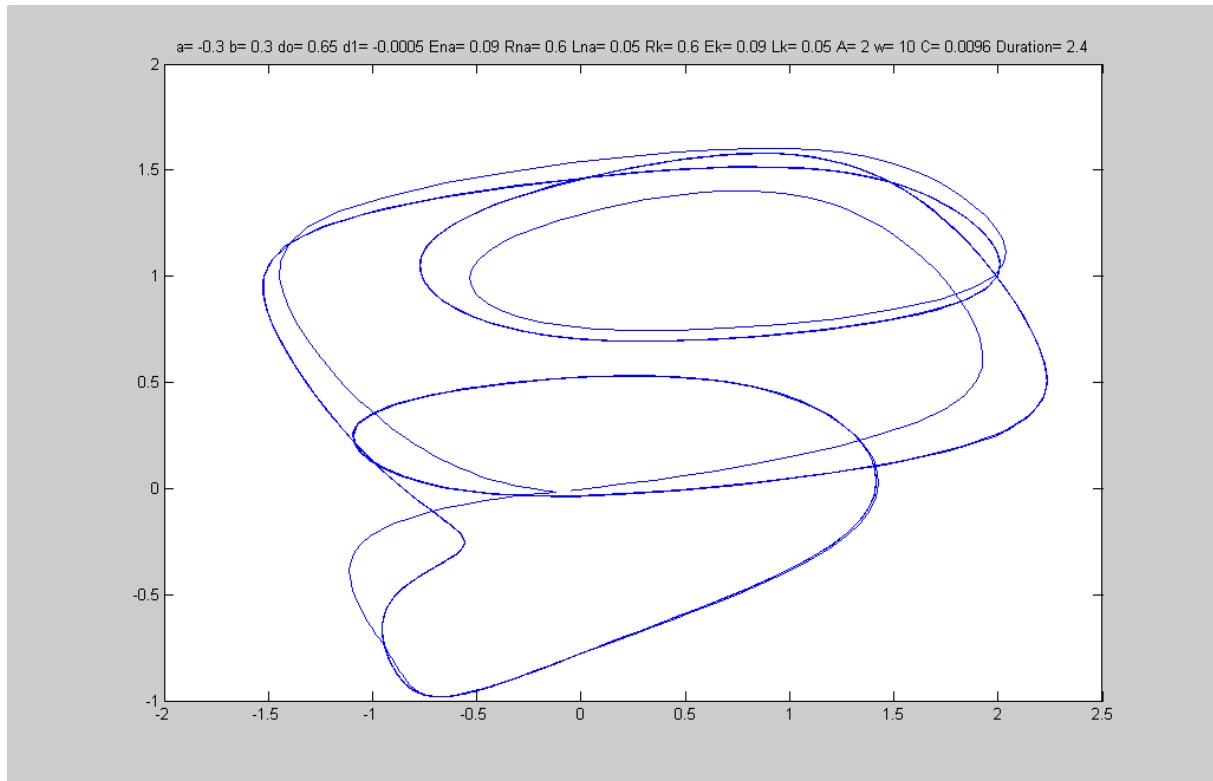


Figure:plan (V,Ik)

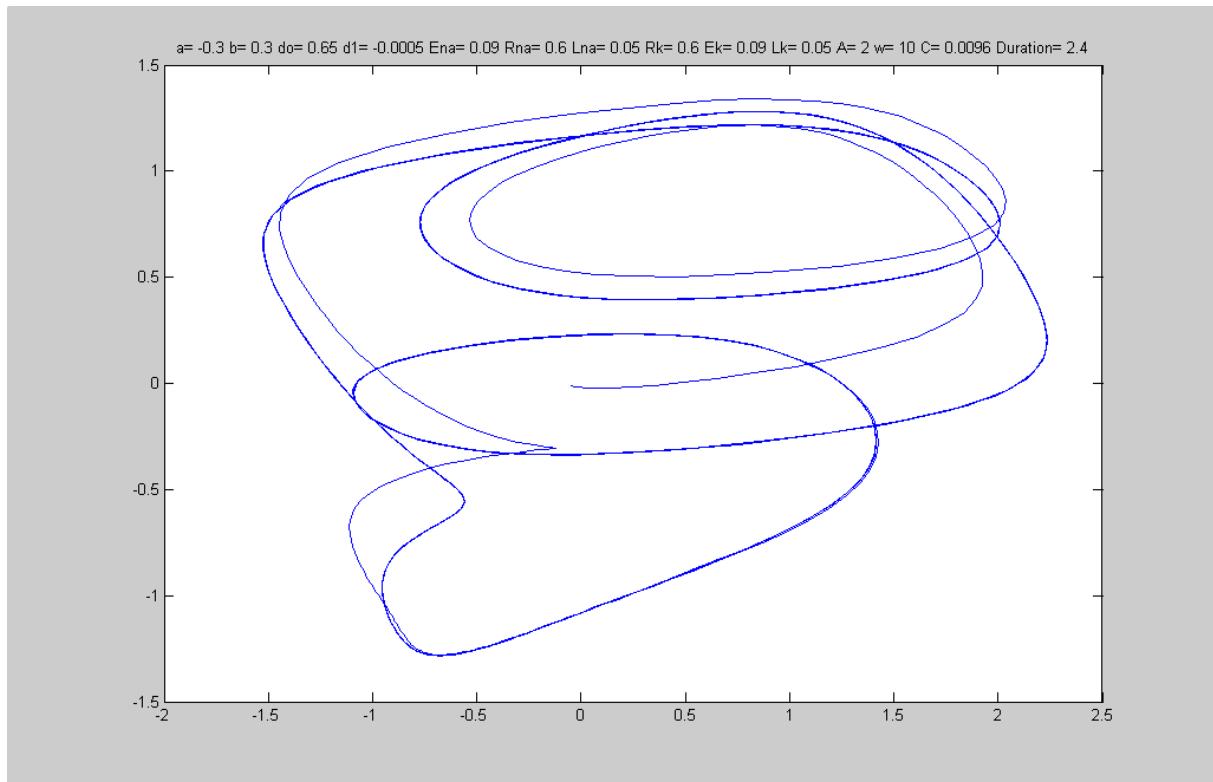
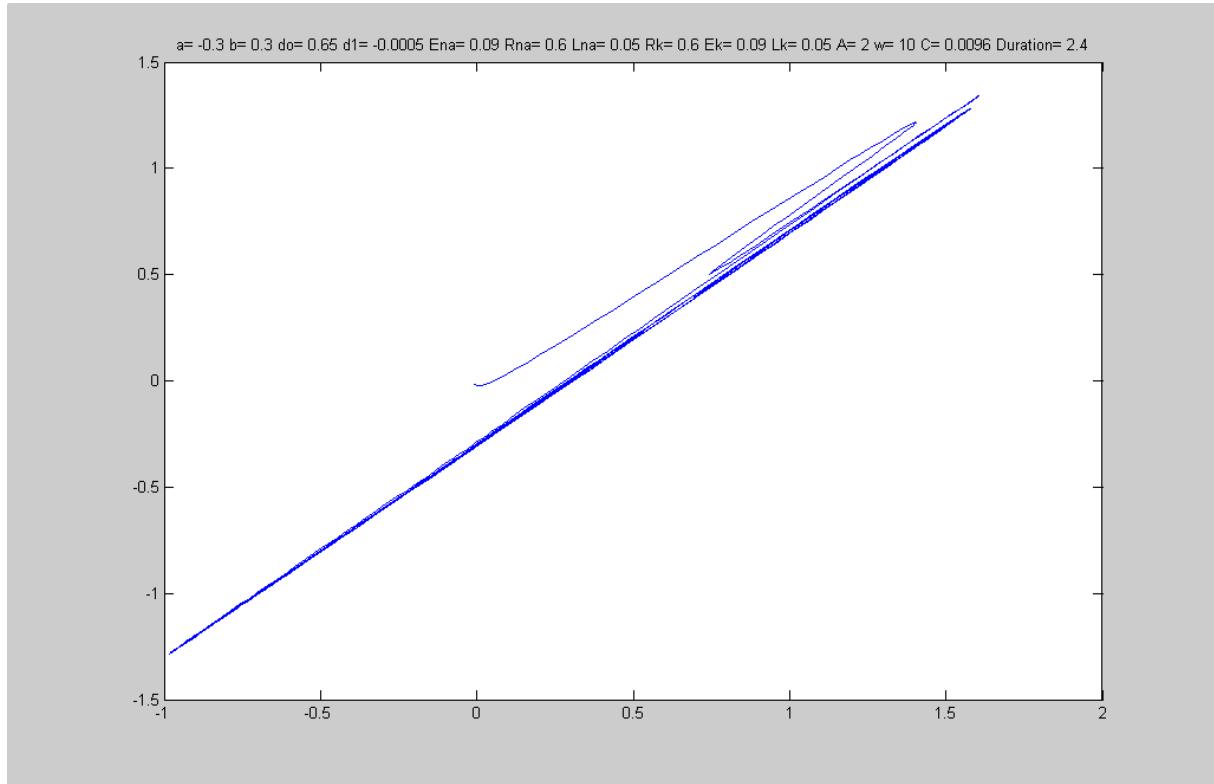


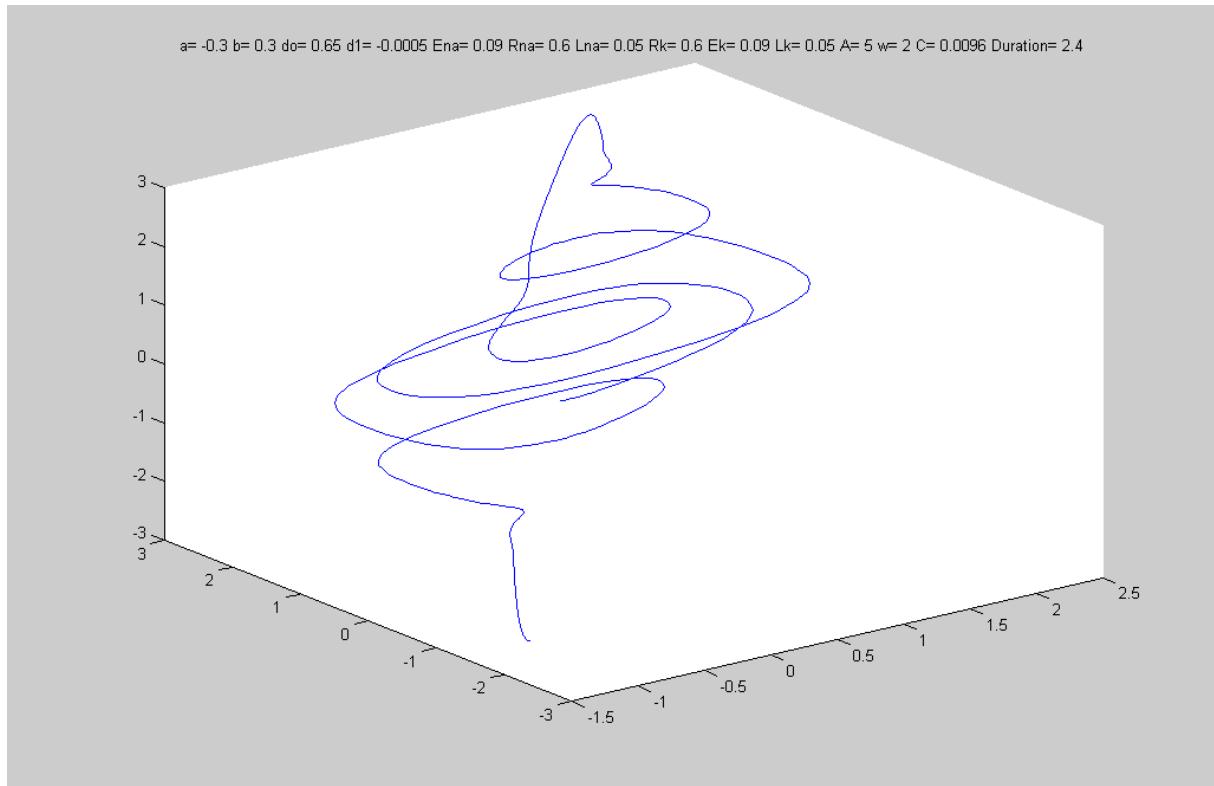
Figure:plan (Ina,Ik)



2) $w=2 \quad A=5$

Figure ;plan(V,Ina,Ik)

We have like shilnikov,isoclinic trajectory(no heteroclinic(see
Proceedings IEEE transact circuits and systems L.Chua



Figure;V(t)

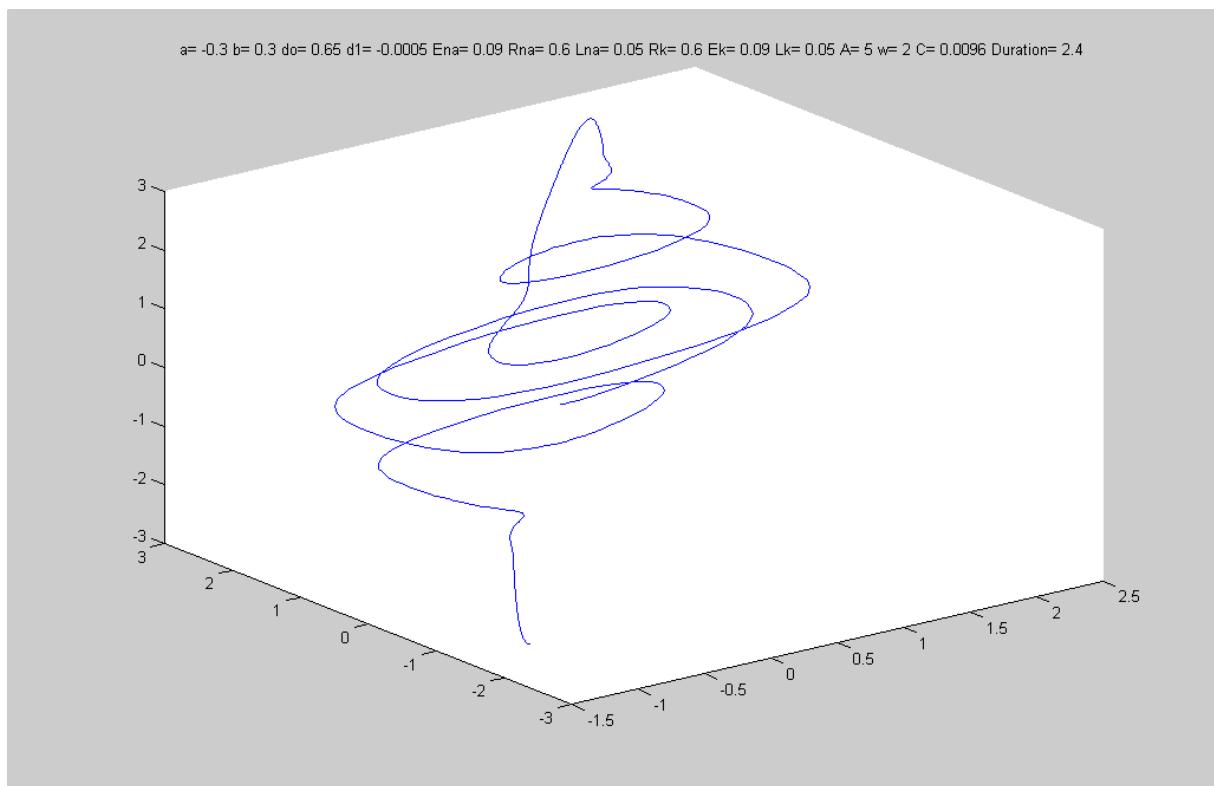
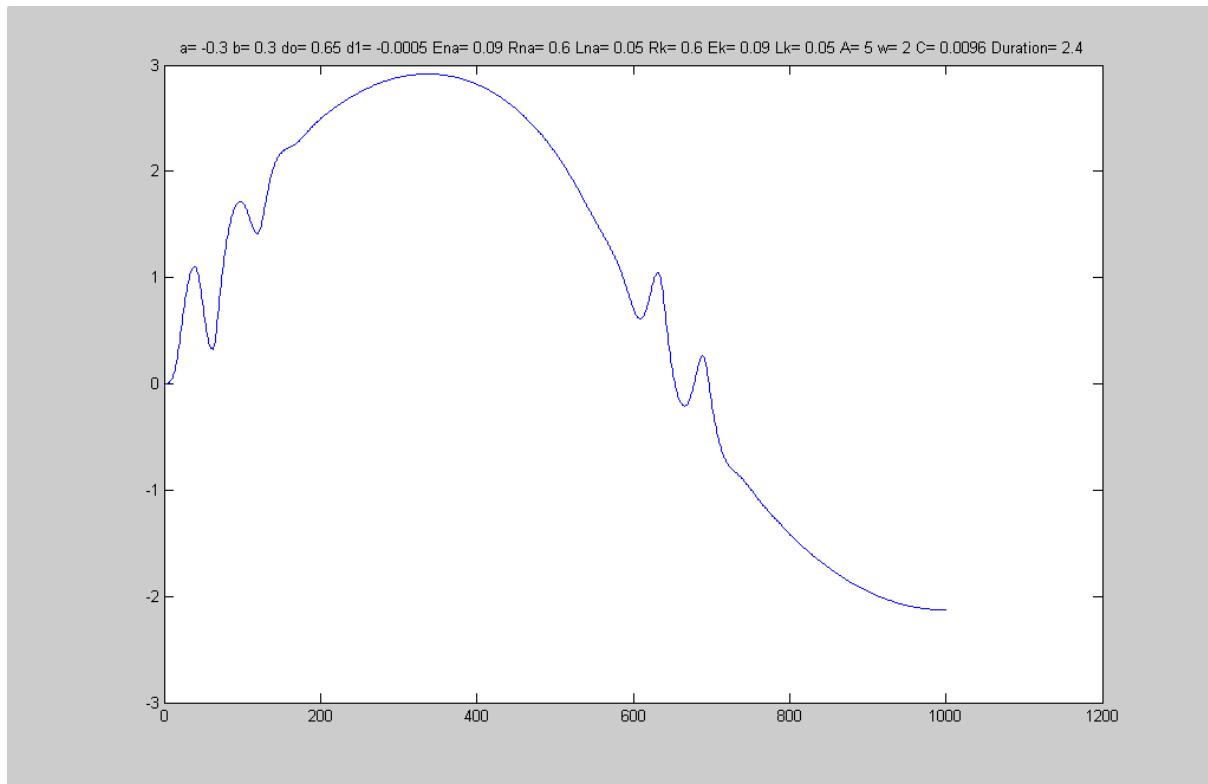


Figure:Ina(t)**Figure:Ik(t)**

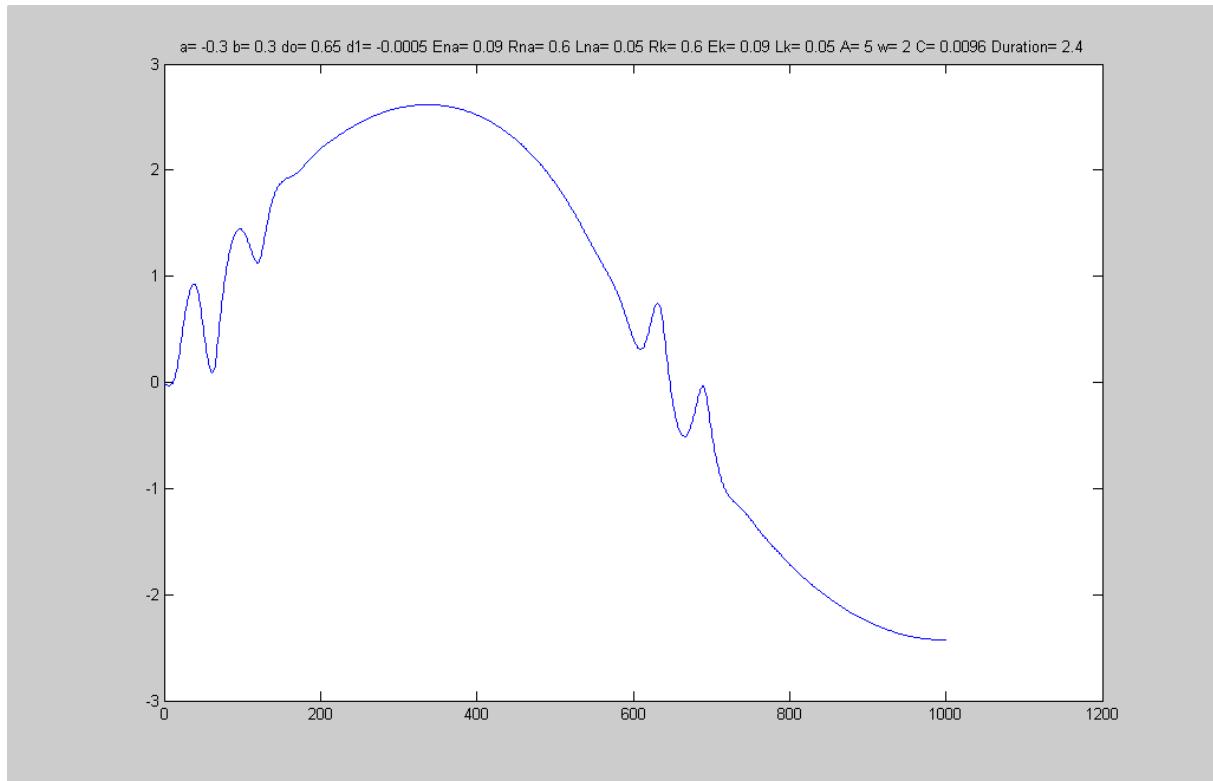


Figure:plan (V,Ina)

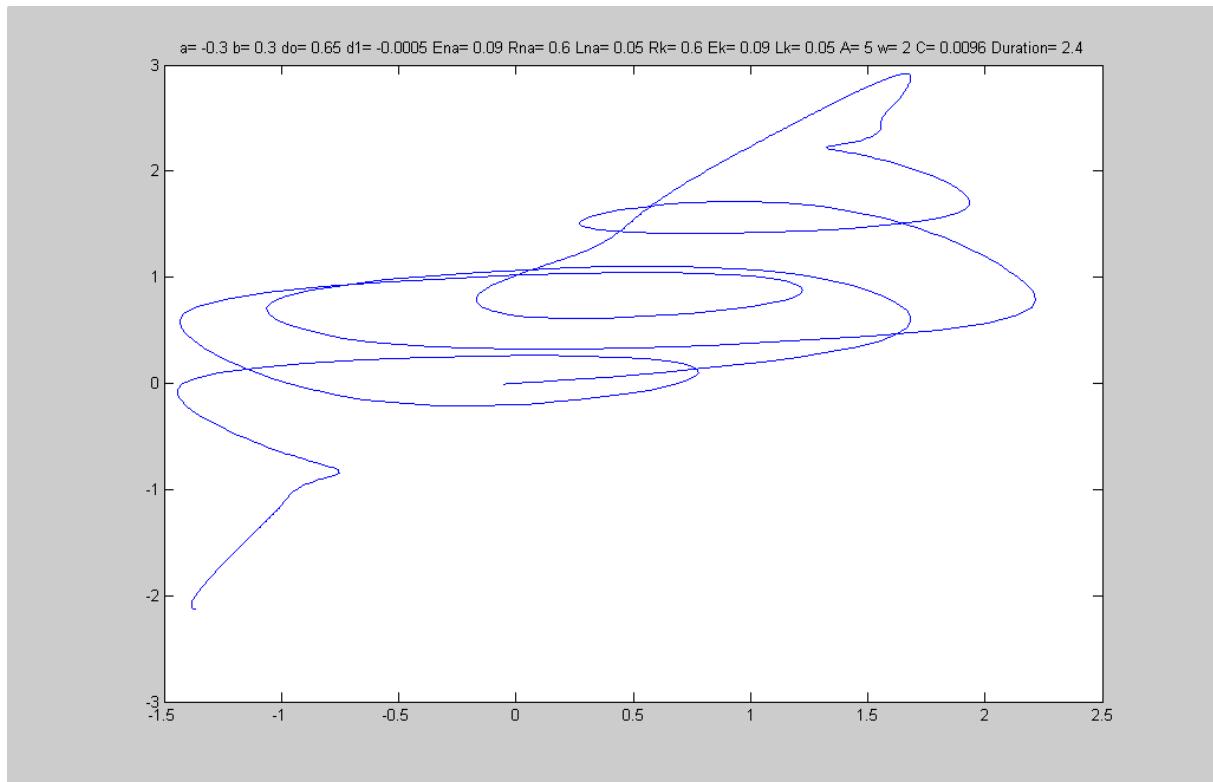
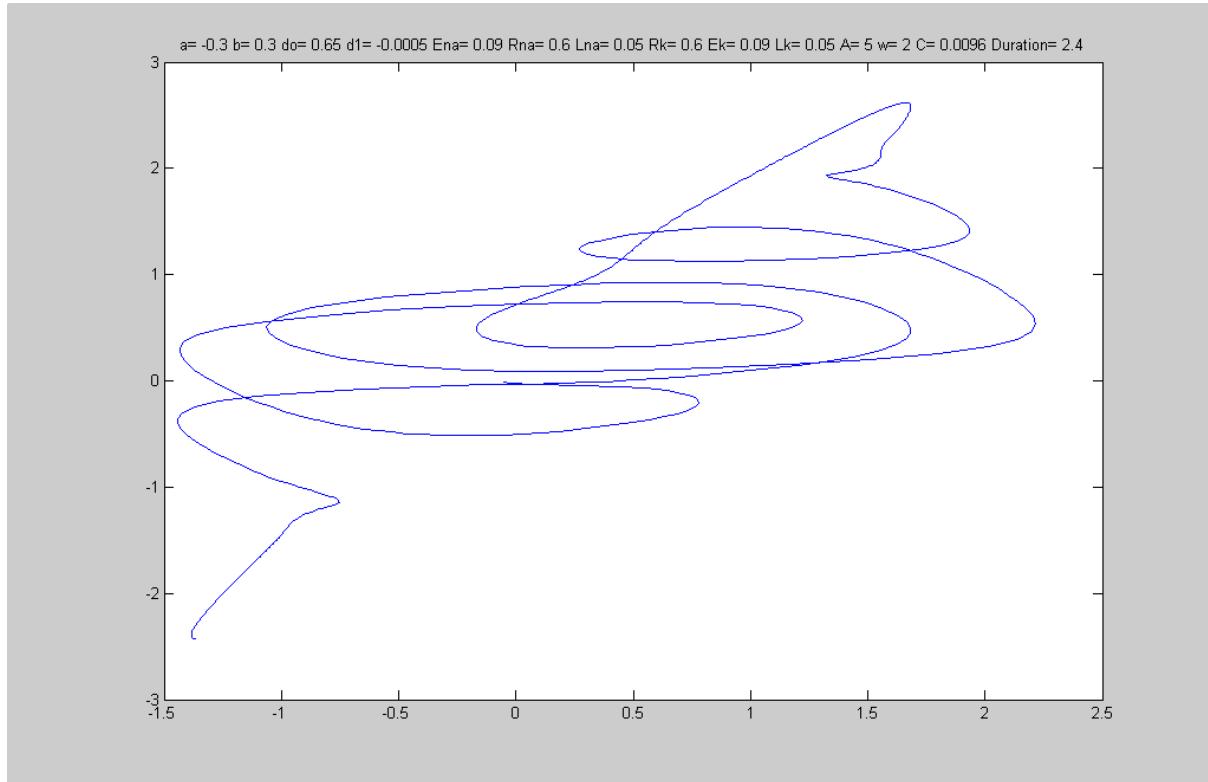
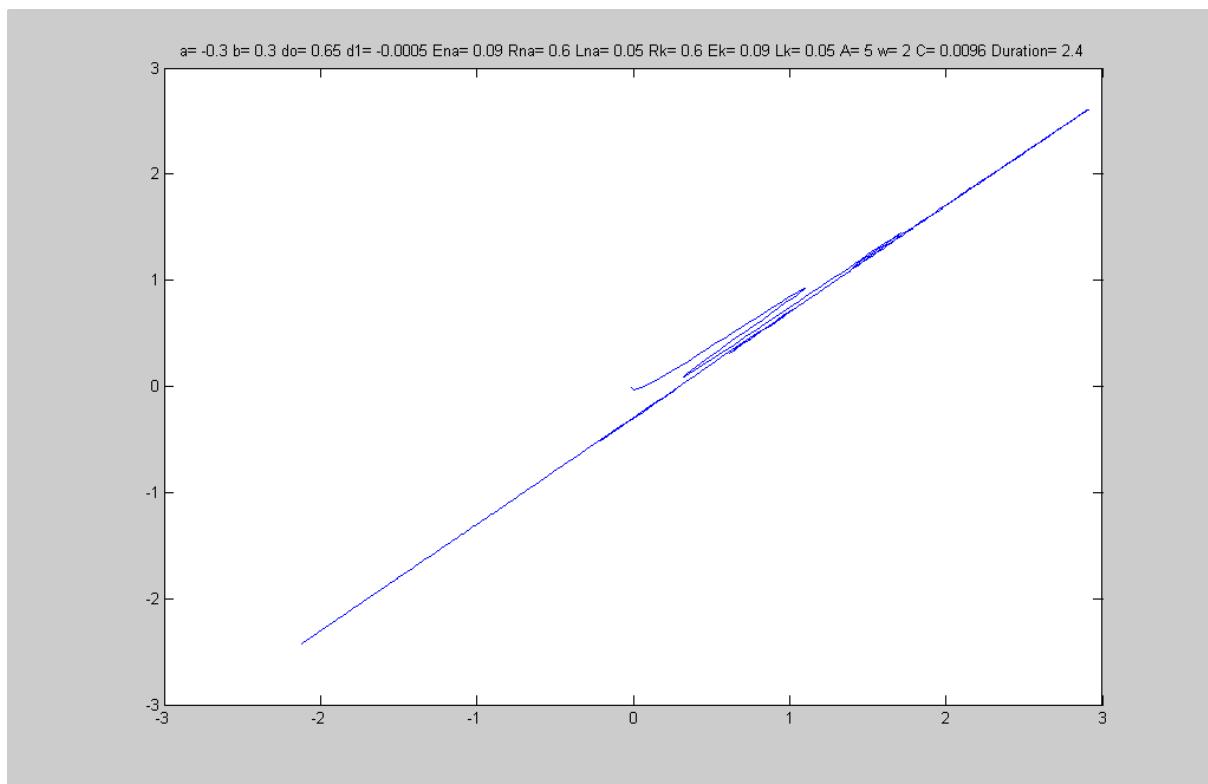


Figure:plan(V,Ik)**Figure:plan(Ina,Ik)**

3) w= 3 A=5 shilnikov isoclinic trajectory
Figure:plan(V,I_n,I_k)

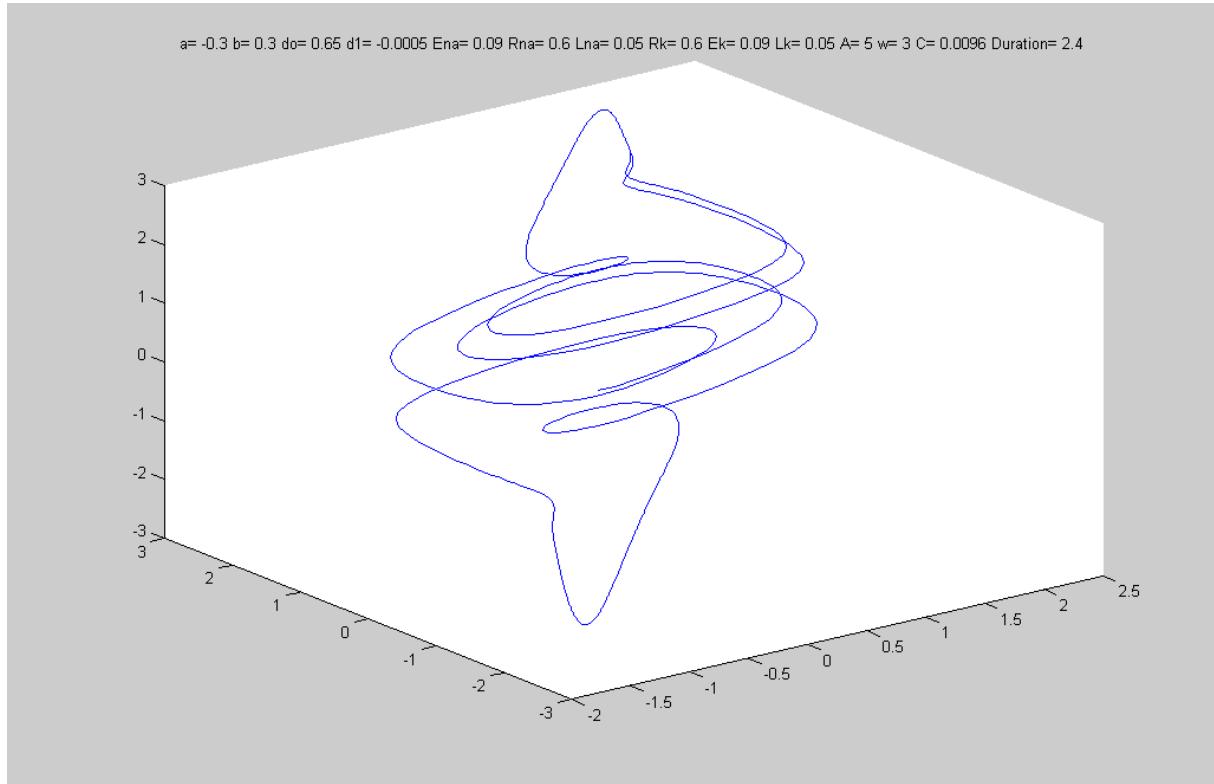


figure: V(t)

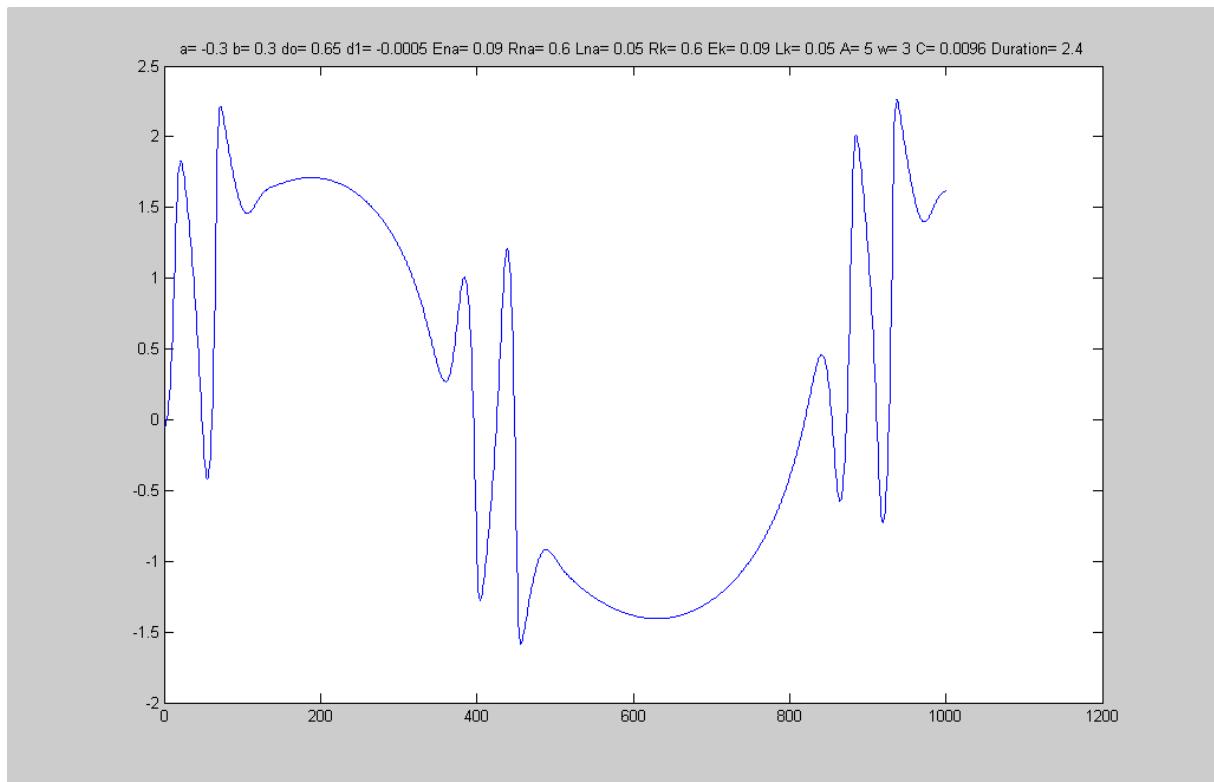
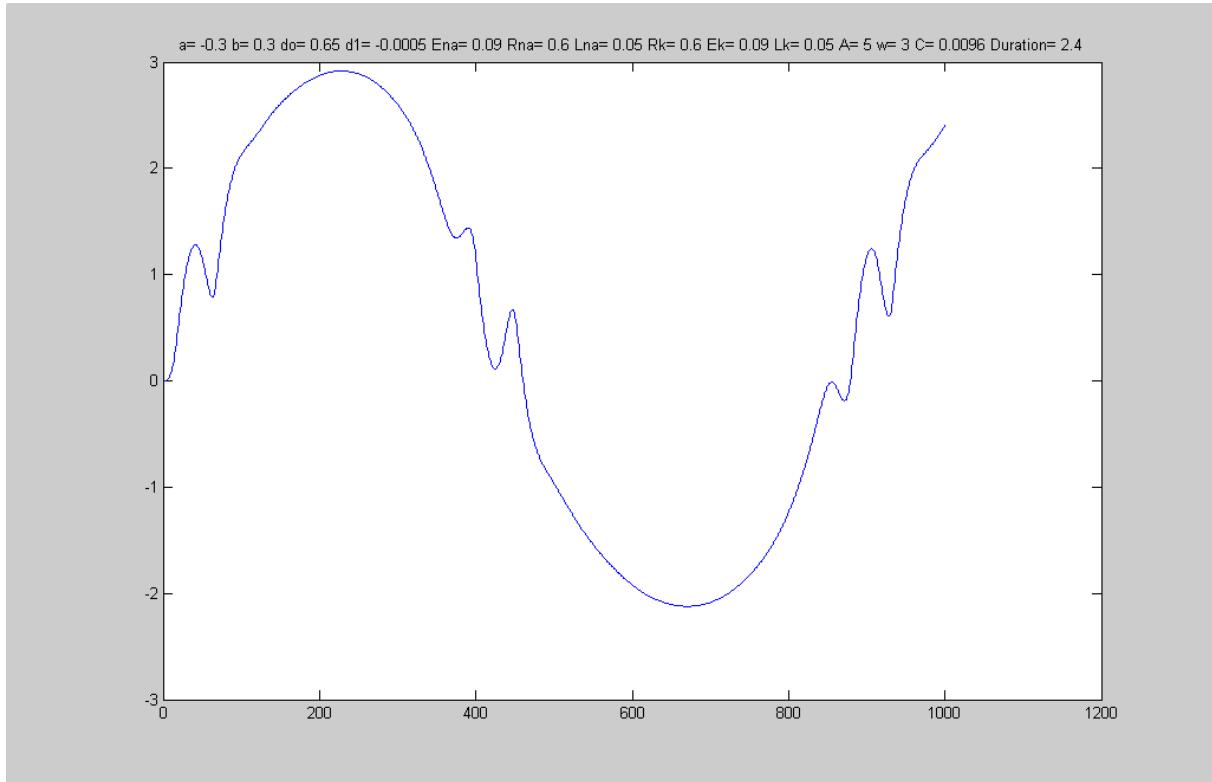
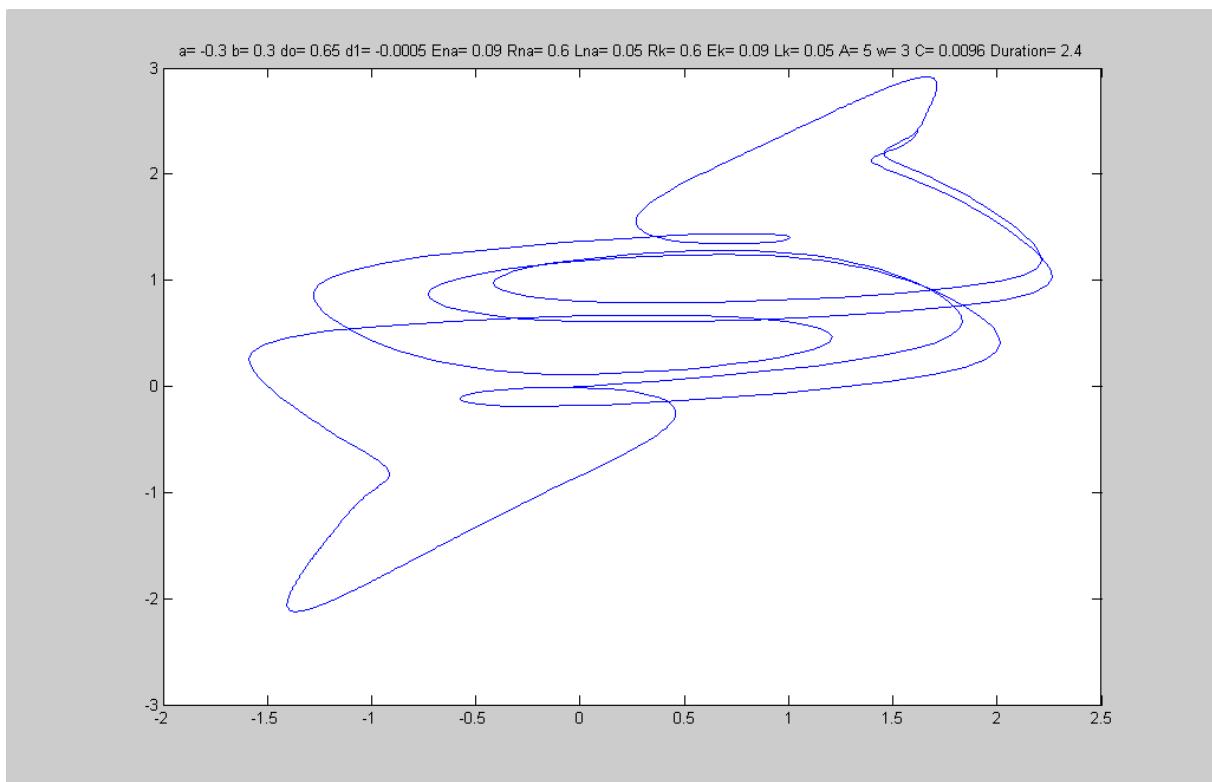


Figure:Ina(t)**Figure:plan(V,Ina)**

2 instable equilibrium points of shilnikov

4) w=4 A=5

Figure:plan(V,I_a,I_k)

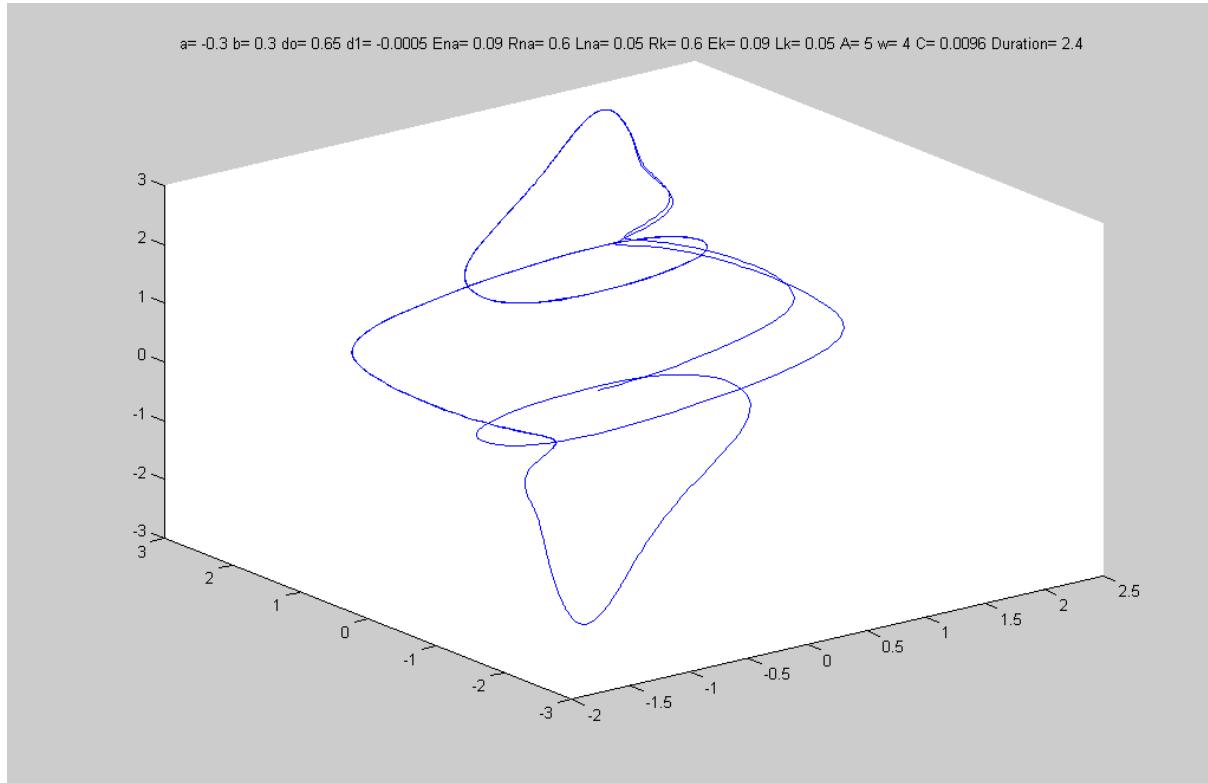


figure:plan V(t)

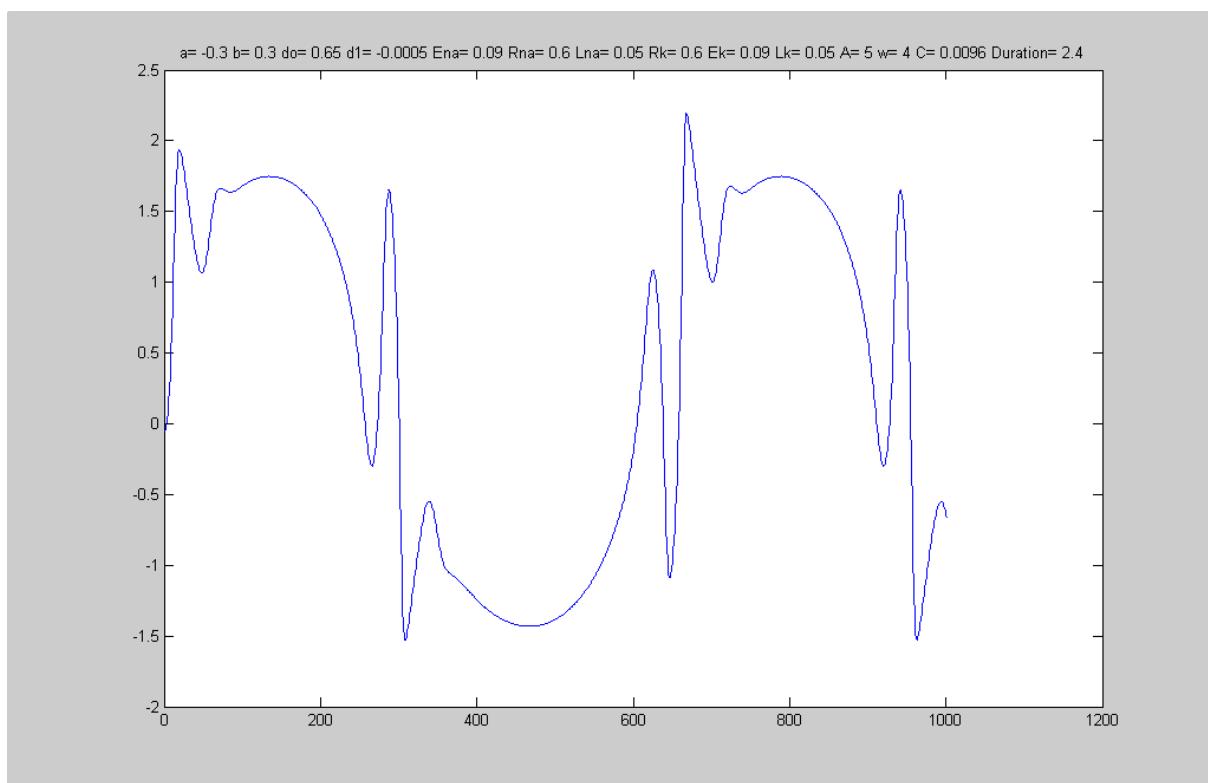
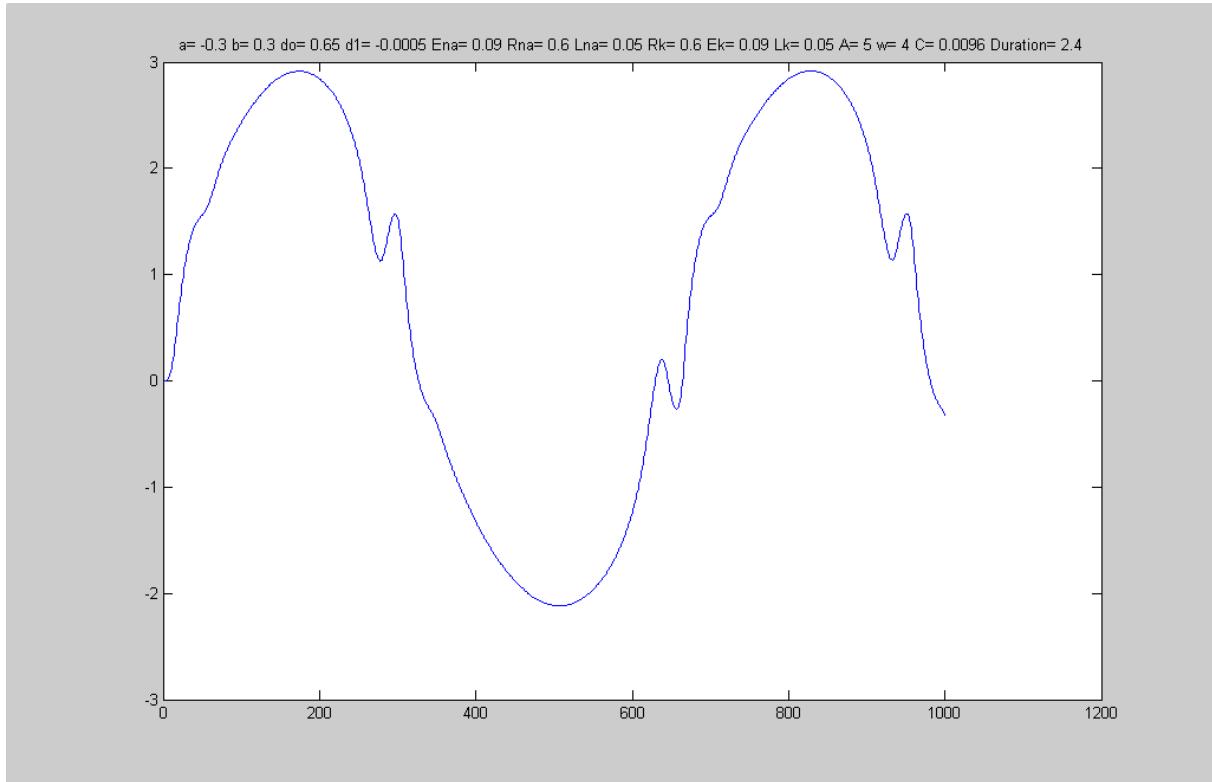
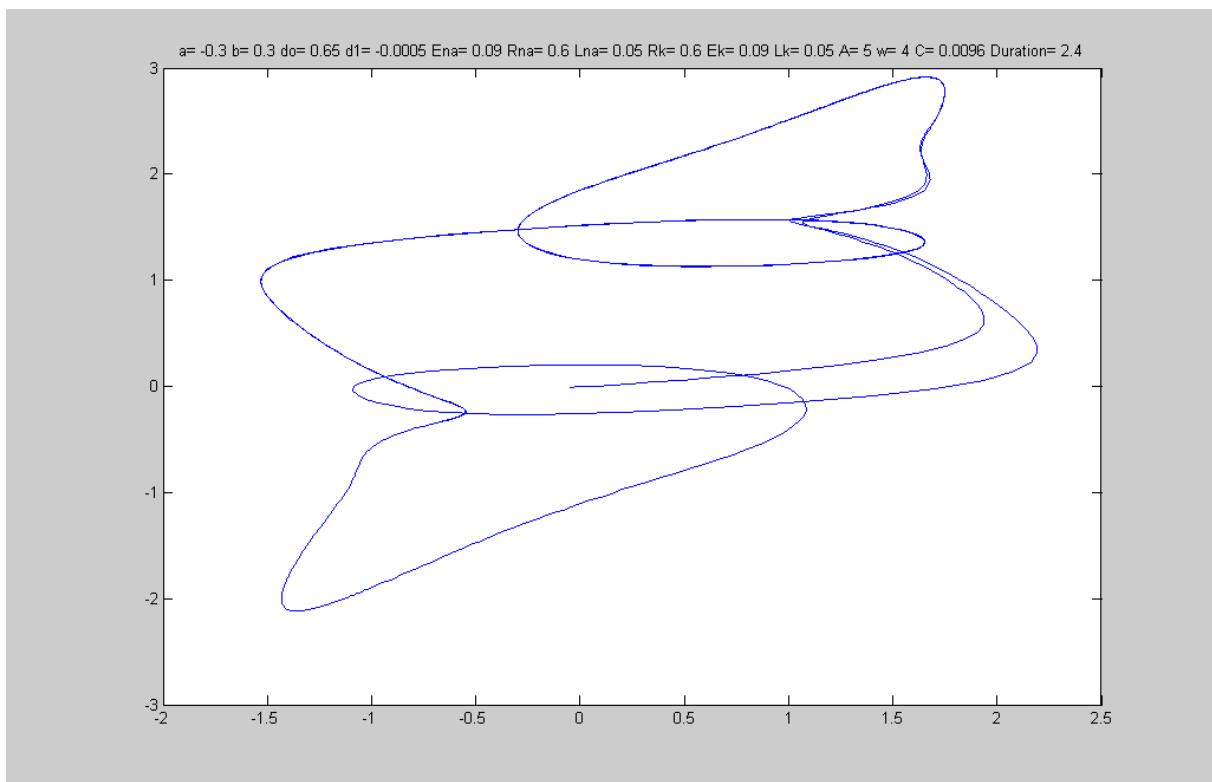
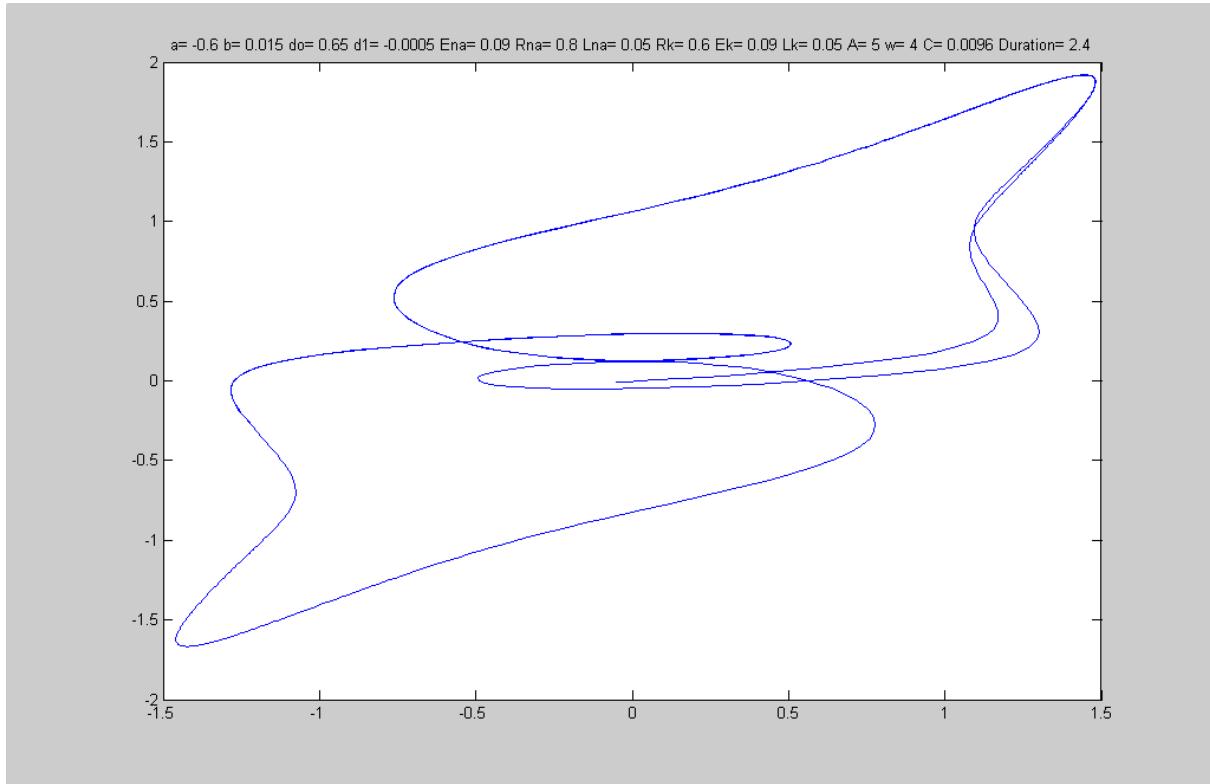


Figure:Ina(t)**Figure:plan(V,Ina)**

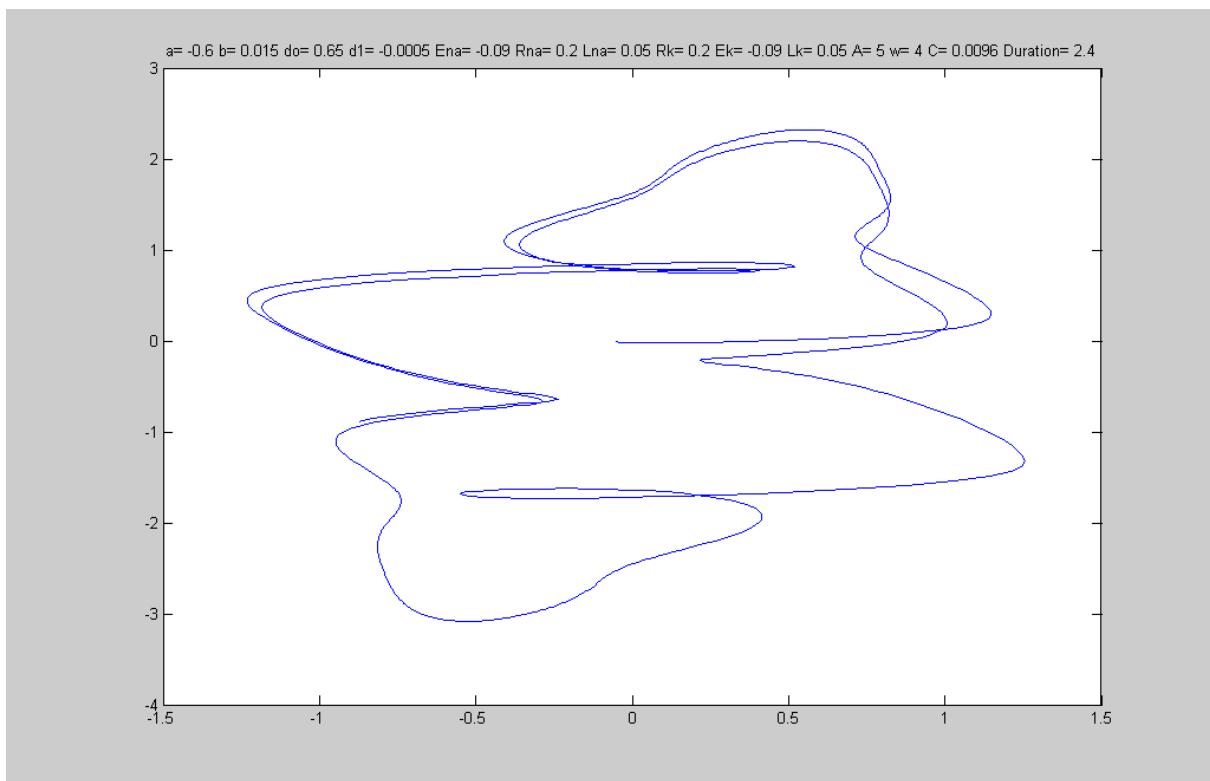
6) w=4 A=5 a=-0.6;b=15e-3;Rna=0.8;Rk=0.6

figure;plan(V,I_a,I_k)

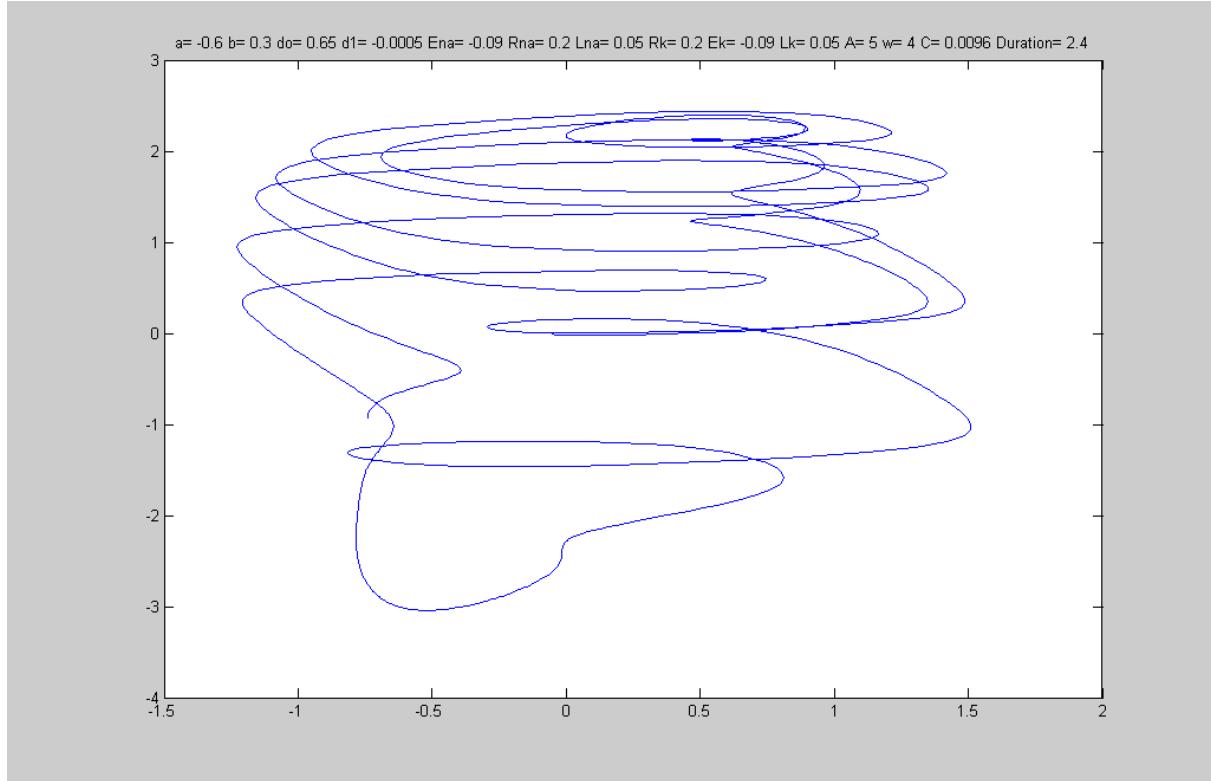


6)Rna=Rk=0.2

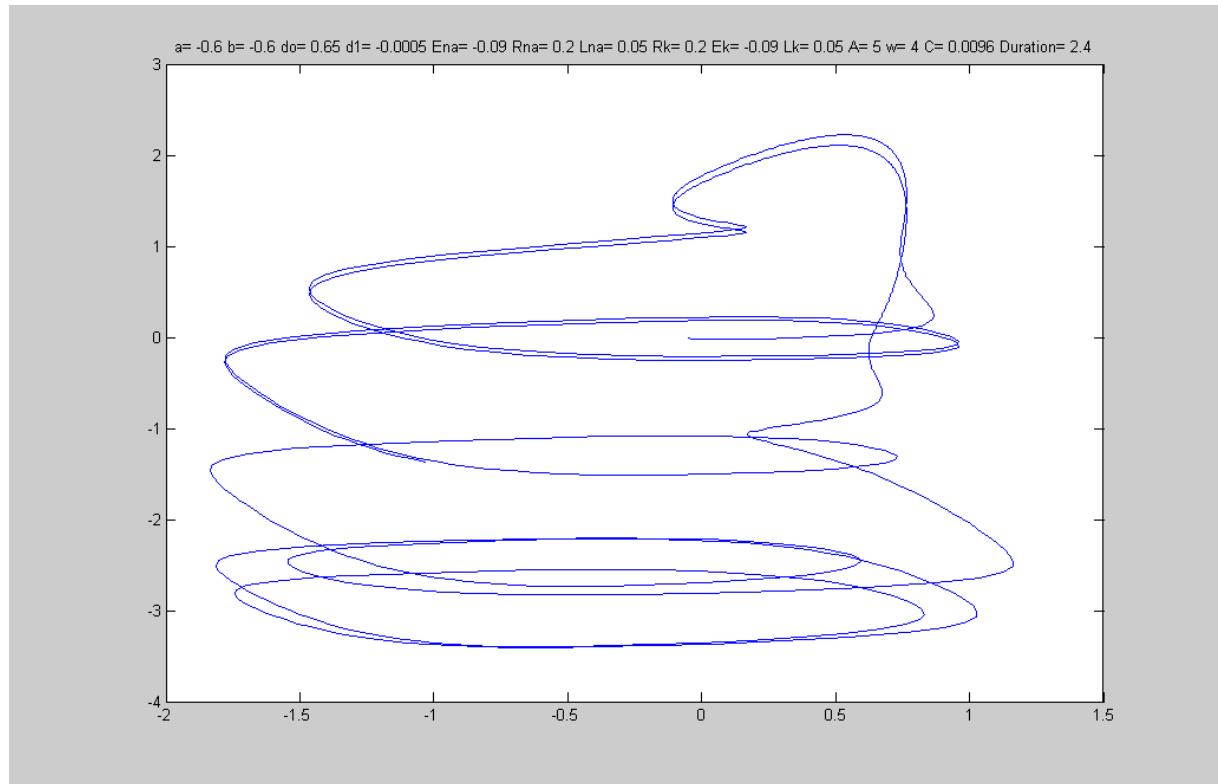
Figure;plan (V,I_a,I_k)



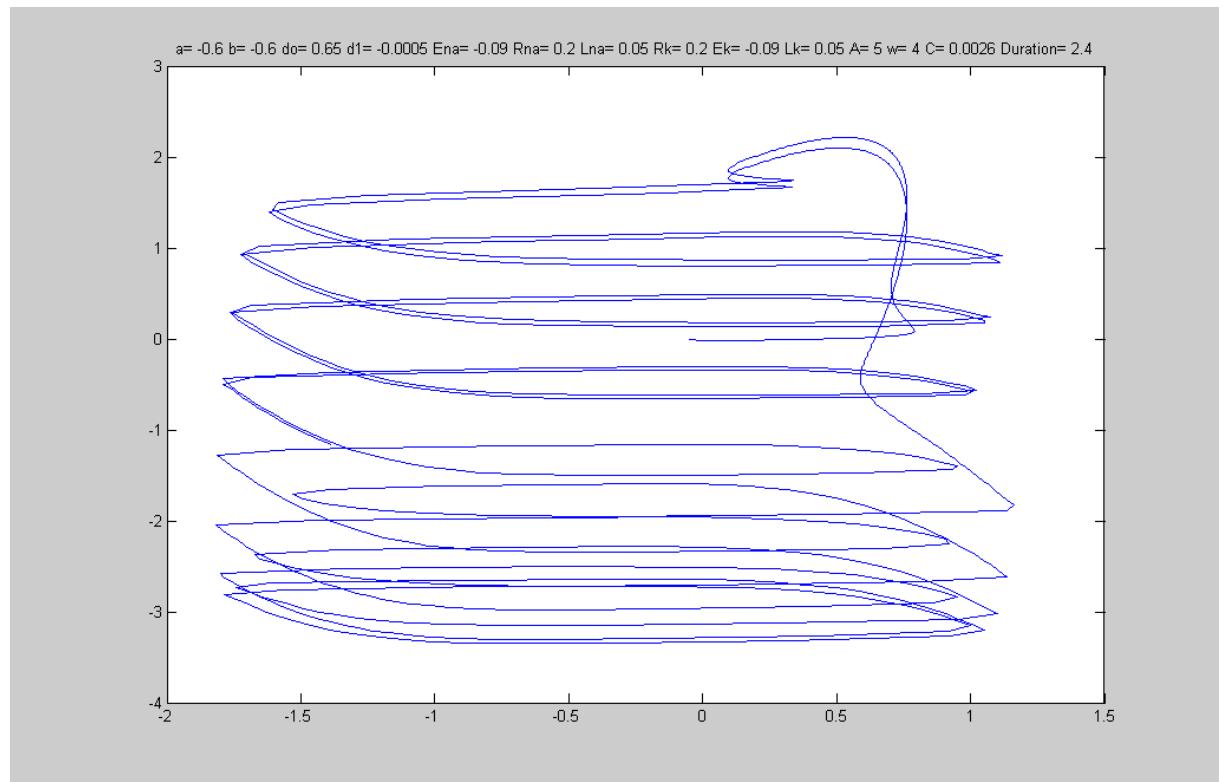
7) $b=0.3$
figure:plan(V,Ina,Ik)



8) $b=-0.6$
figure:plan(V,Ina,Ik)



9) $C=2600\mu F$
Figure:plan(V,Ina,Ik)



SERIE 3 VOLUME 11

1)investigation, chao-car(chao-porshe) modele pacemaker VI1
a= -0.6; b= 0.3; do= 0.65; d1= 0.005; E= 90mV; R= 0.6;
L=50mH; C=9600 μ F; w=1; A=1

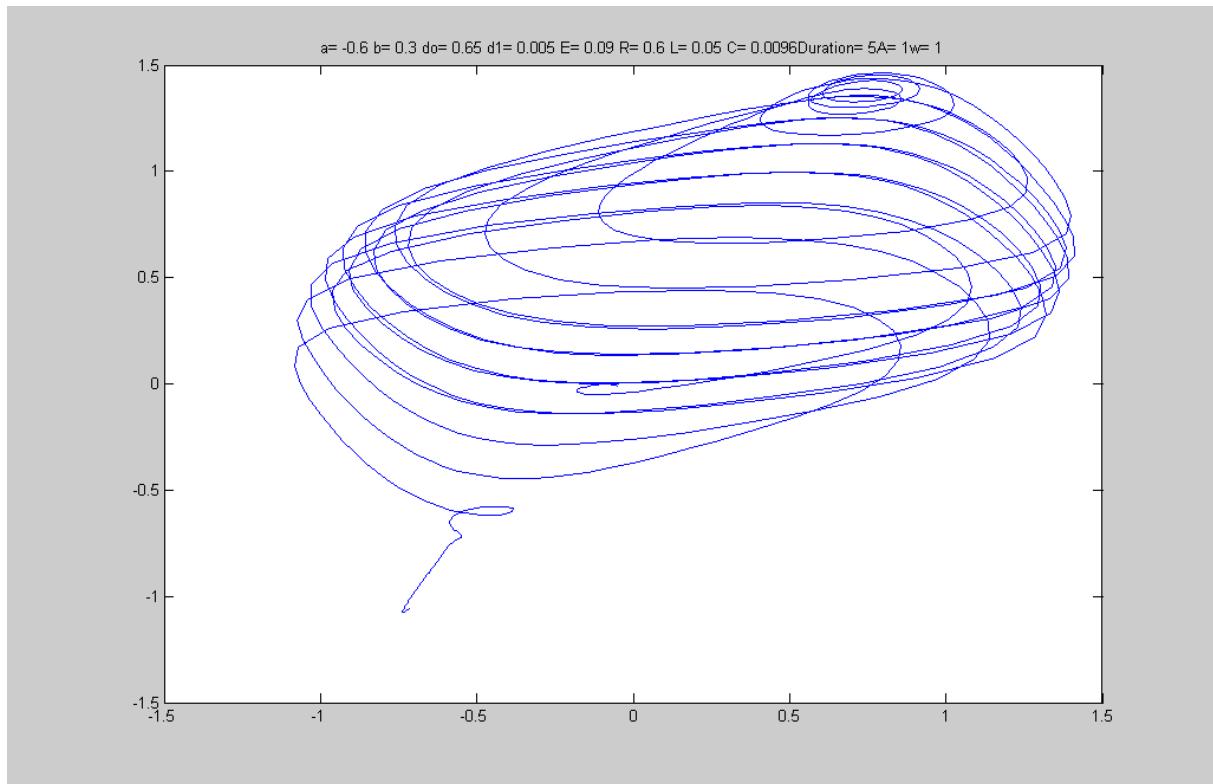


Figure :V(t)

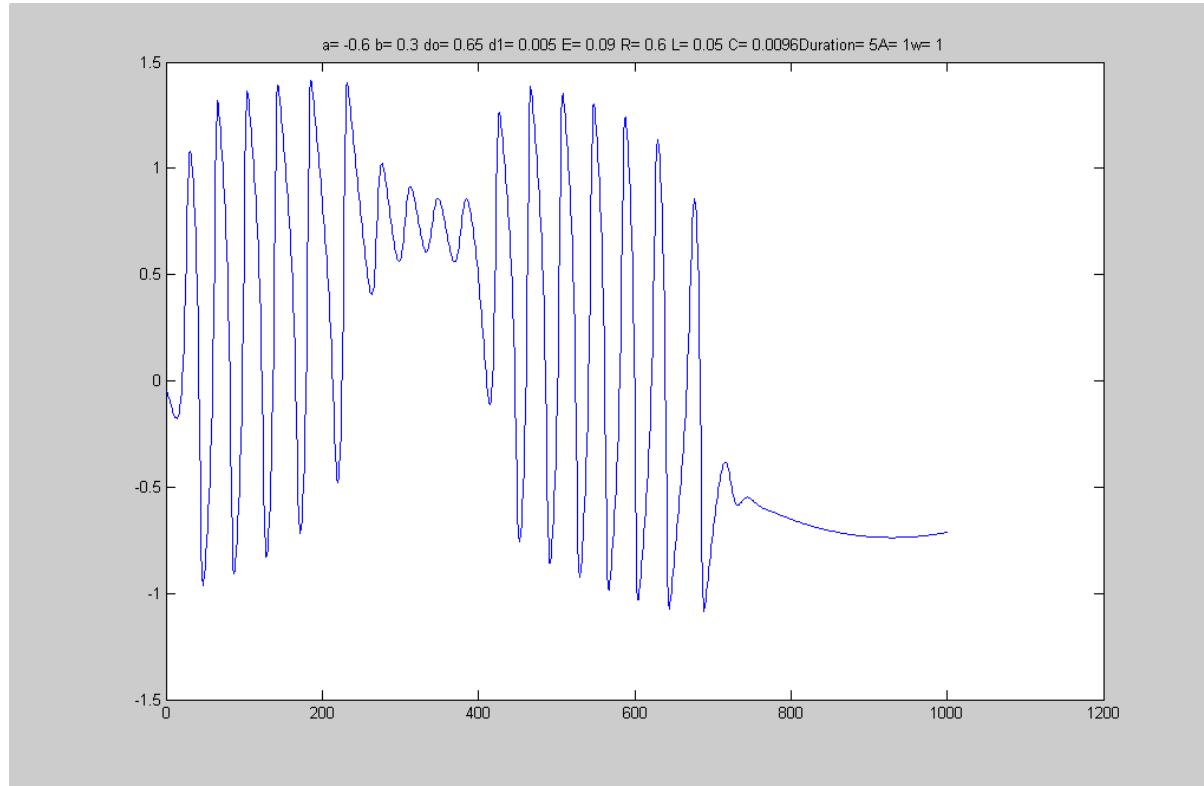
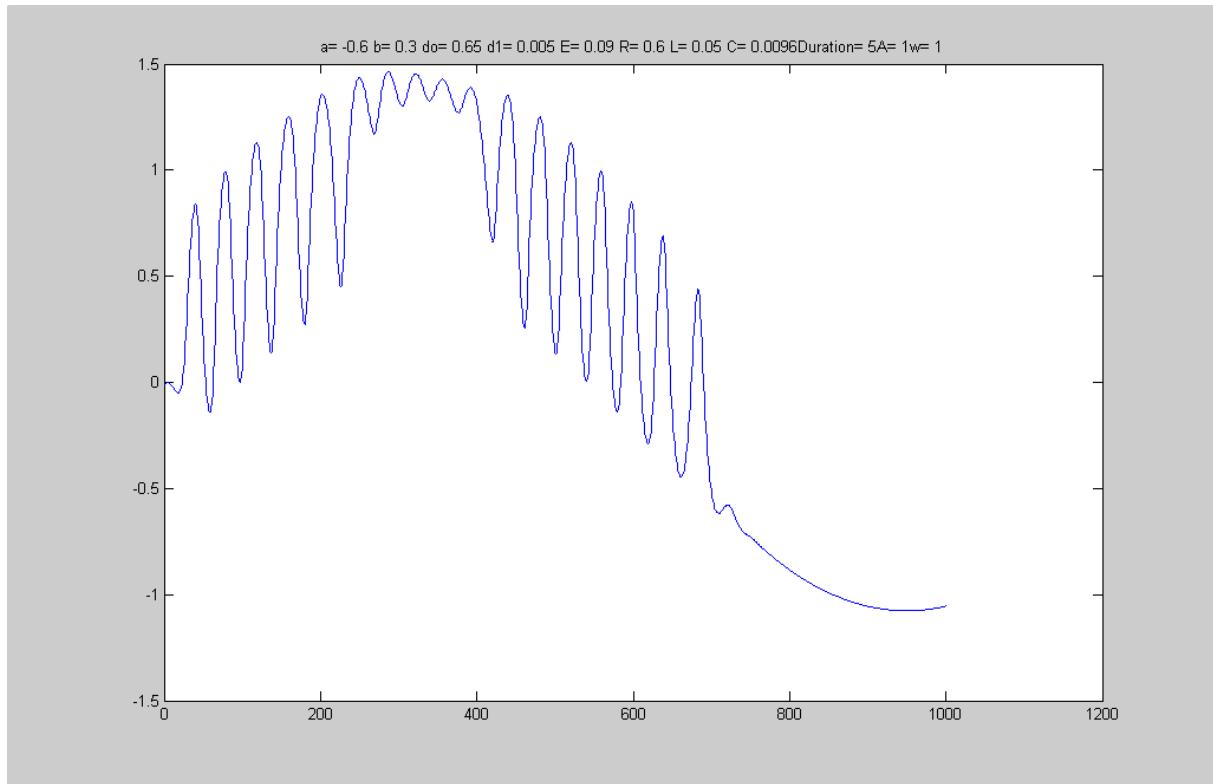


Figure:I1(t)



2) w=2 step w by multiple of 2

Figure:plan(V,I1)

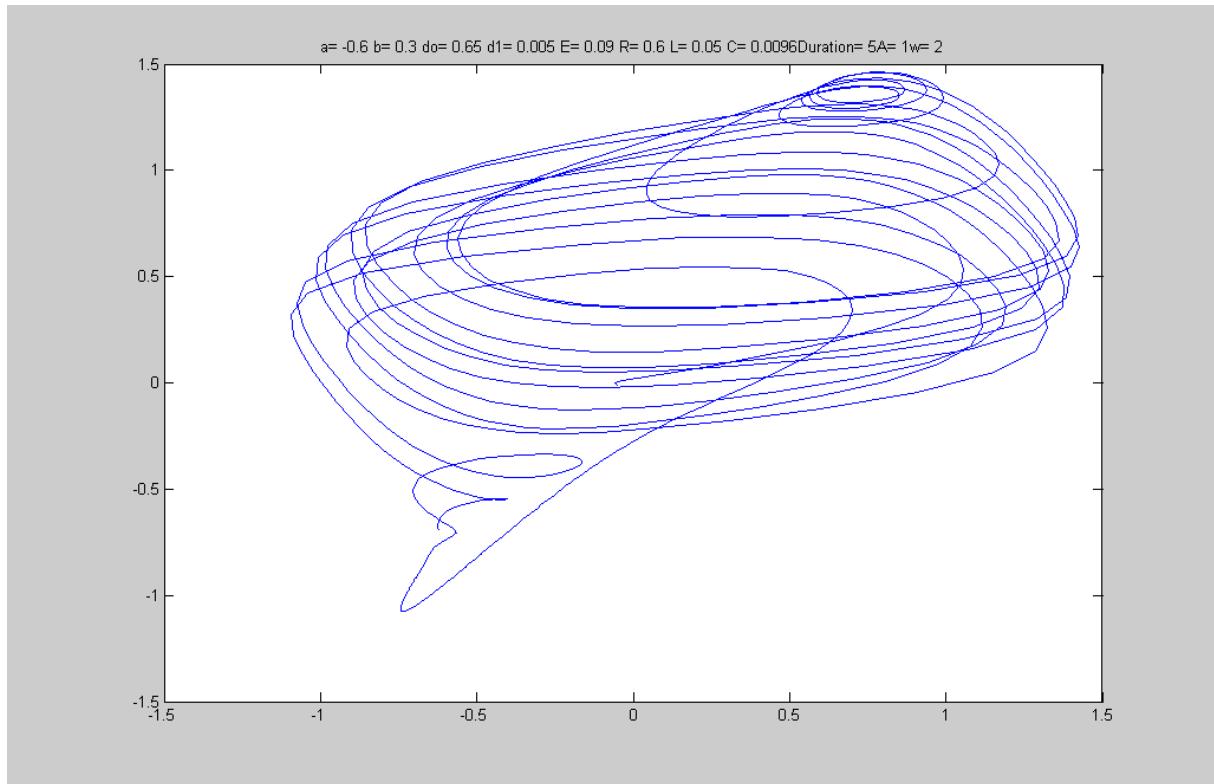


Figure:V(t)

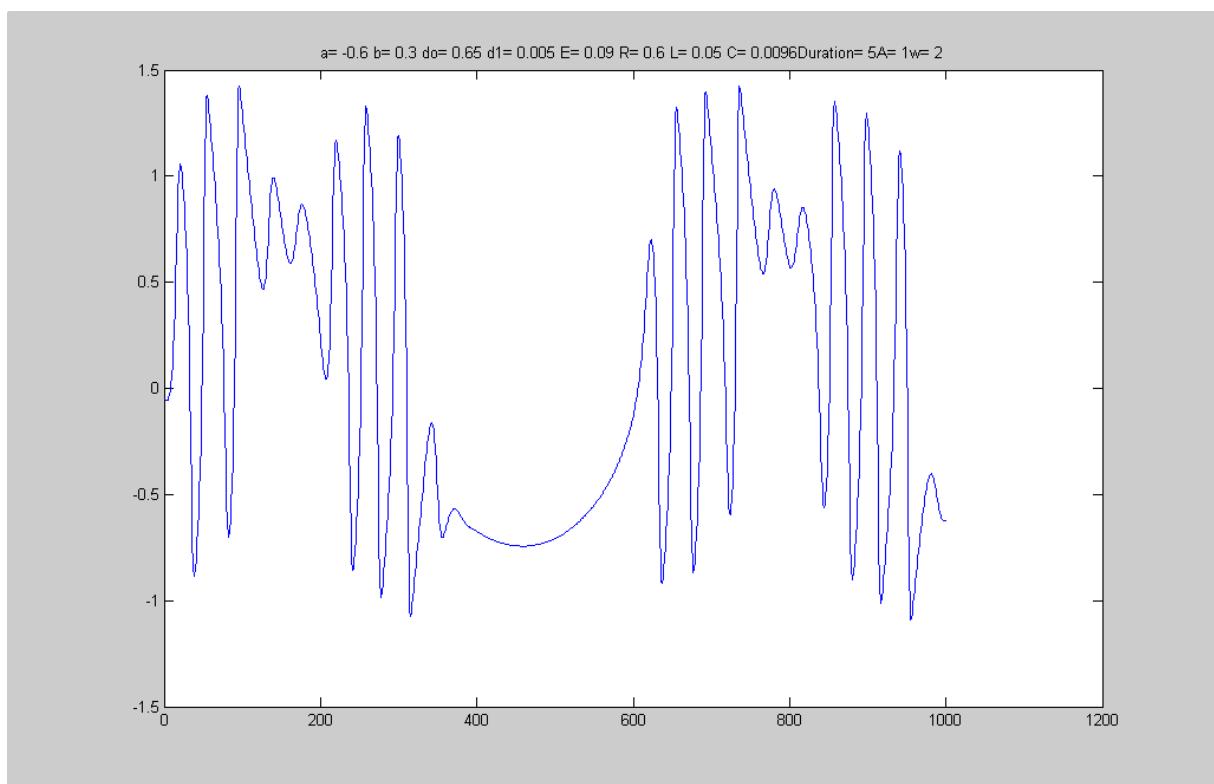
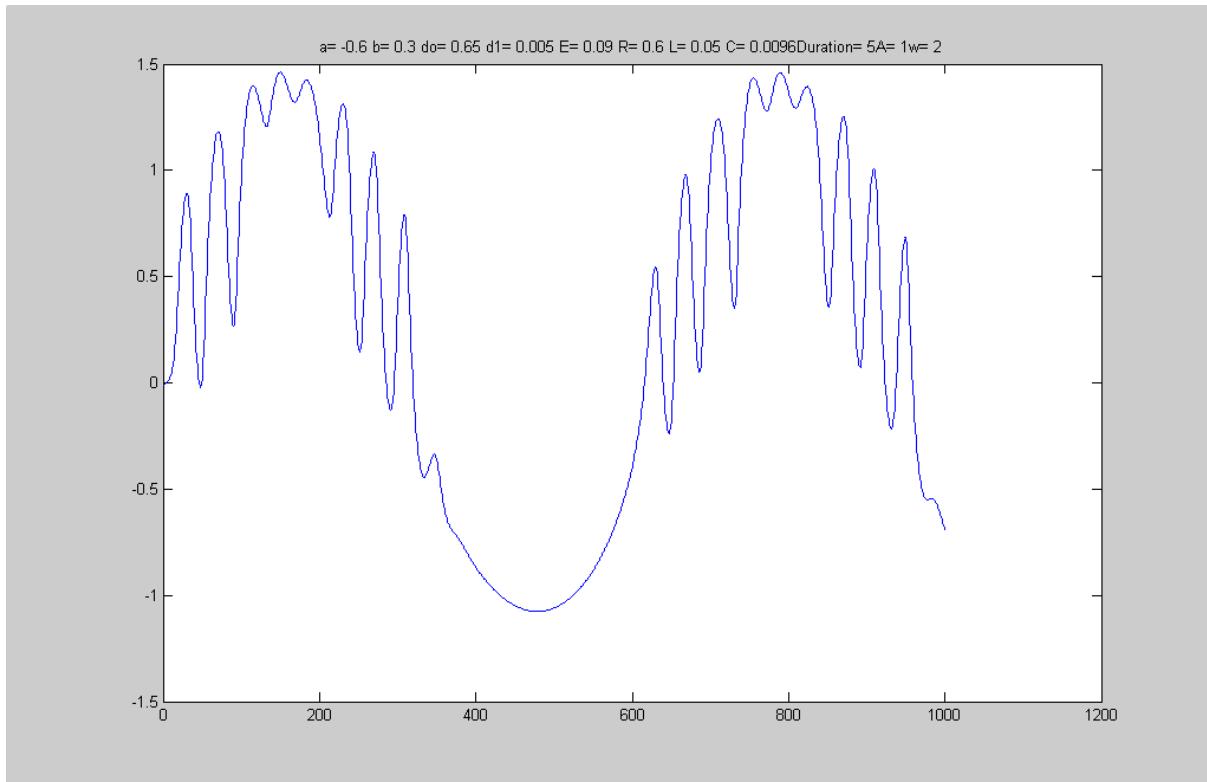
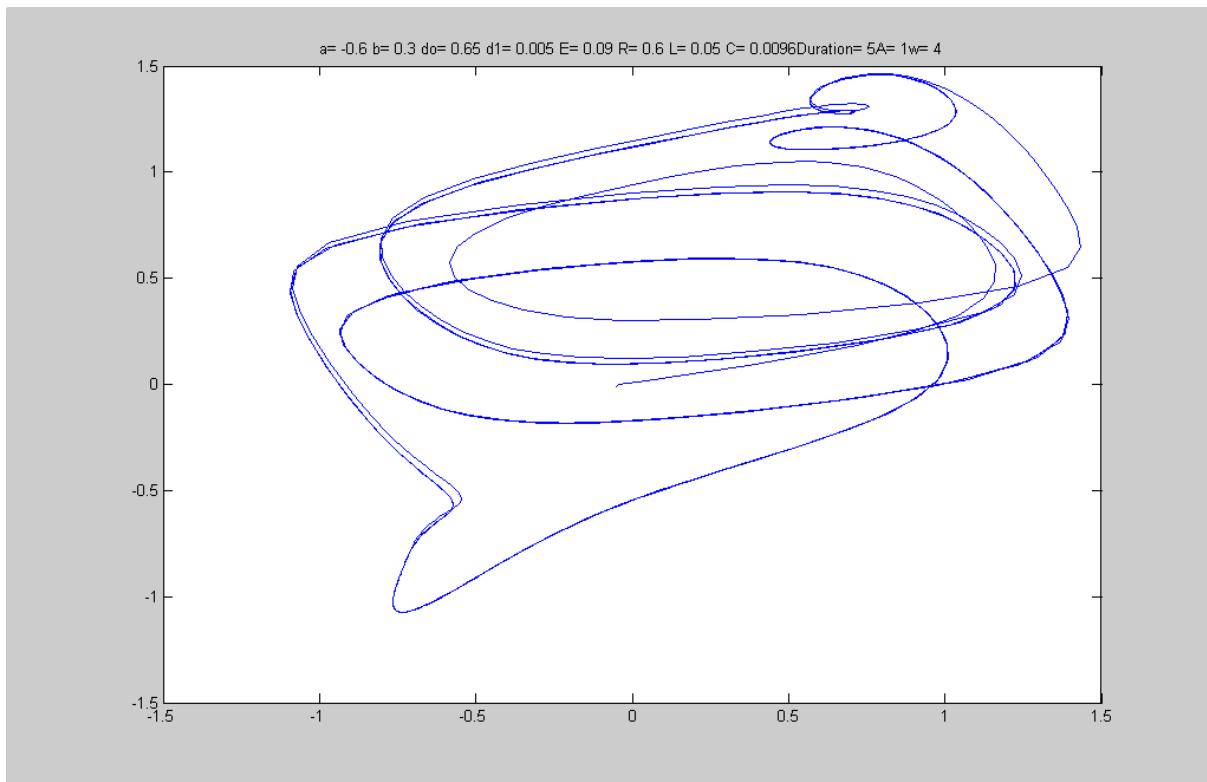


Figure:I1(t)

3)w = 4

Figure:plan(V,I1)

The chao-car,or chao-porshe is transforme doubling frequency(feighenbaum) in to airplane-chao.

Figure;V(t)

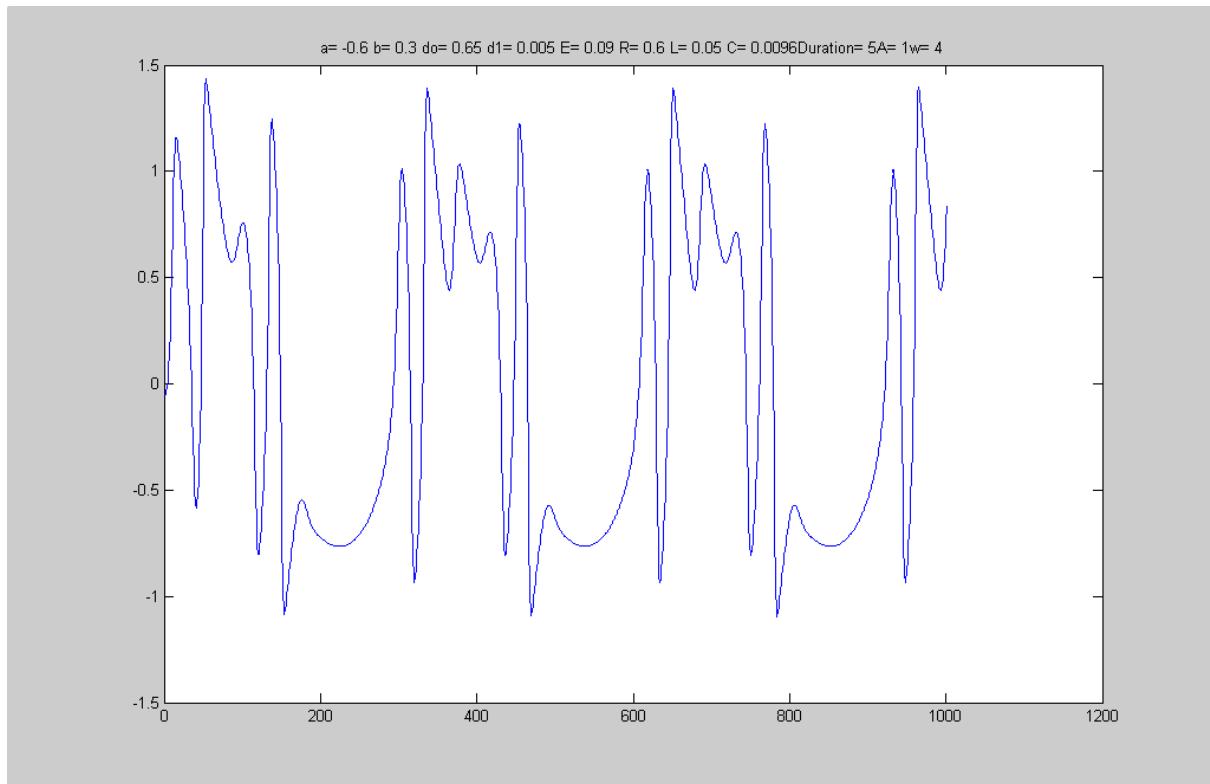
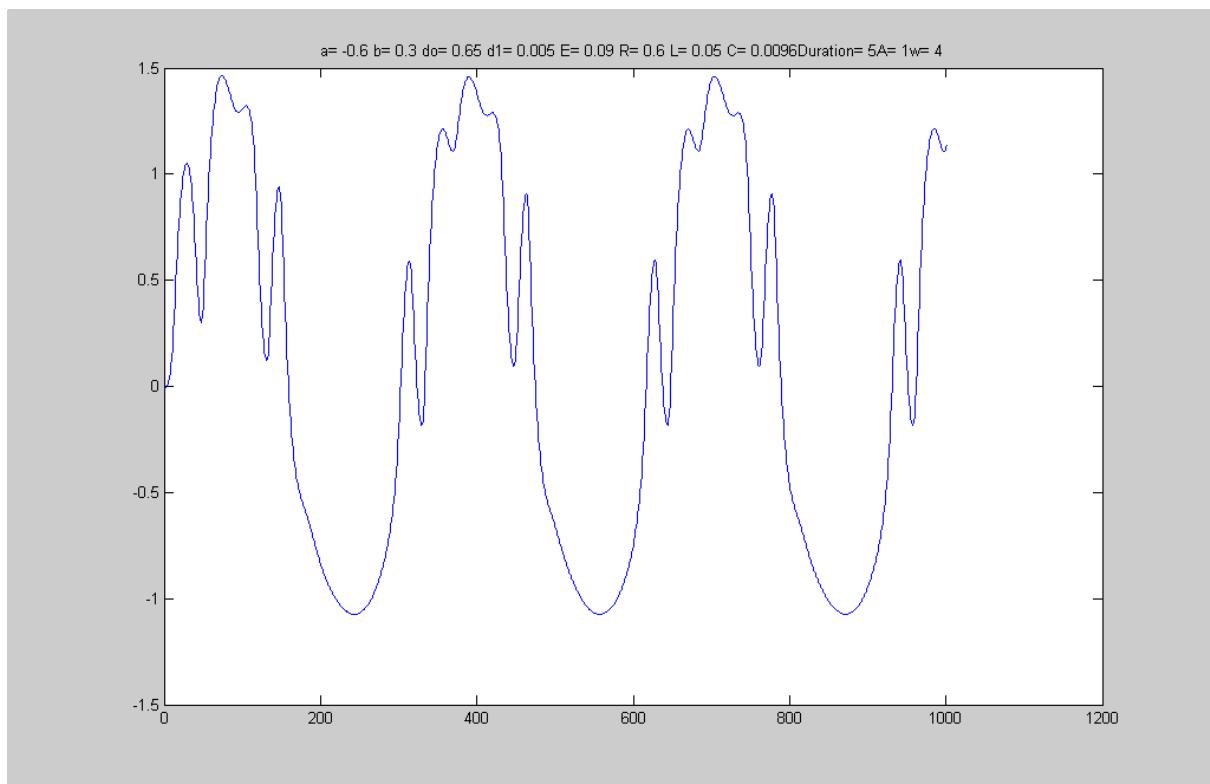
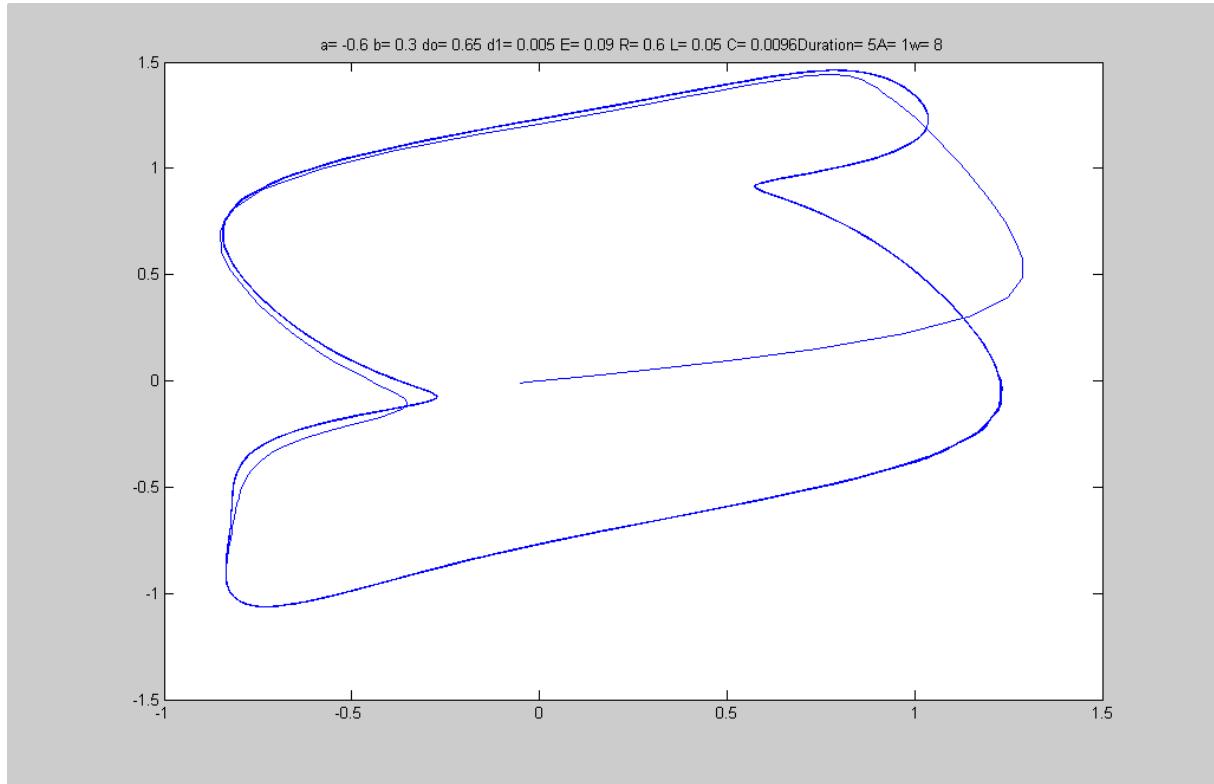


Figure:I1(t)



4) w=8

Figure:plan(V,I1)



Figure; V(t)

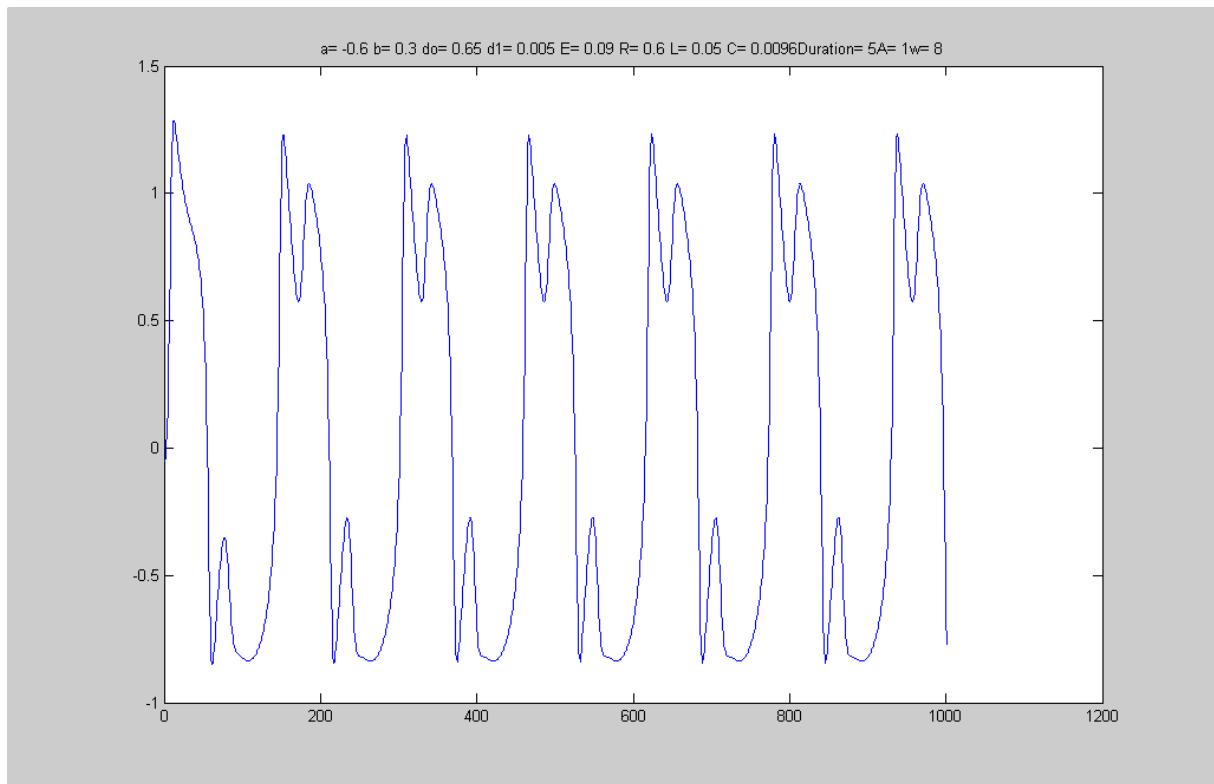
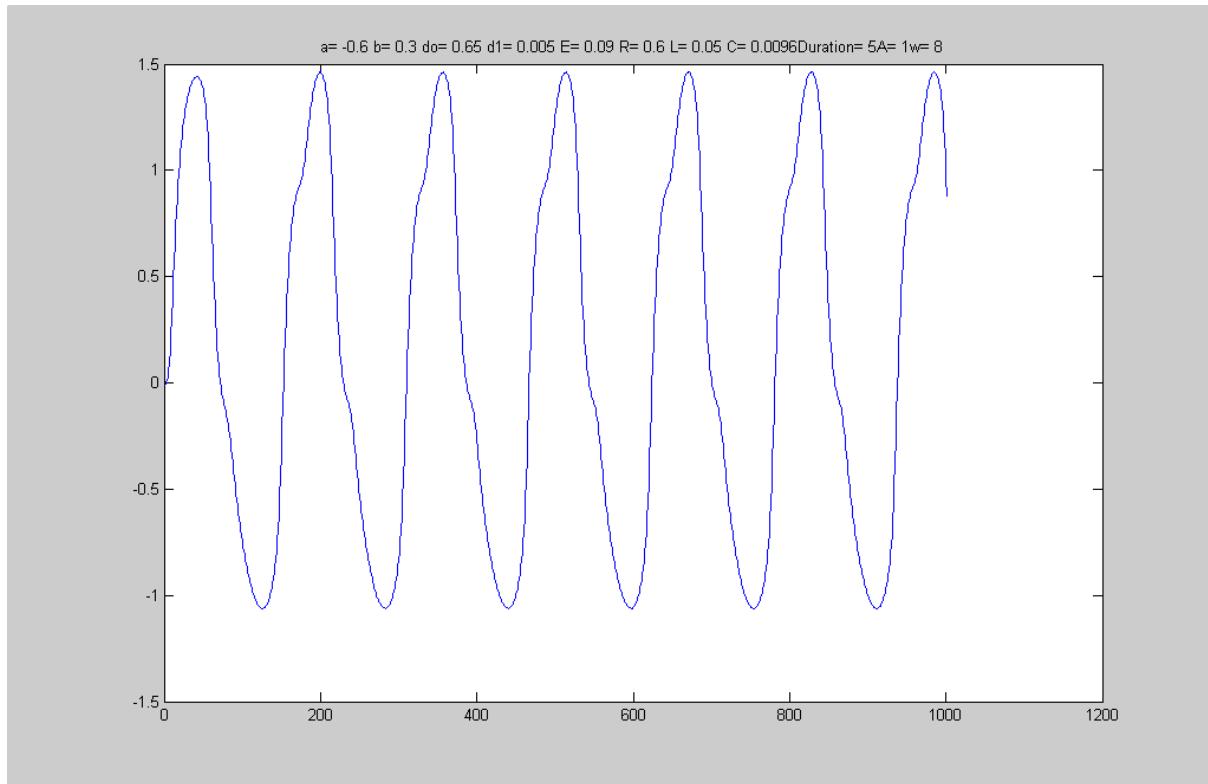
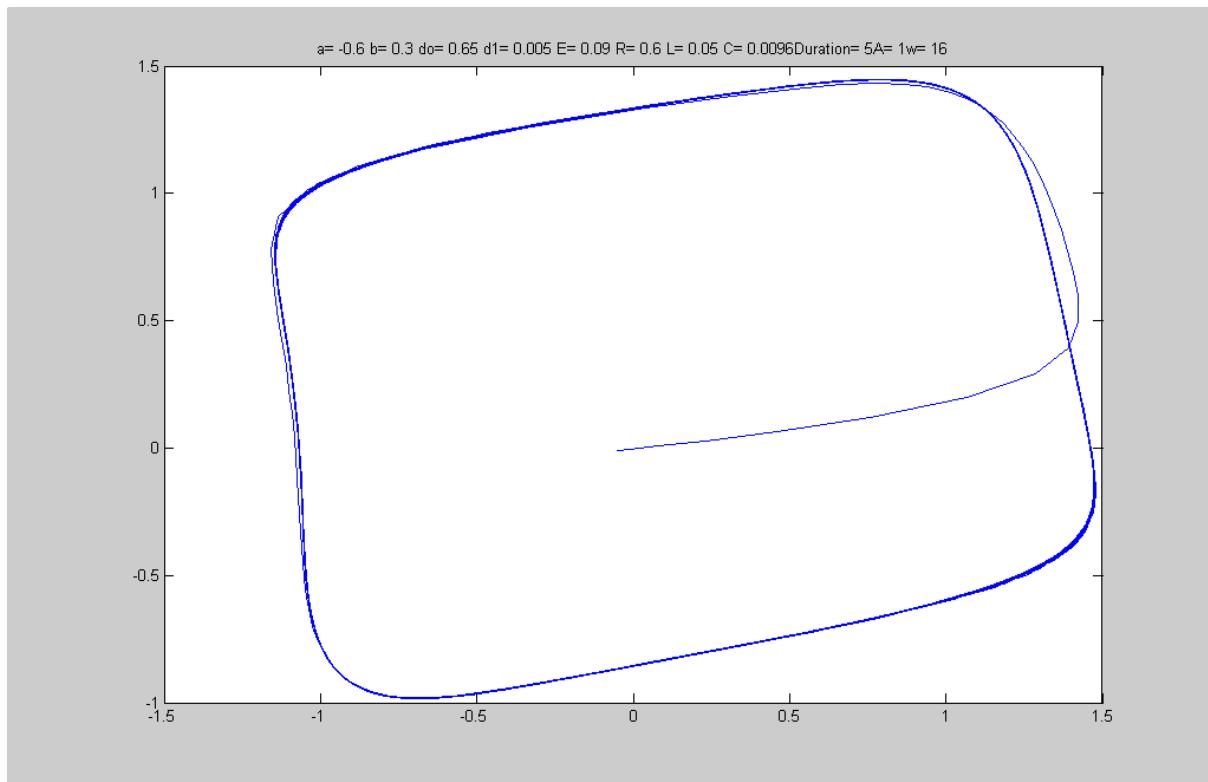


Figure:I1(t)

5) w=16
Figure:plan(V,I1)



**5) w=128 bifurcation
figure:plan (V,I1)**

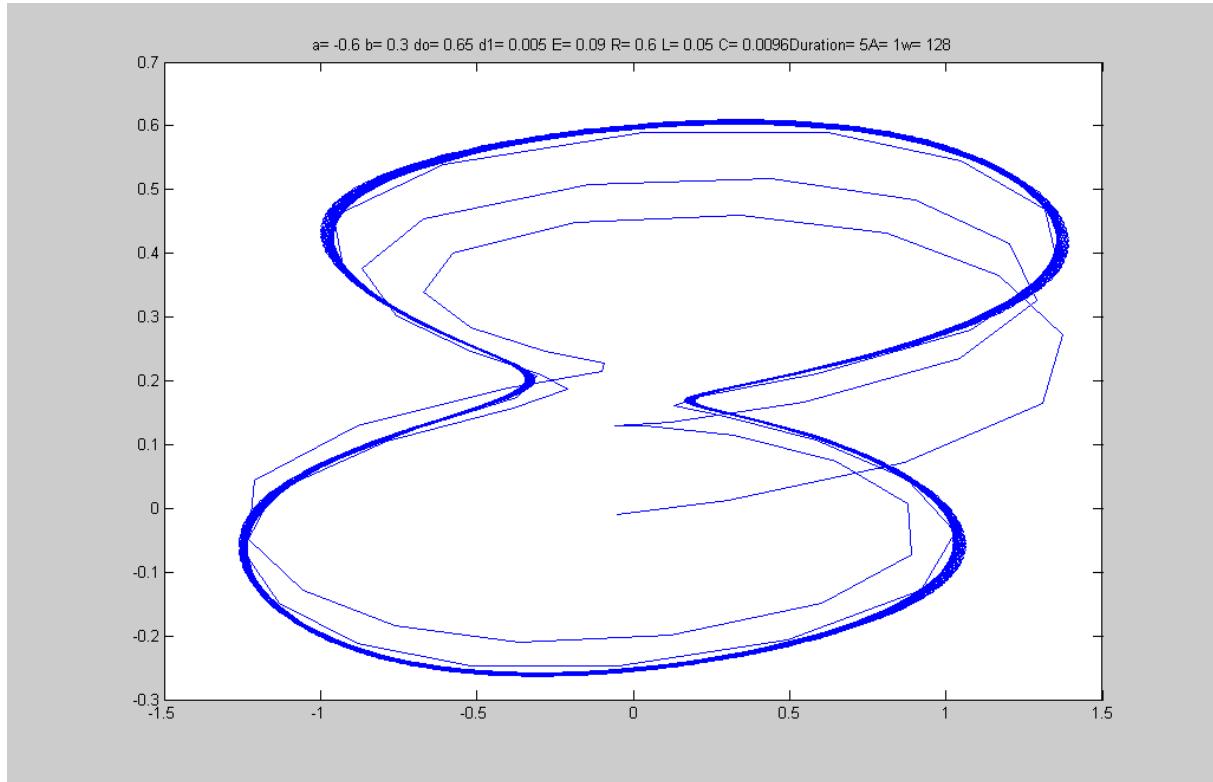


Figure:V(t)

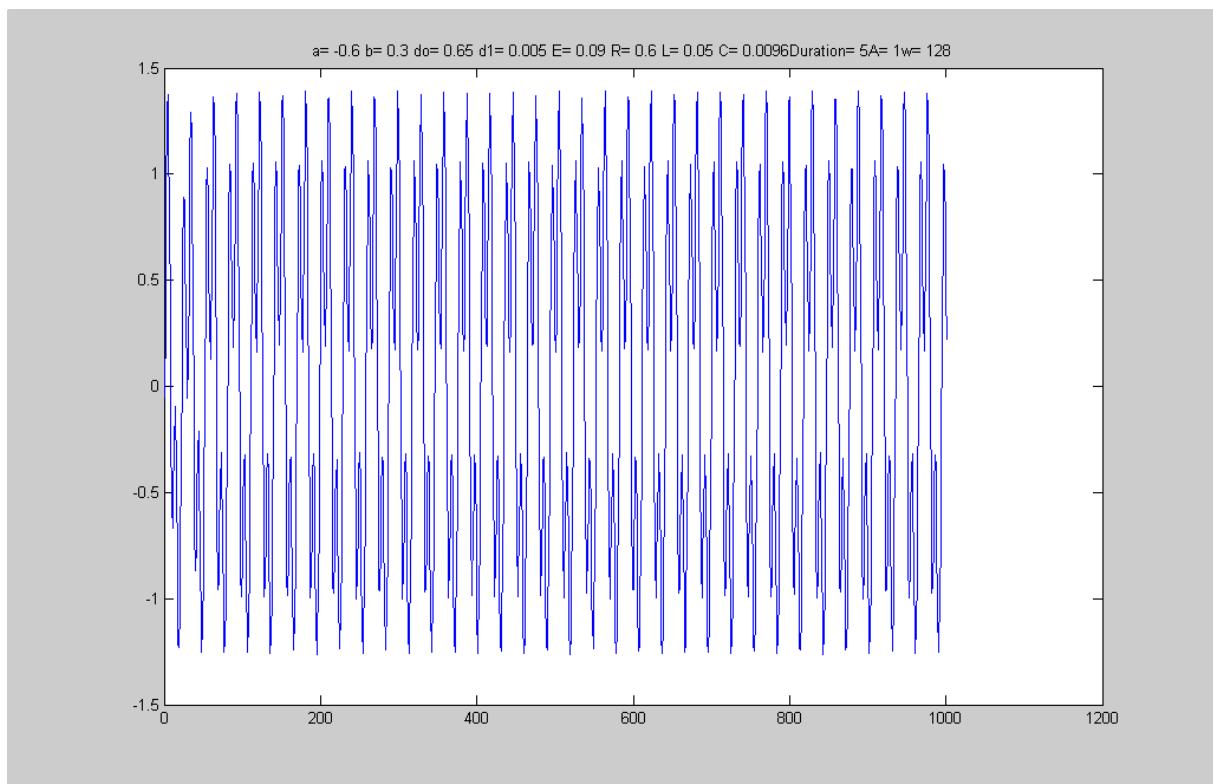
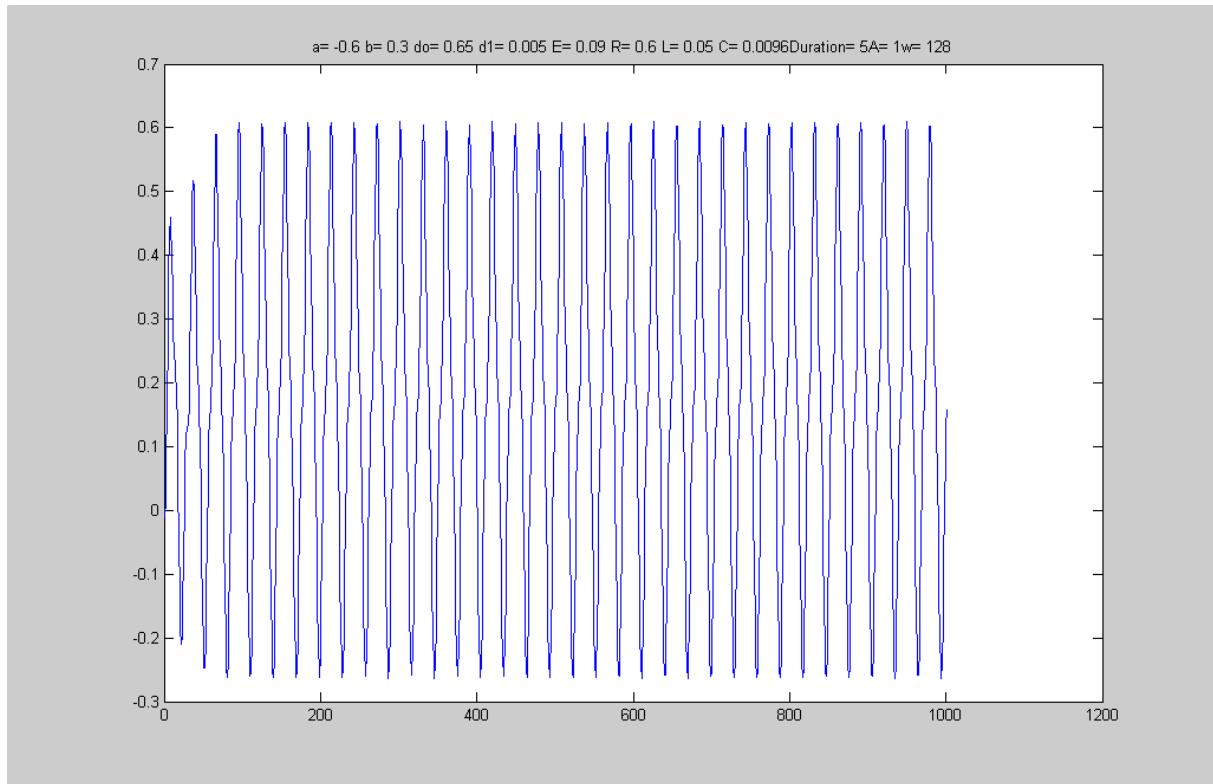


Figure:I1(t)

**6) w=256 porshe-chao is transformed in torus 2D
figure:plan(V,I1)**

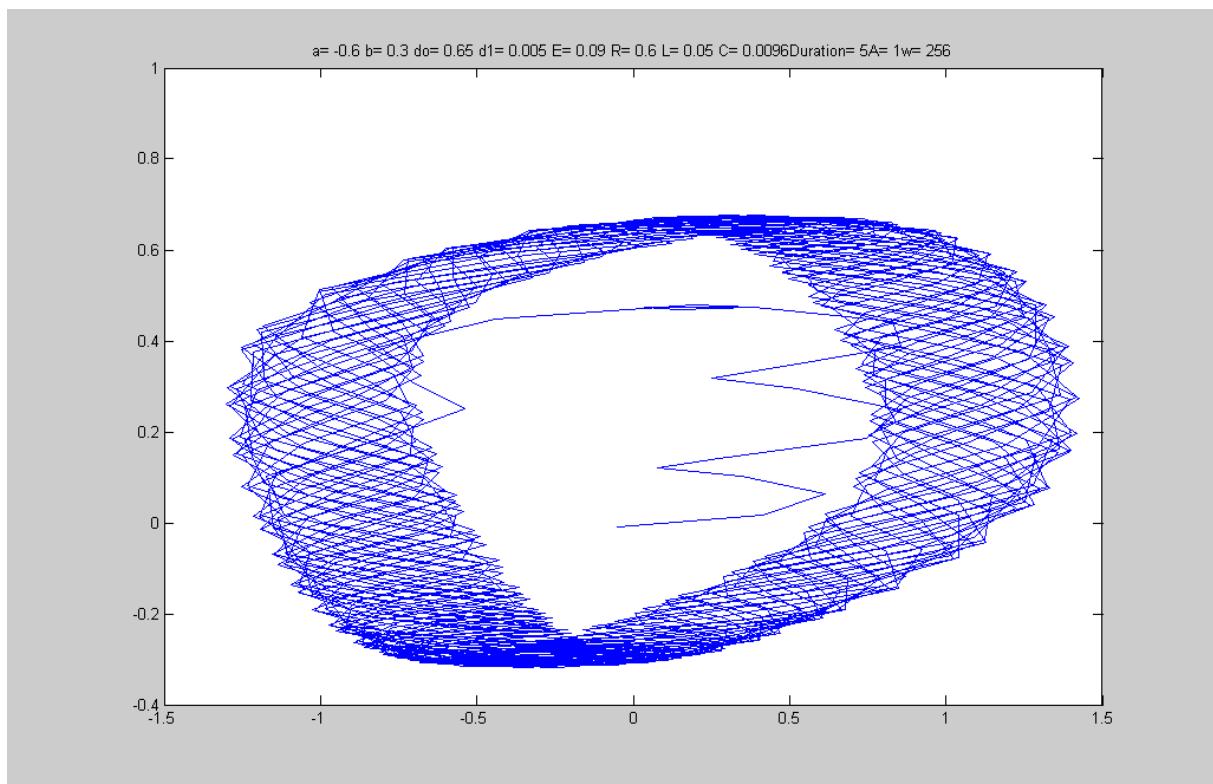
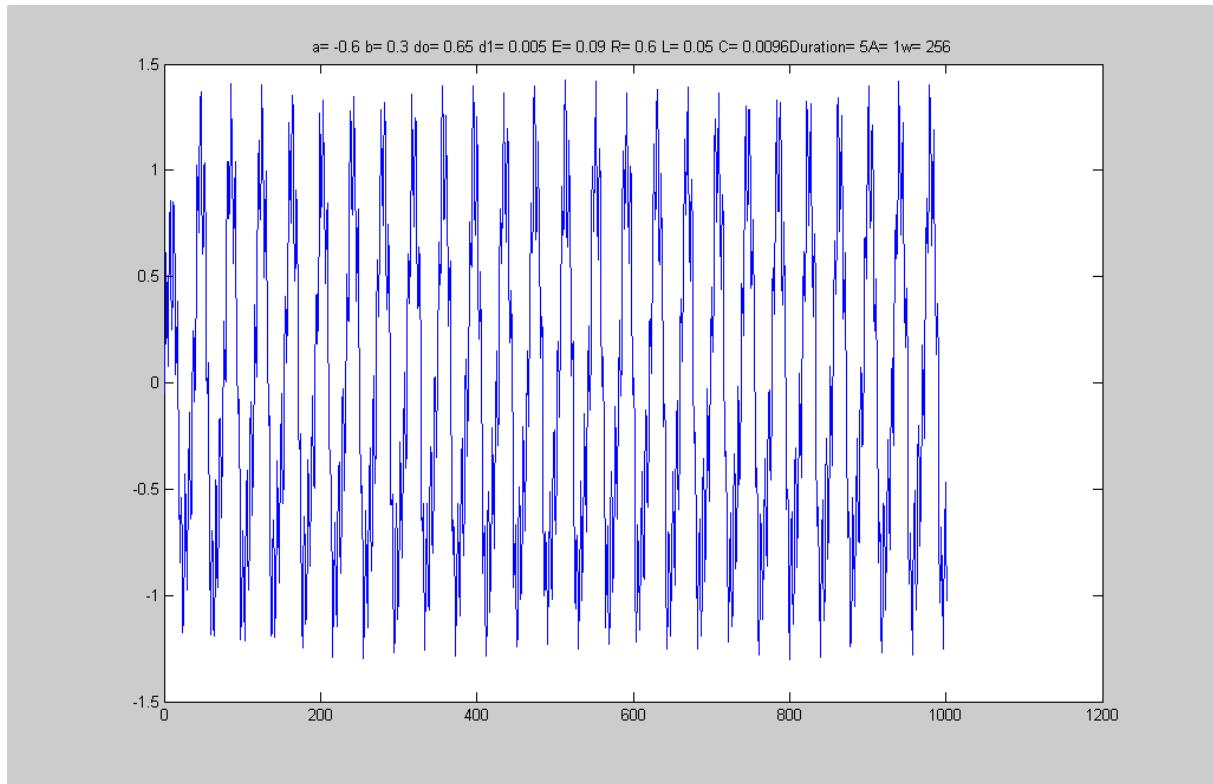
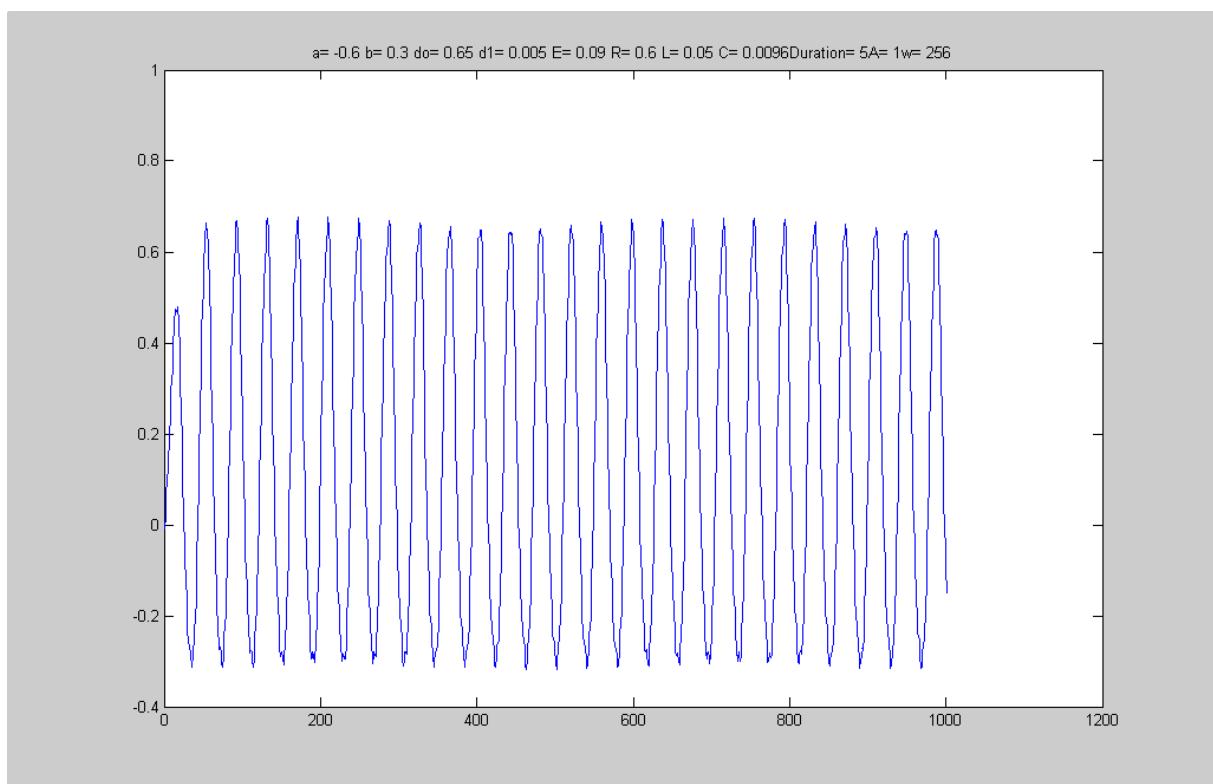


Figure:V(t)**Figure:I1(t)**

7) w= 512
figure:plan(V,I1)

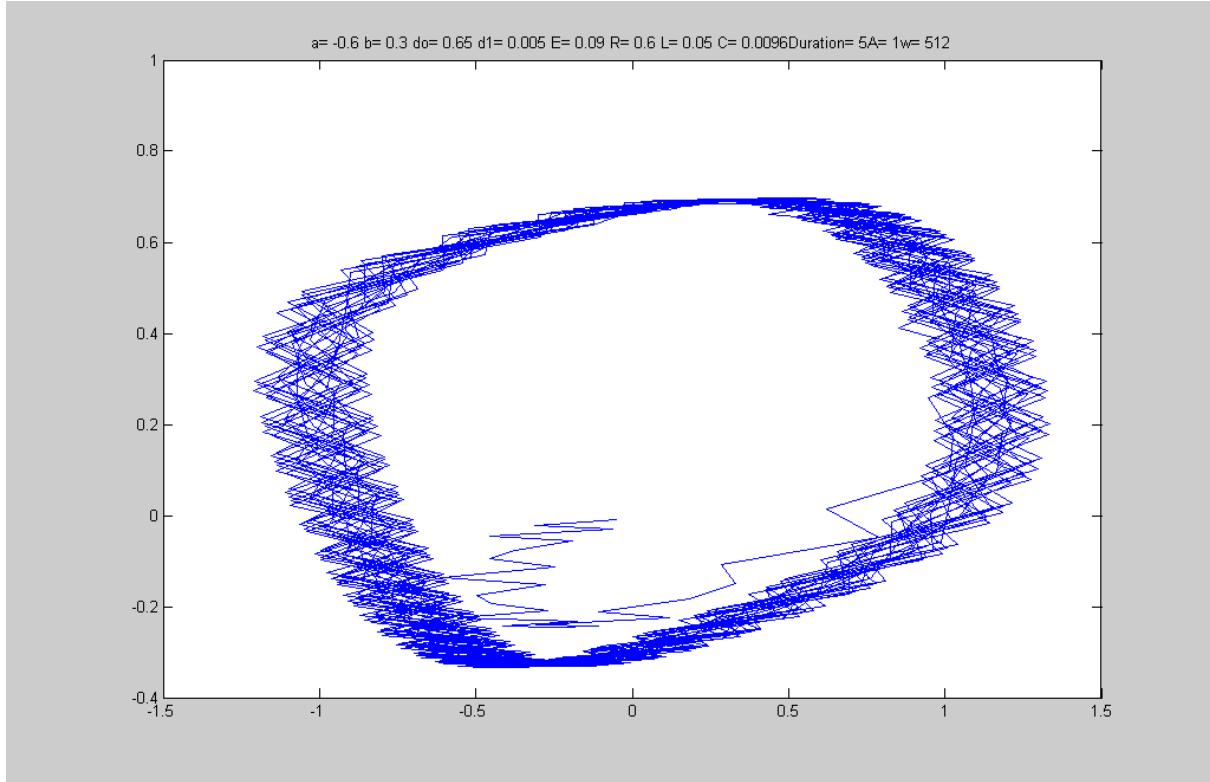


Figure:V(t)

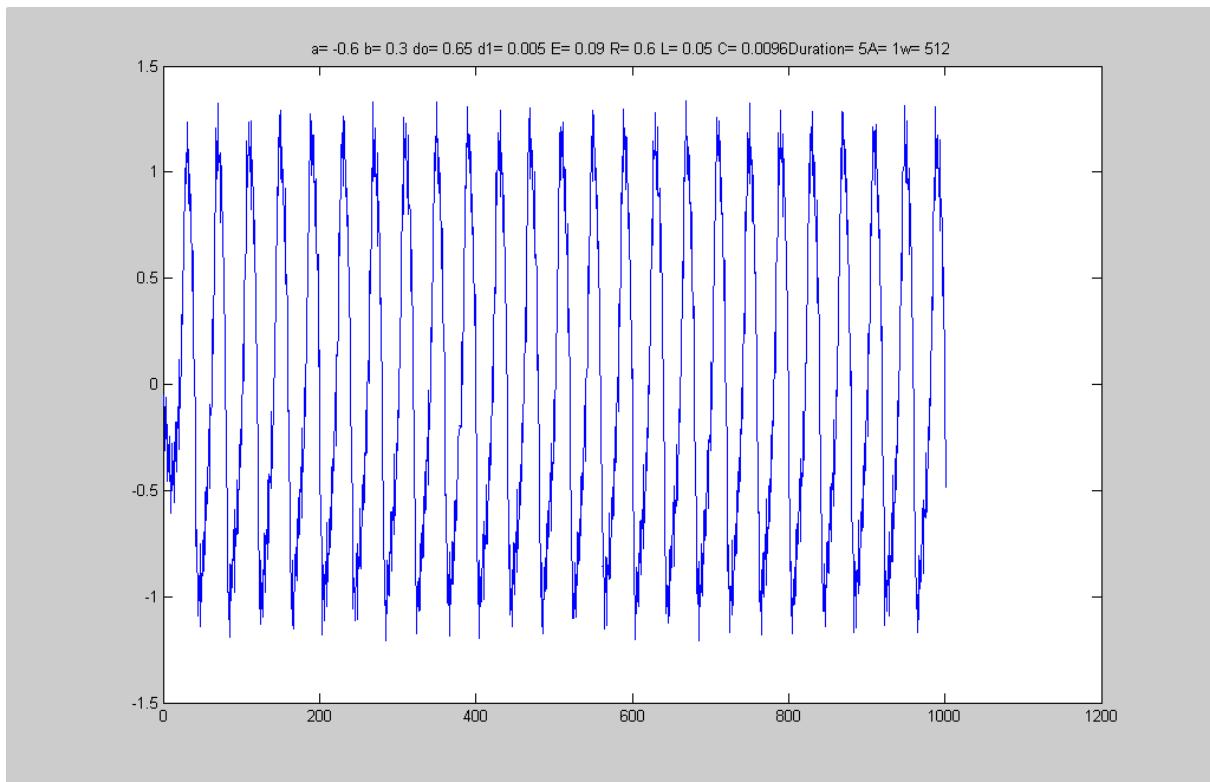
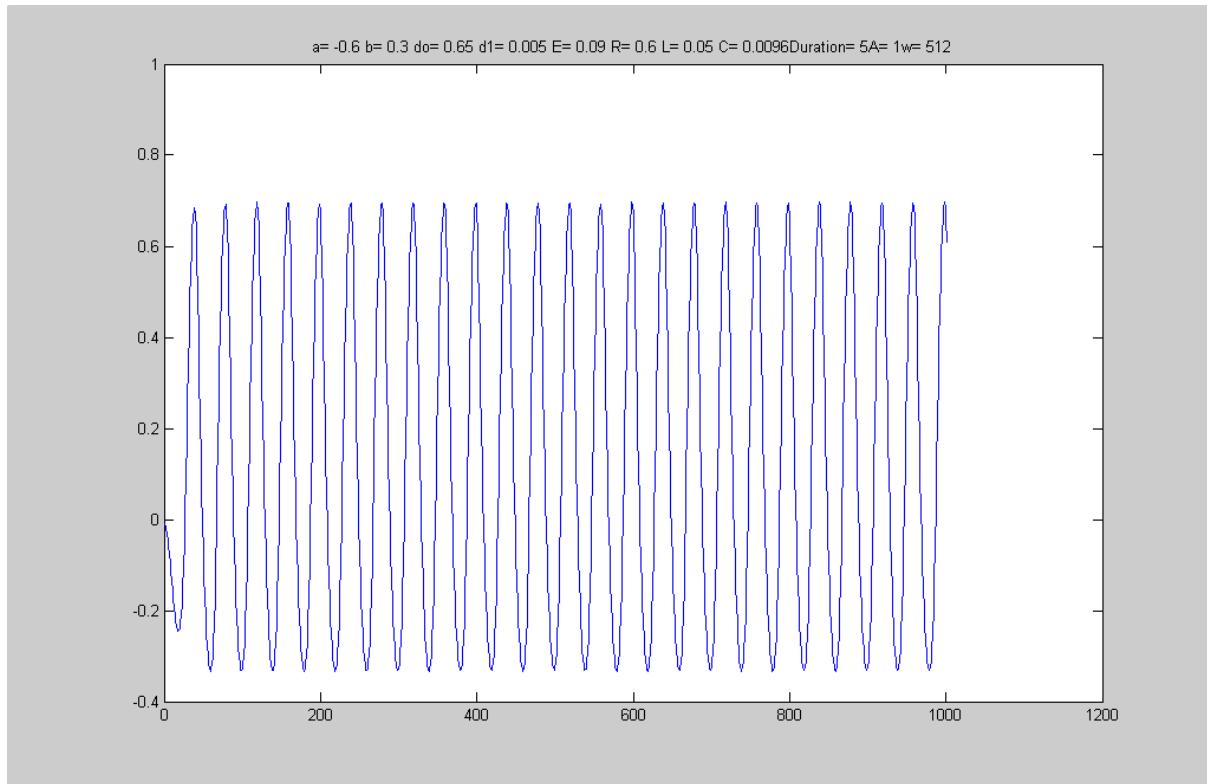
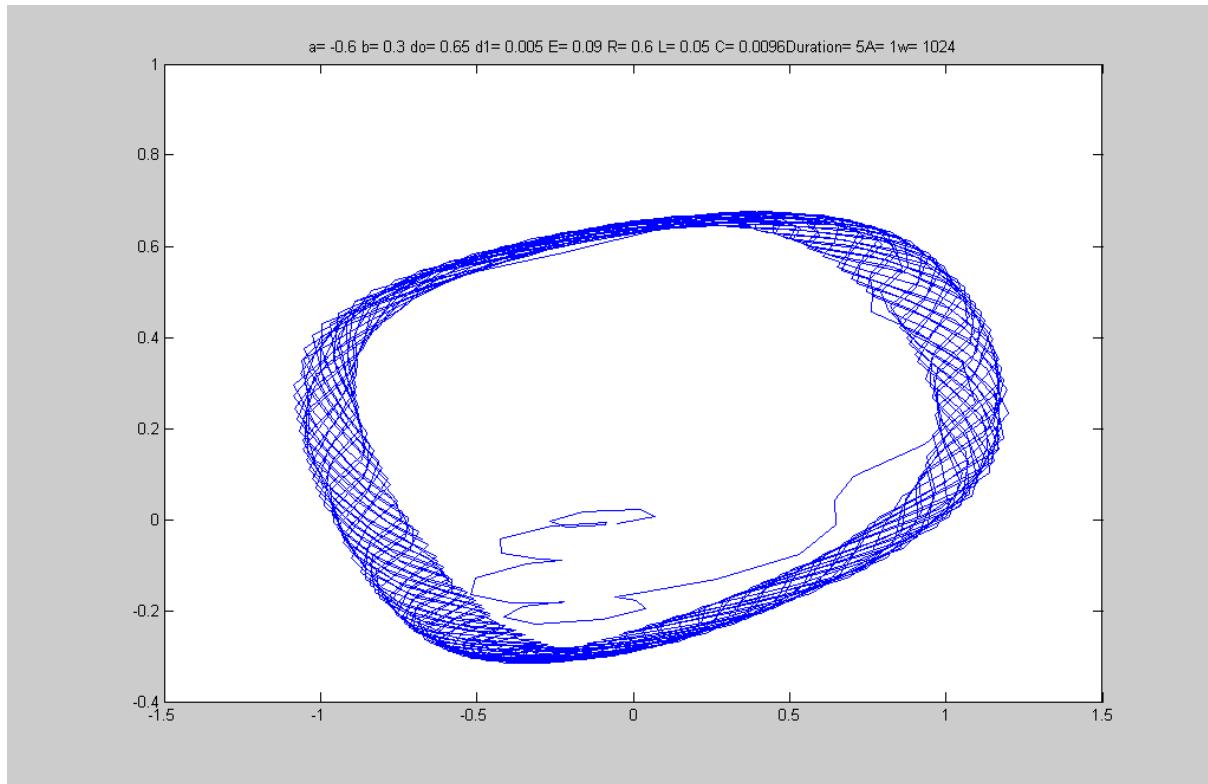


Figure:I1(t)

One industrial case is important,I think about the power control of laser(ousta loup france**) by the control of amplitude and frequency ratio; w and A.I laught to thing of france orsay problem.In the film video of Michael Jackson,he sets many transformation of his body,like the mind transformation of proshe-chao to complex figures.**

8) $w=1024$

figure:plan(V,I1)

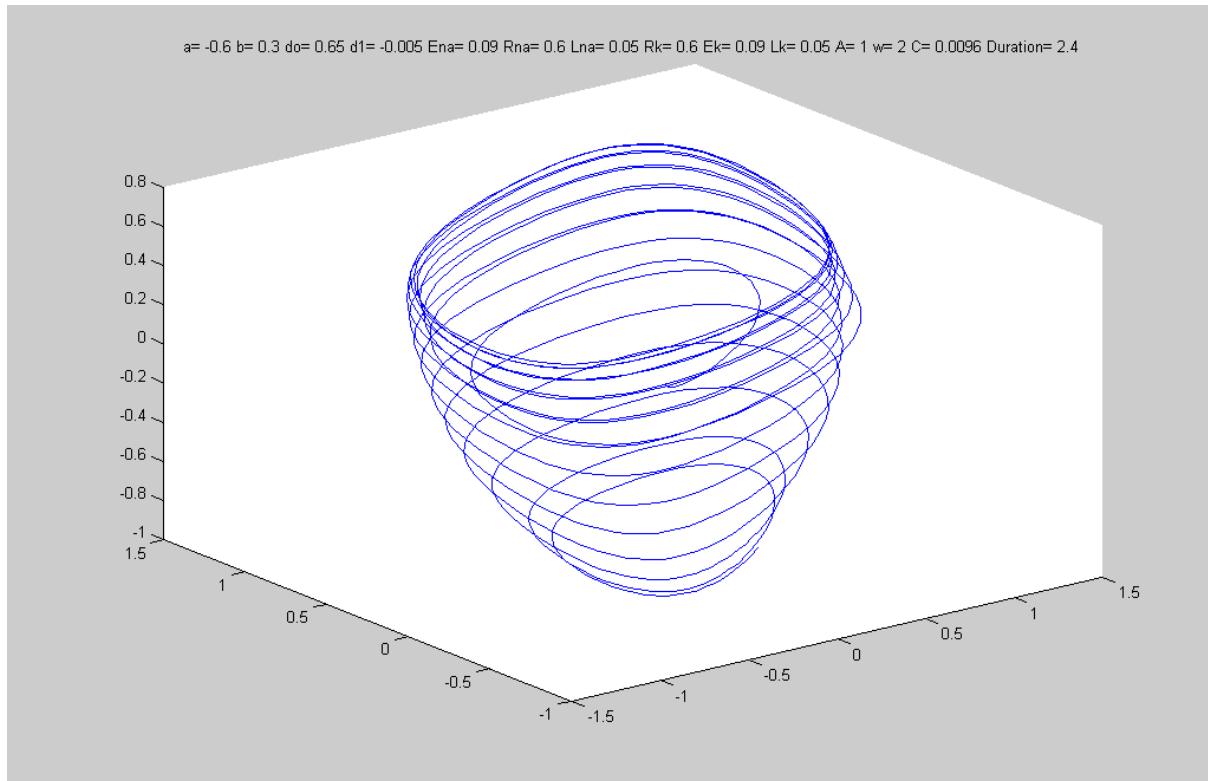


2)Investigation porshe-chao from VI1 to VINAIK in dimension
3.

**a= -0.6;b=0.3;do=0.65;d1=0.005;Ena=90mV;Lna=50mH;
Rna=0.6;D=2400ms;N=1000;Lk=50mH;C=9600 μ F;
Ek=90mV;w=2;A=1**

I gon on doubling frequency.

Figure:plan(V,Ina,Ik)



The porsche-chao is corresponded in dimension 3 to boat-chao.
figure:V(t)

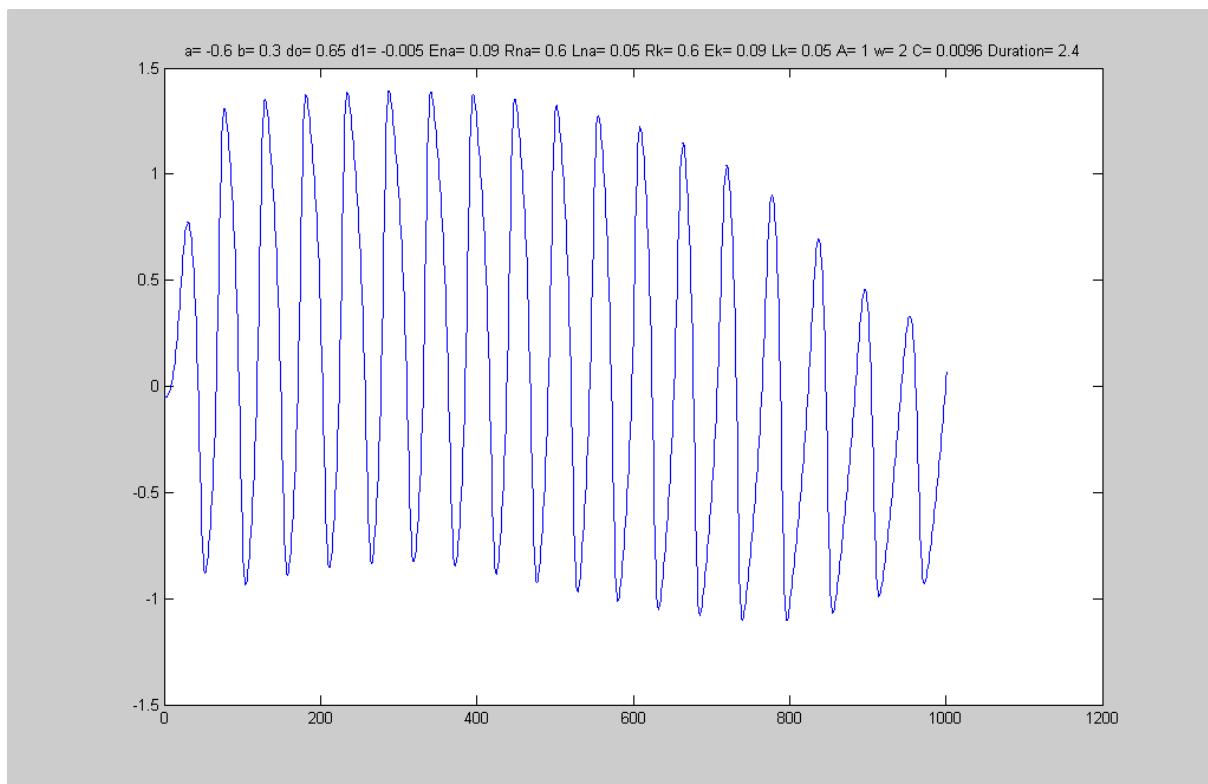
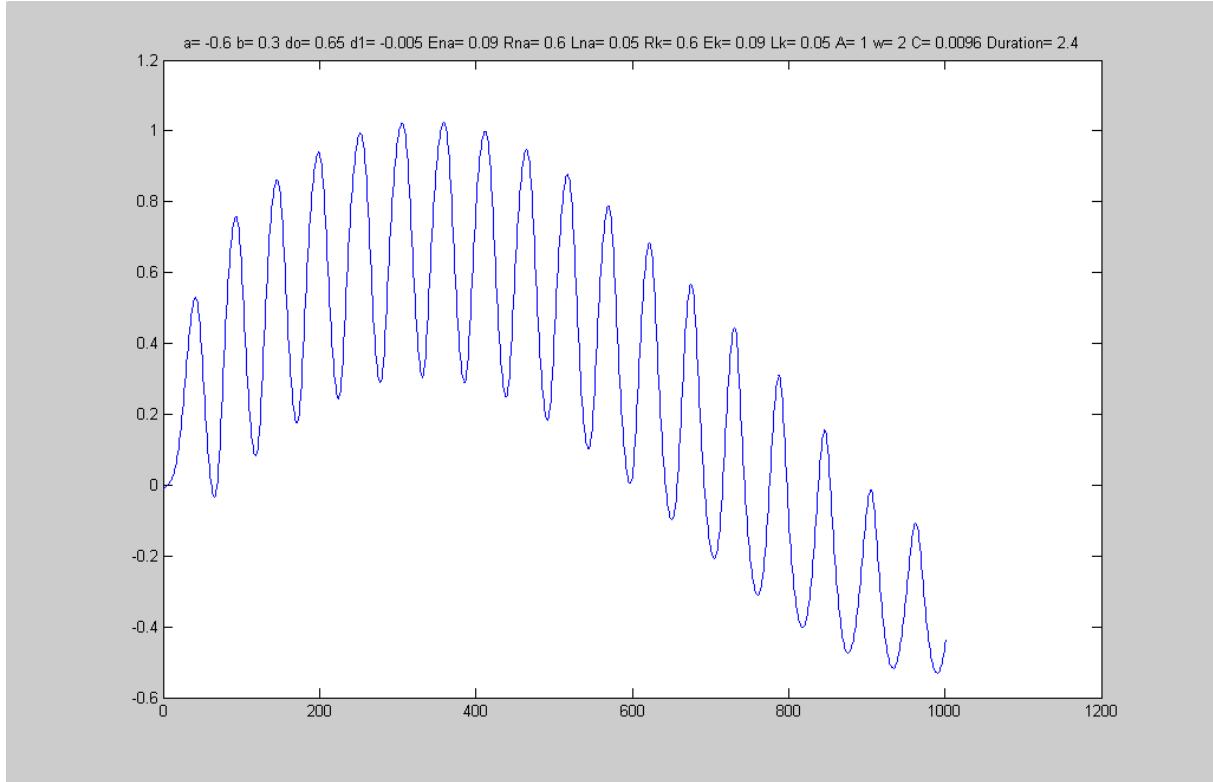
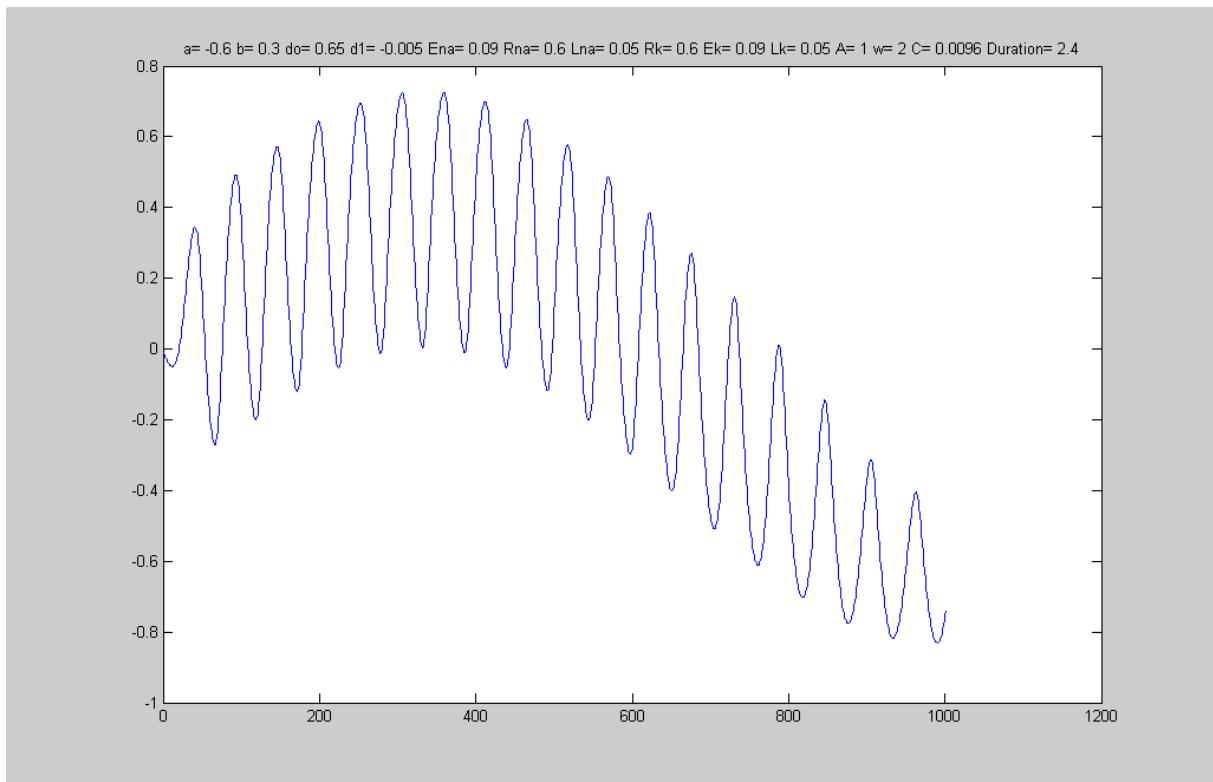
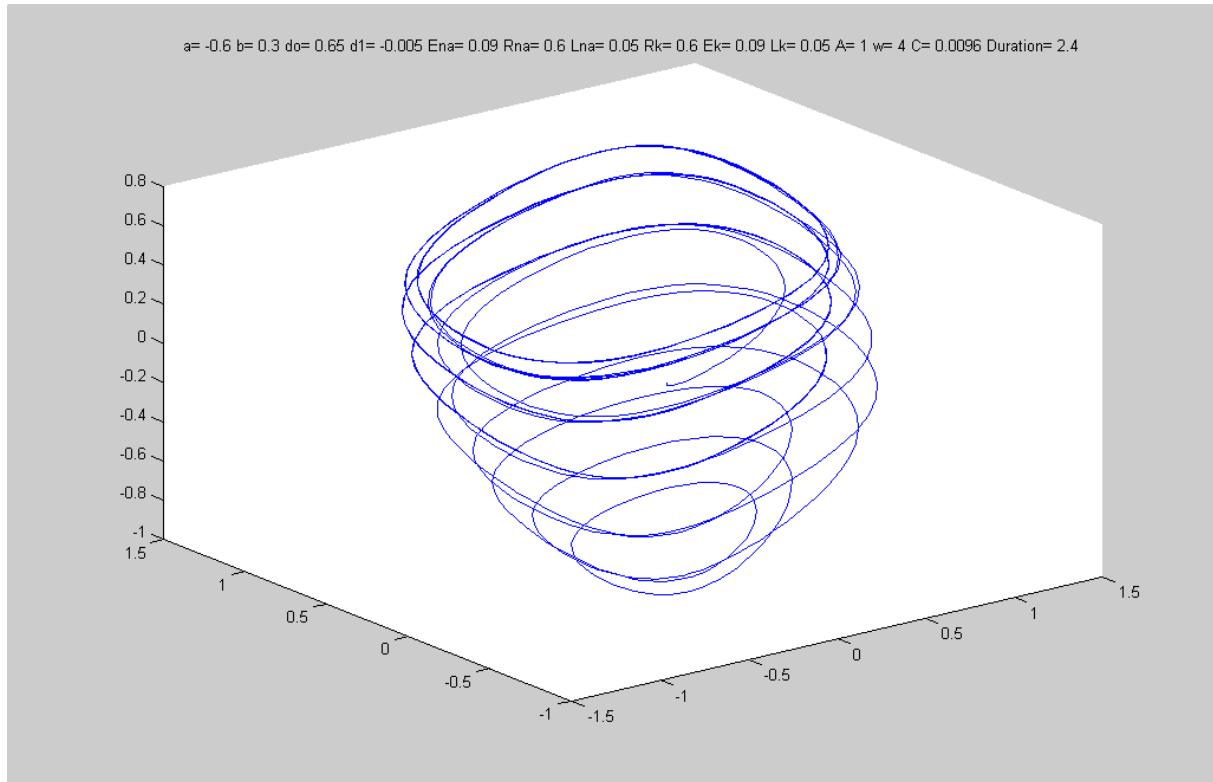


Figure:Ina(t)**Figure:Ik(t)**

2) w= 4

figure:plan(V,I_a,I_k)



Figure;V(t)

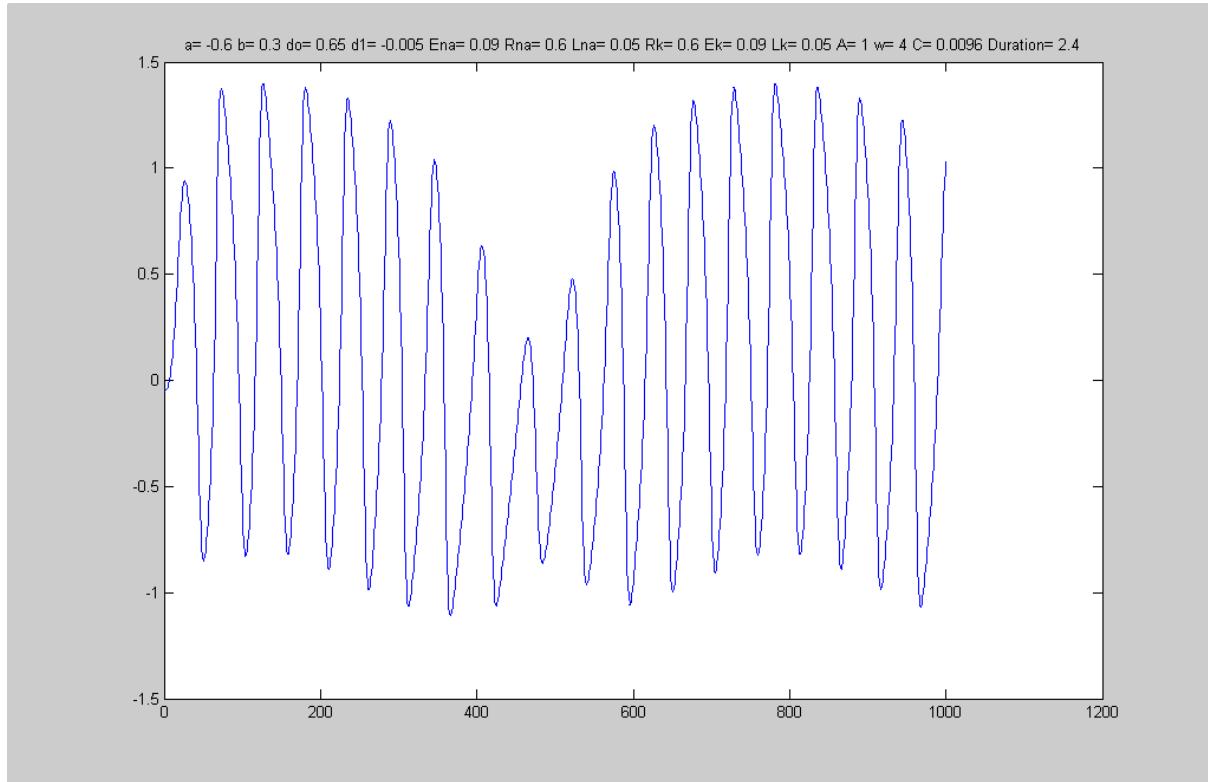


Figure:Ina(t)

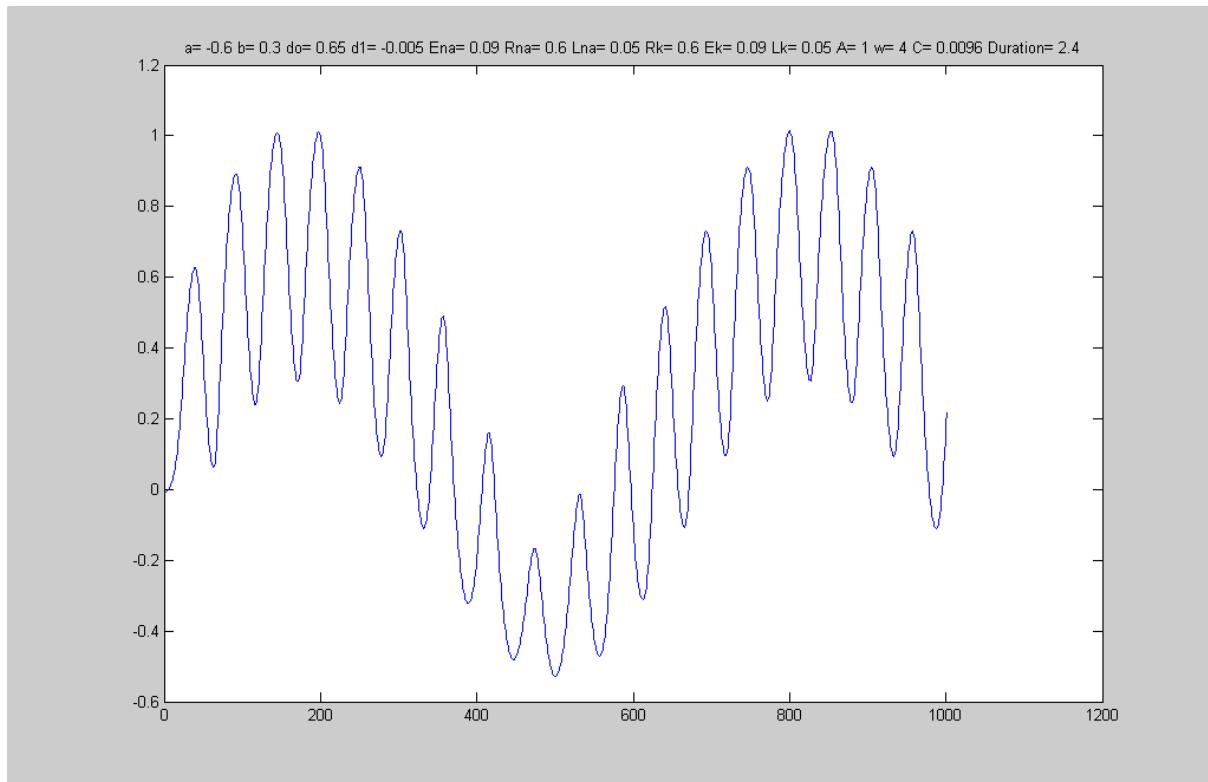
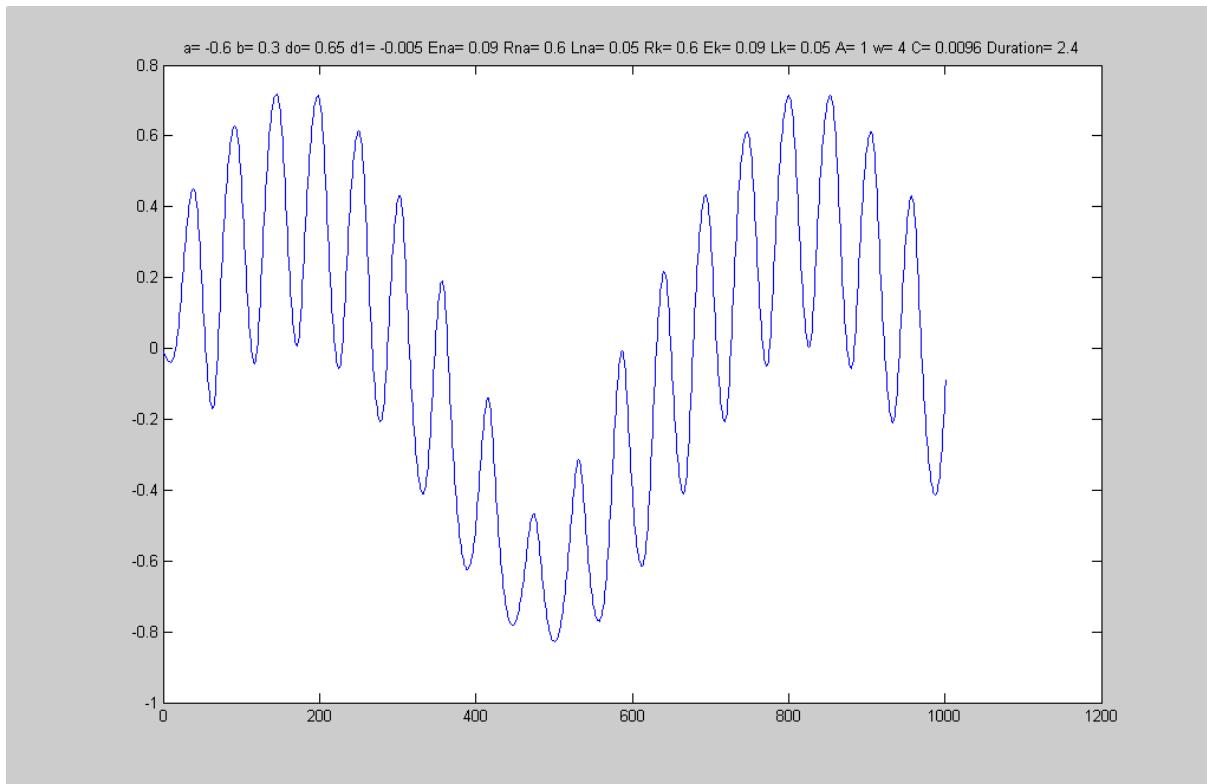


Figure:Ik(t)

3) w=8
figure:plan(V,Ina,Ik)

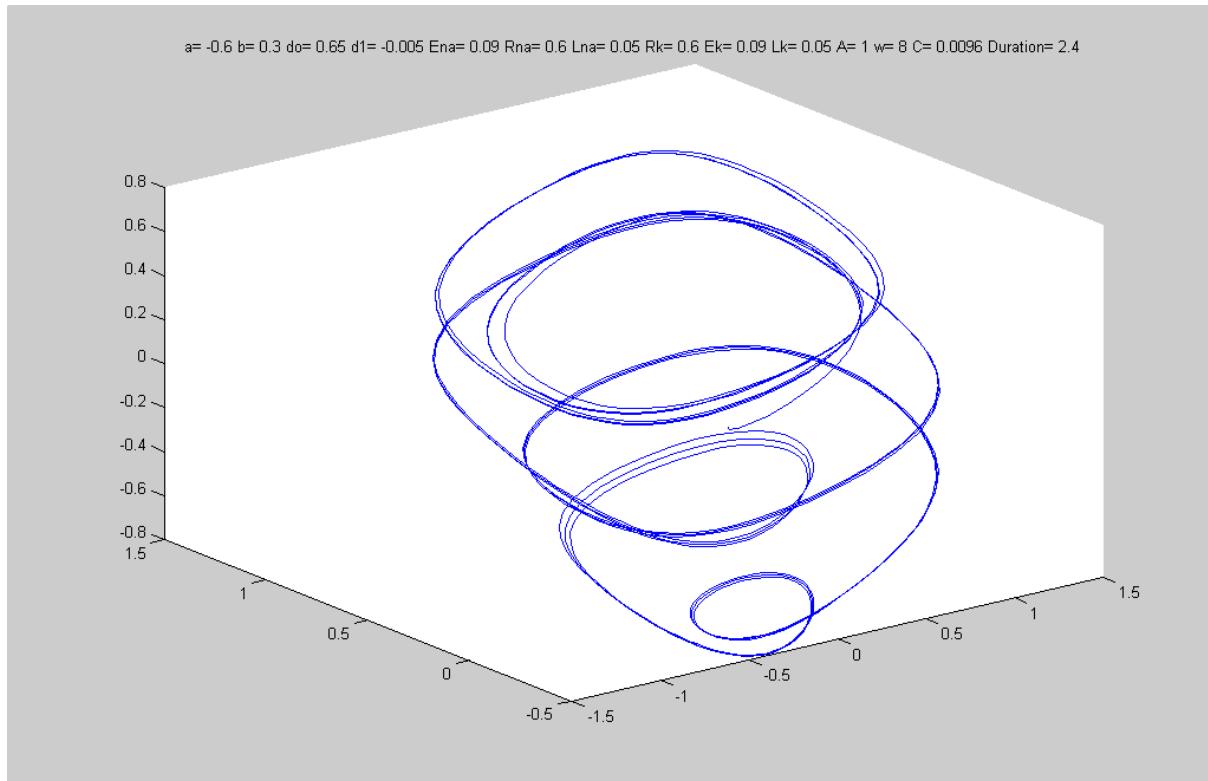


Figure:V(t)

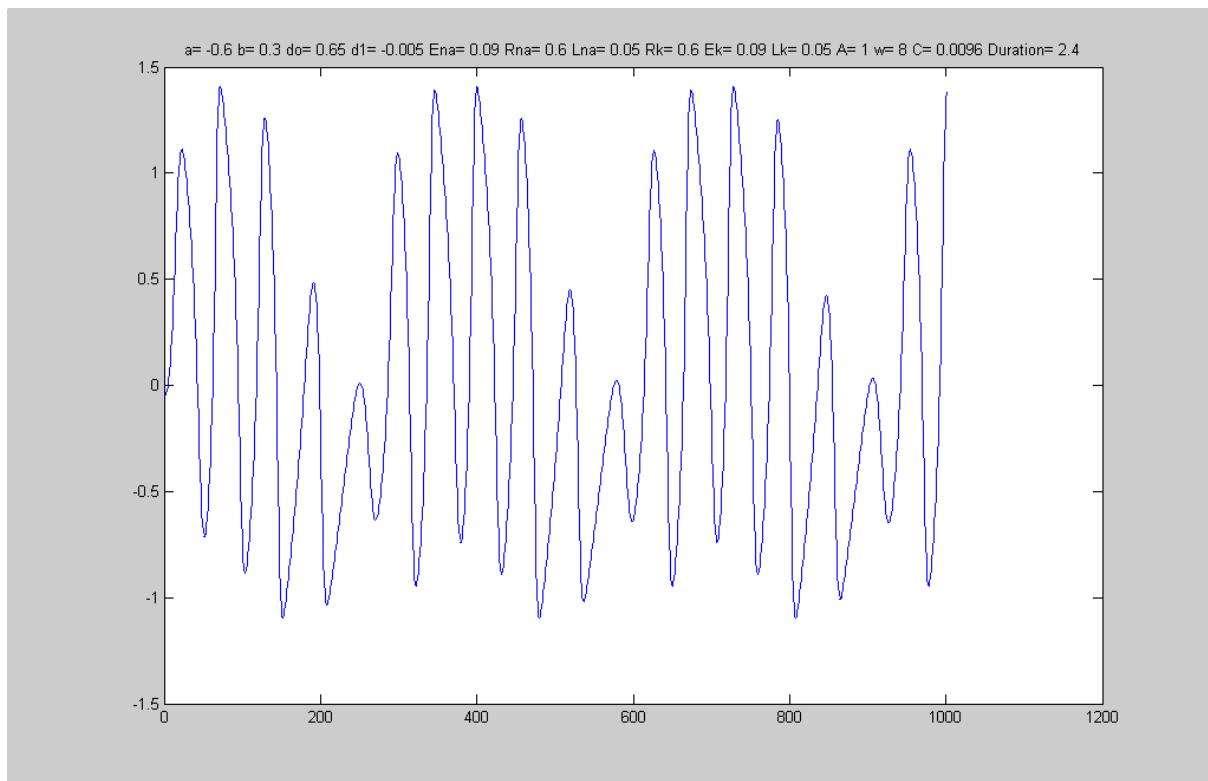
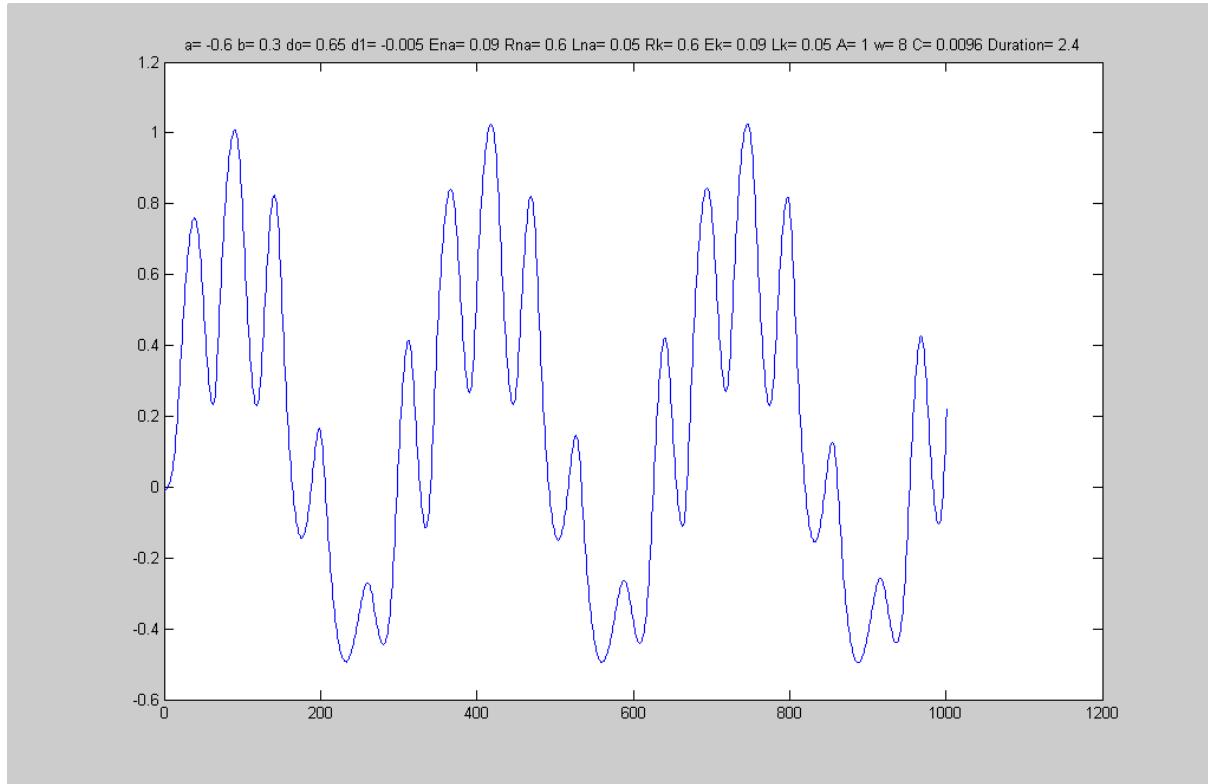
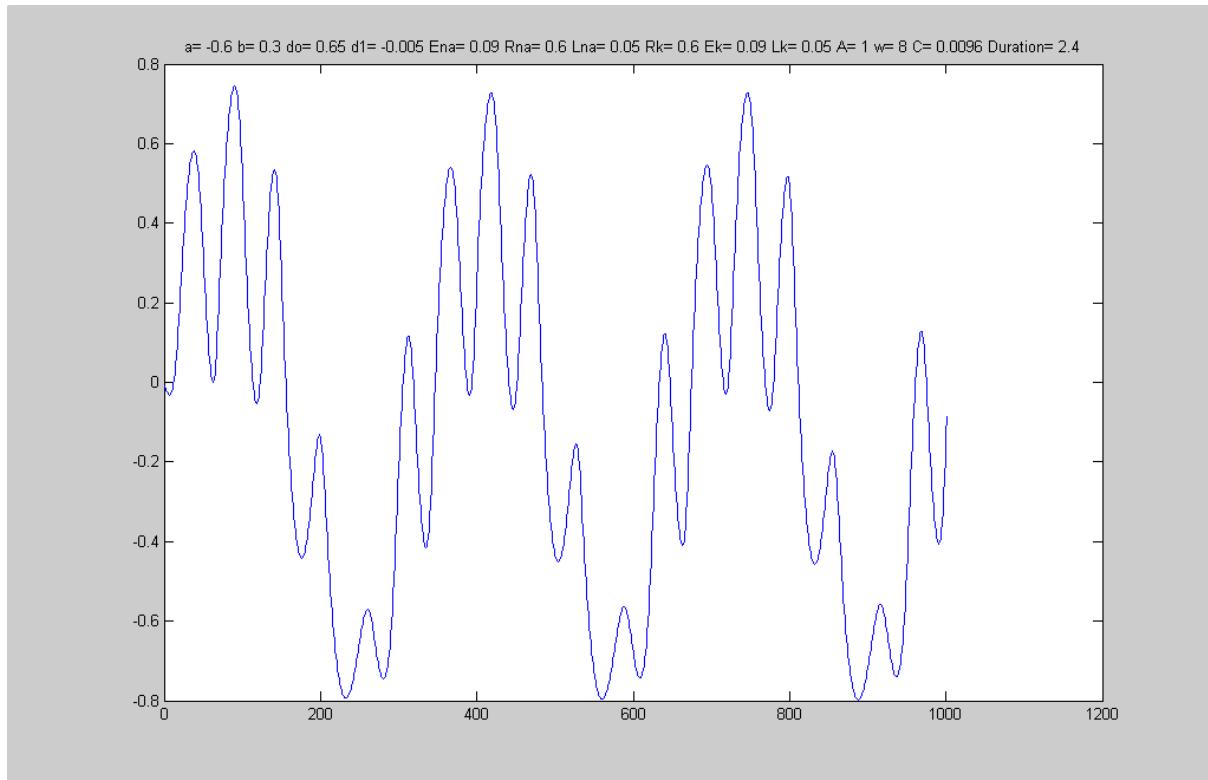


Figure:Ina(t)**Figure:Ik(t)**

4) w= 16
figure:plan(V,Ia,Ik)

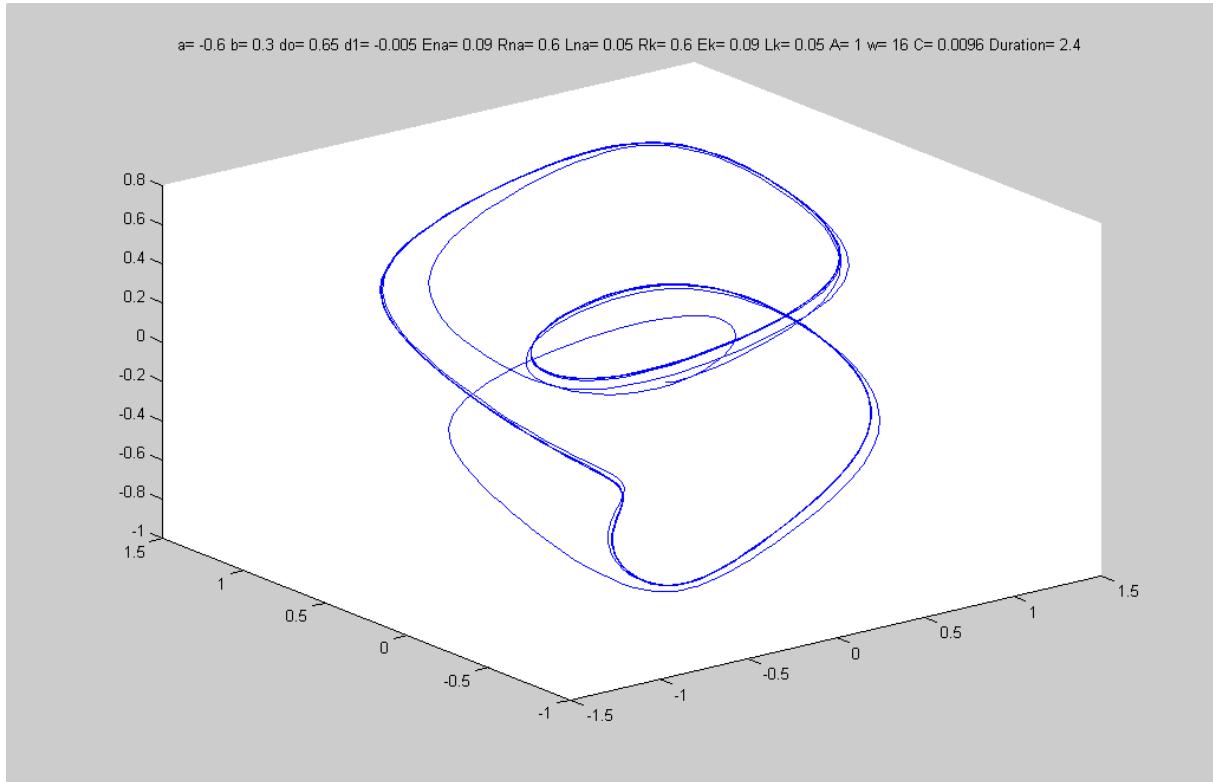


Figure:V(t)

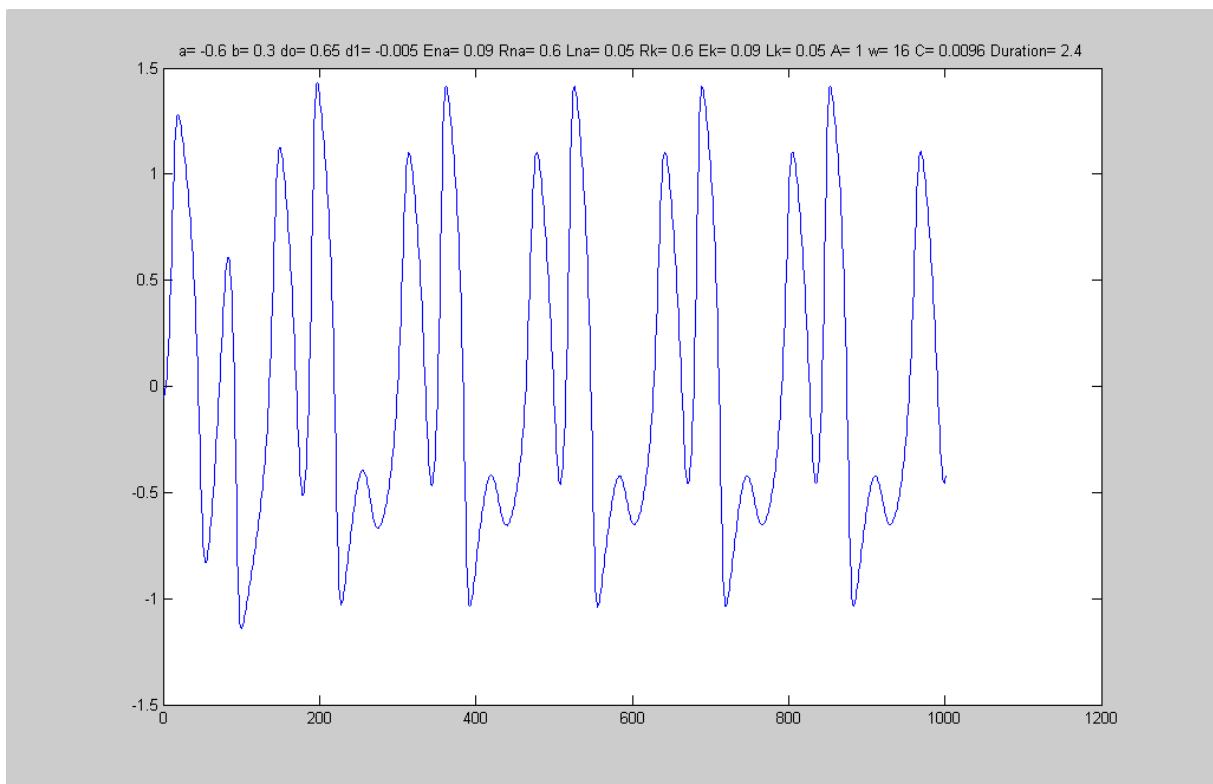
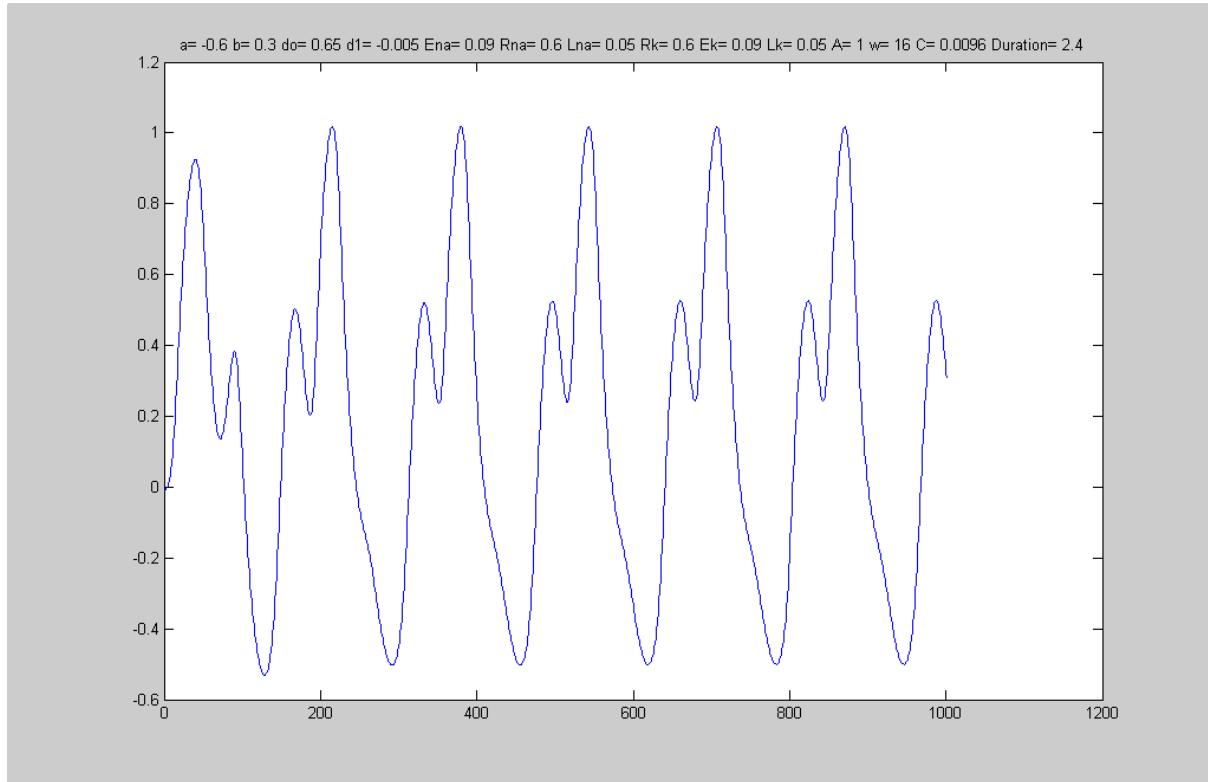
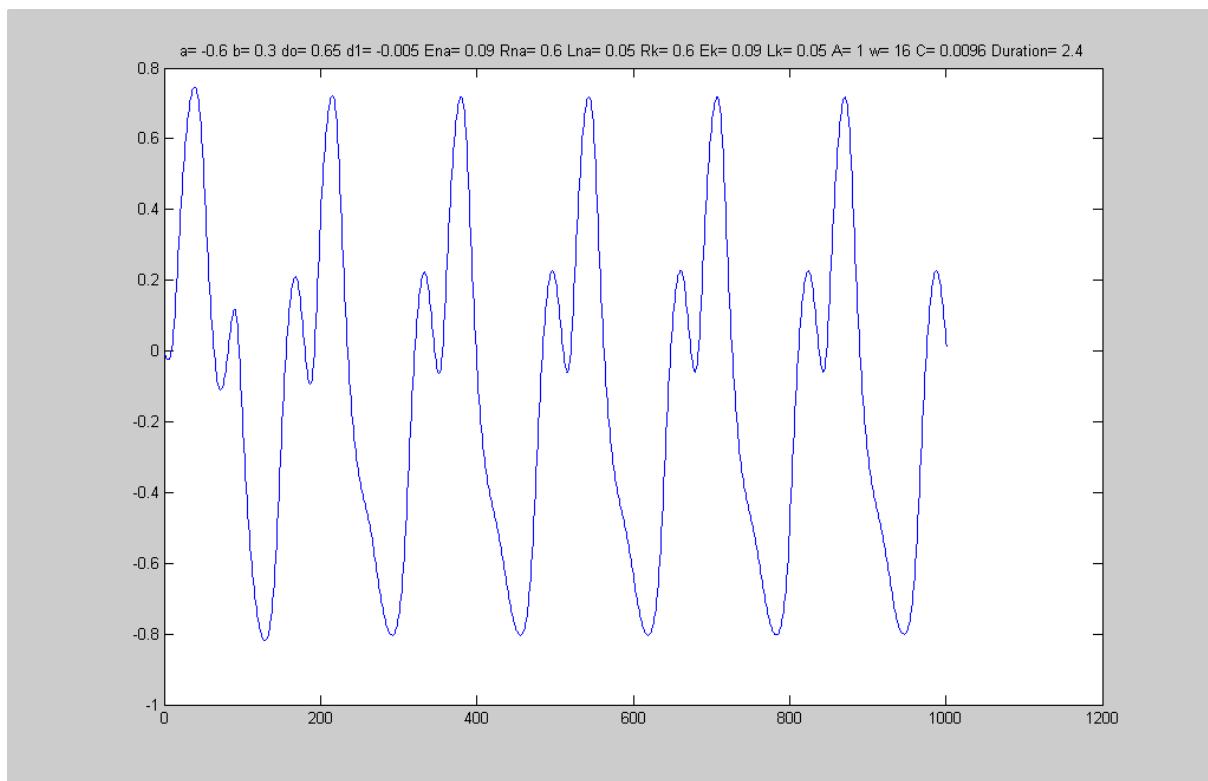
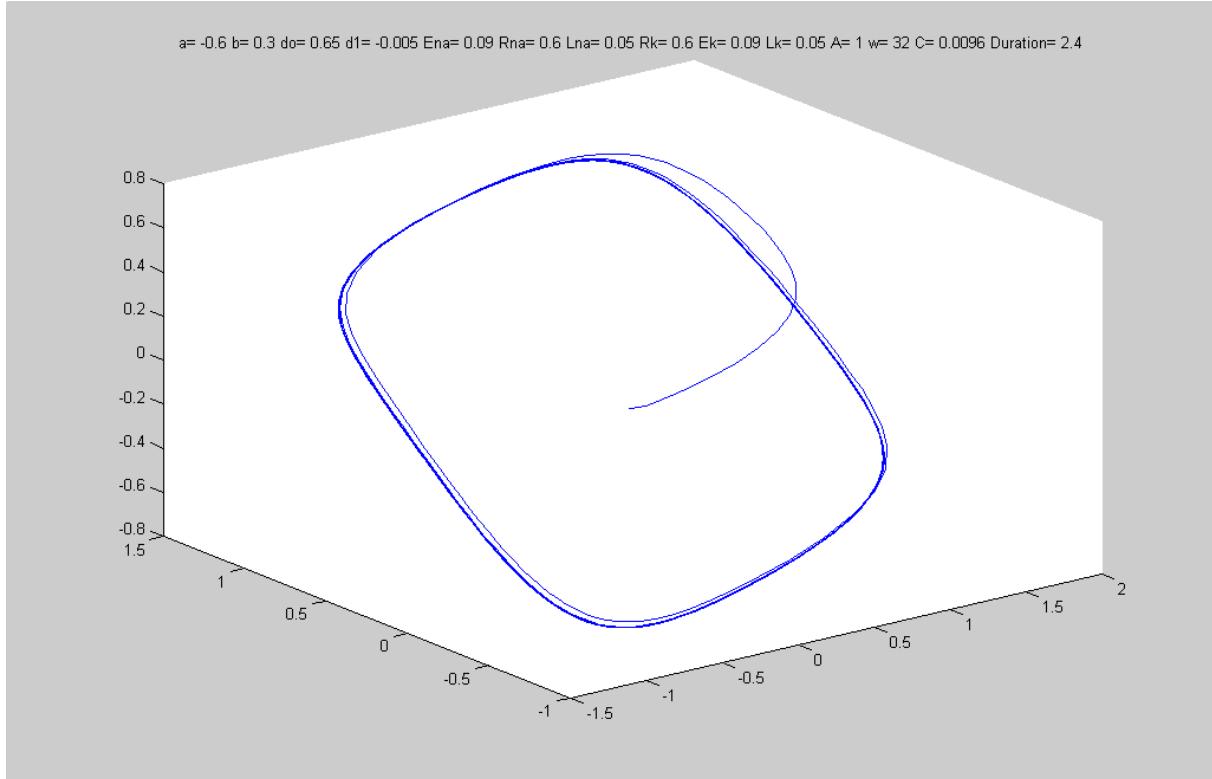


Figure:Ina(t)**Figure:Ik(t)**

5) w=32
figure:plan(V,I_{na},I_k)



6) w=128
figure:plan(V,I_{na},I_k)

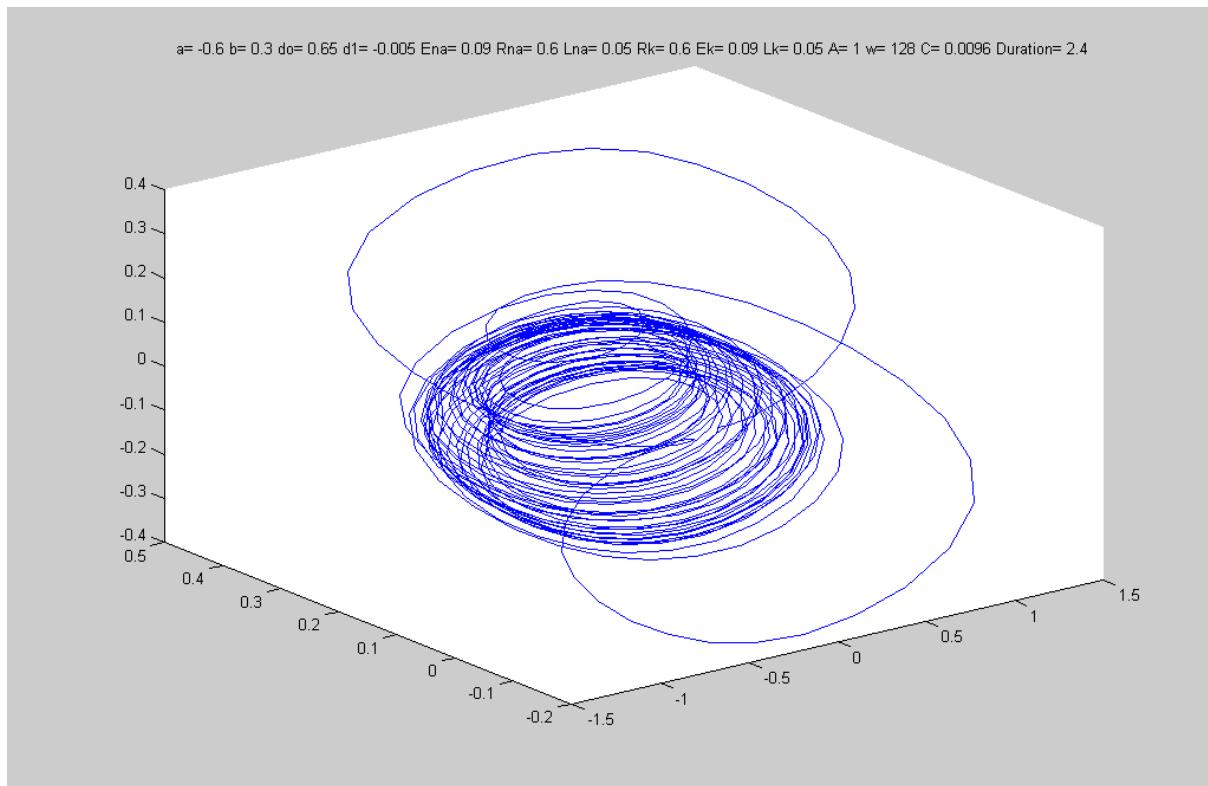


Figure:V(t)

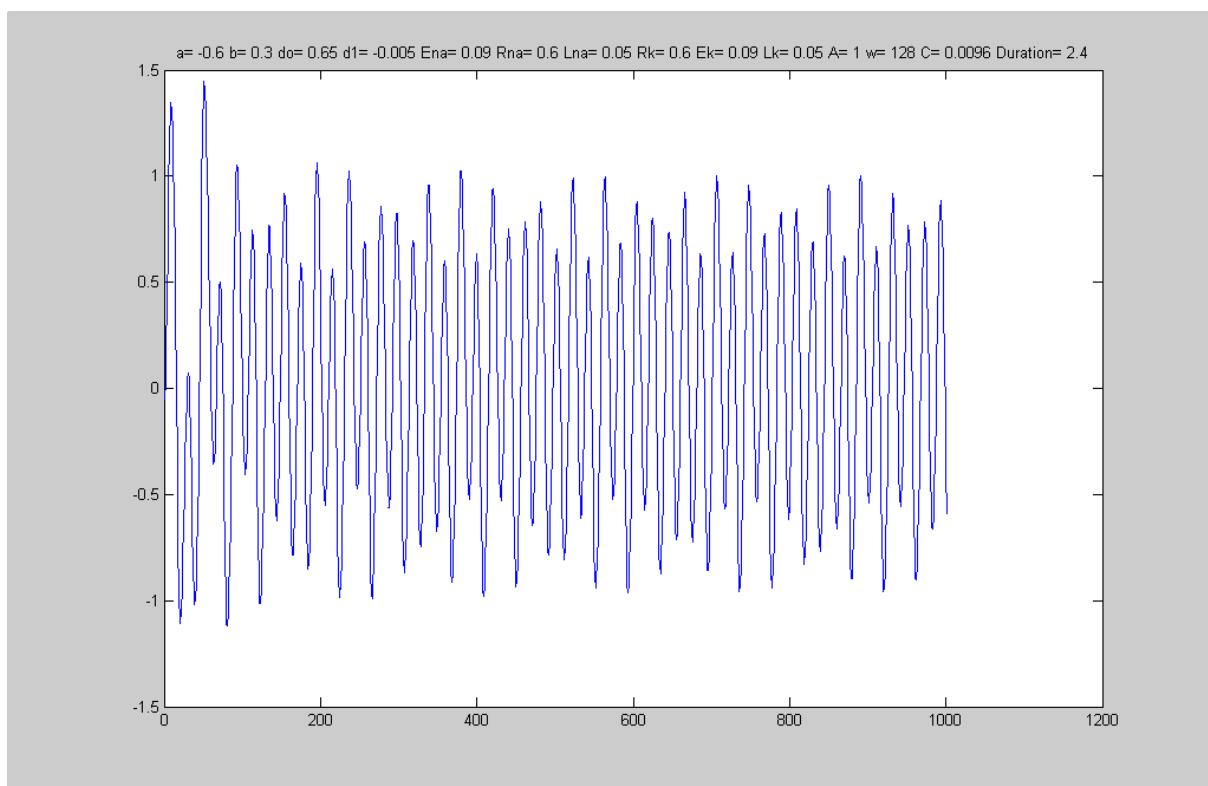
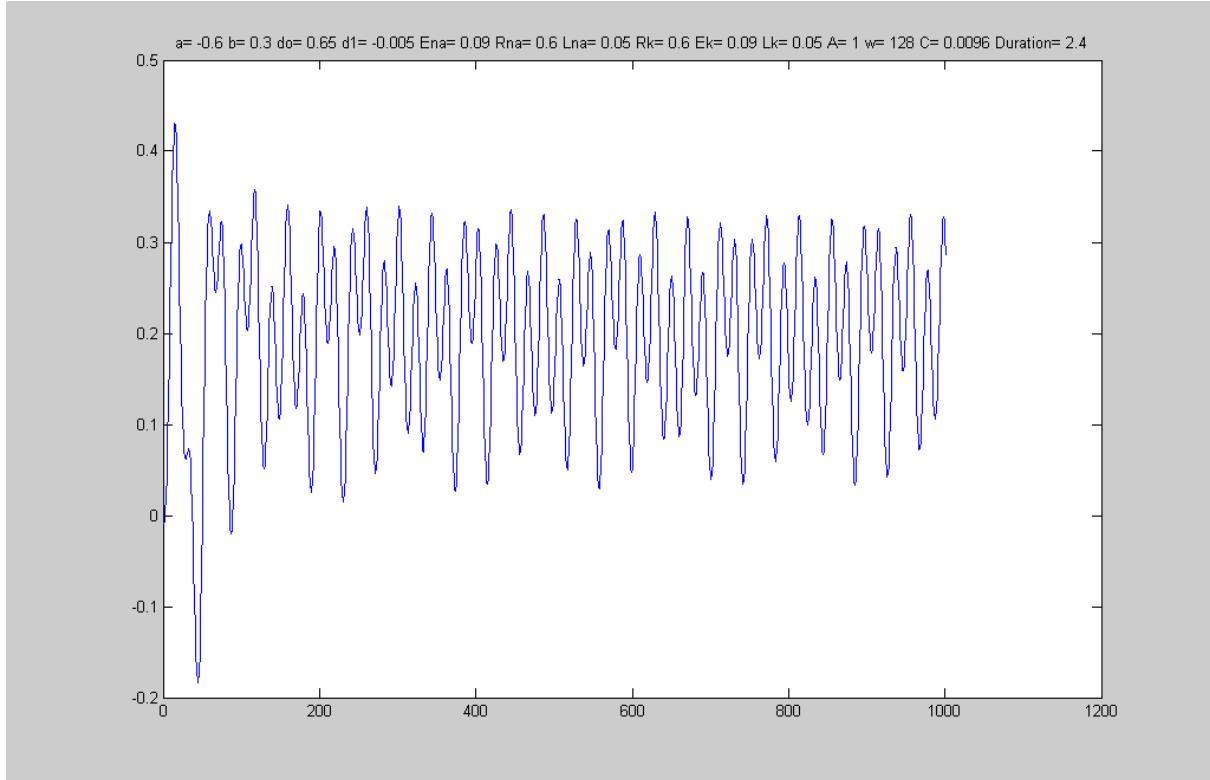
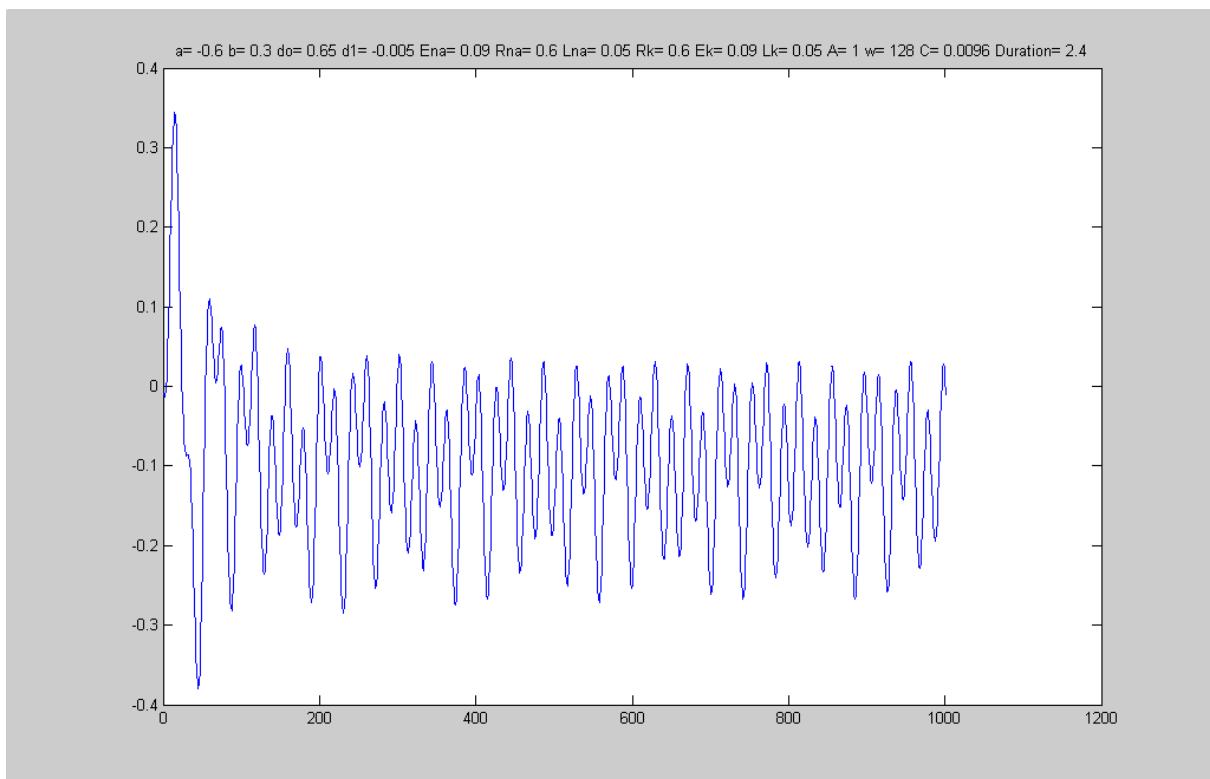


Figure:Ina(t)**Figure:Ik(t)**

7) w=256
figure:plan(V,I_{Na},I_K)

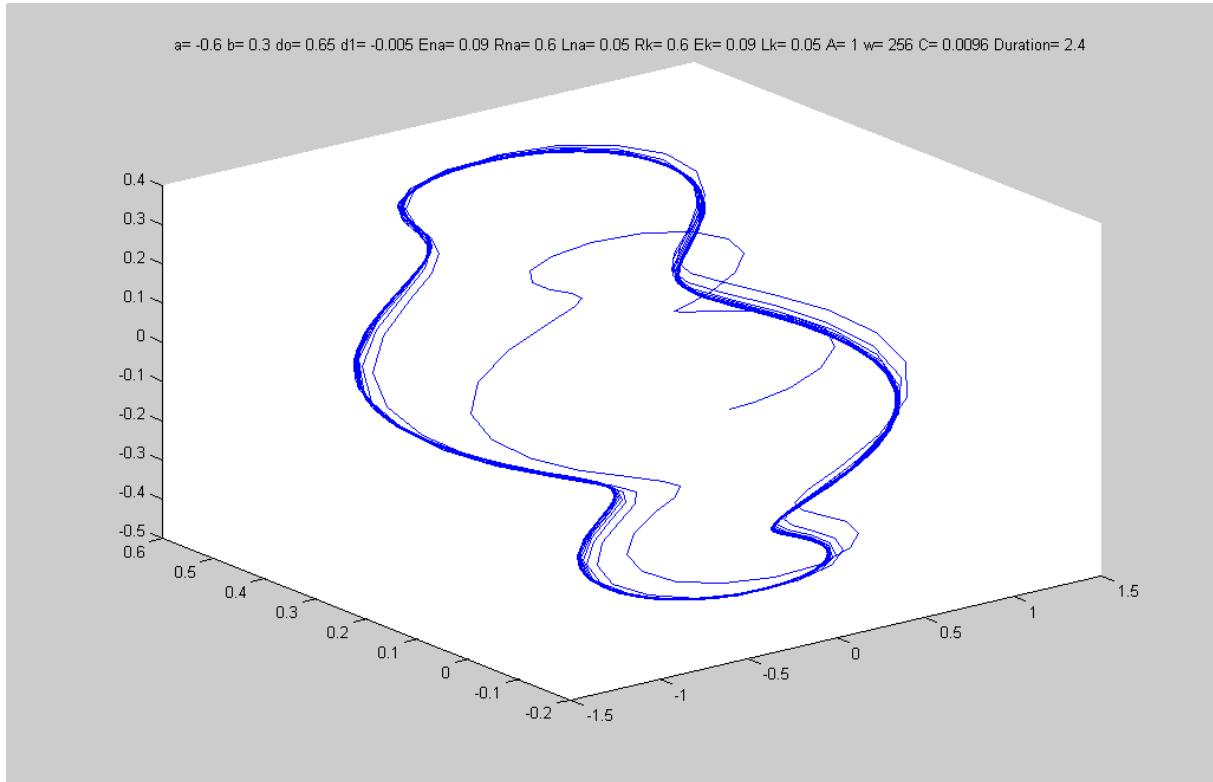


Figure:V(t)

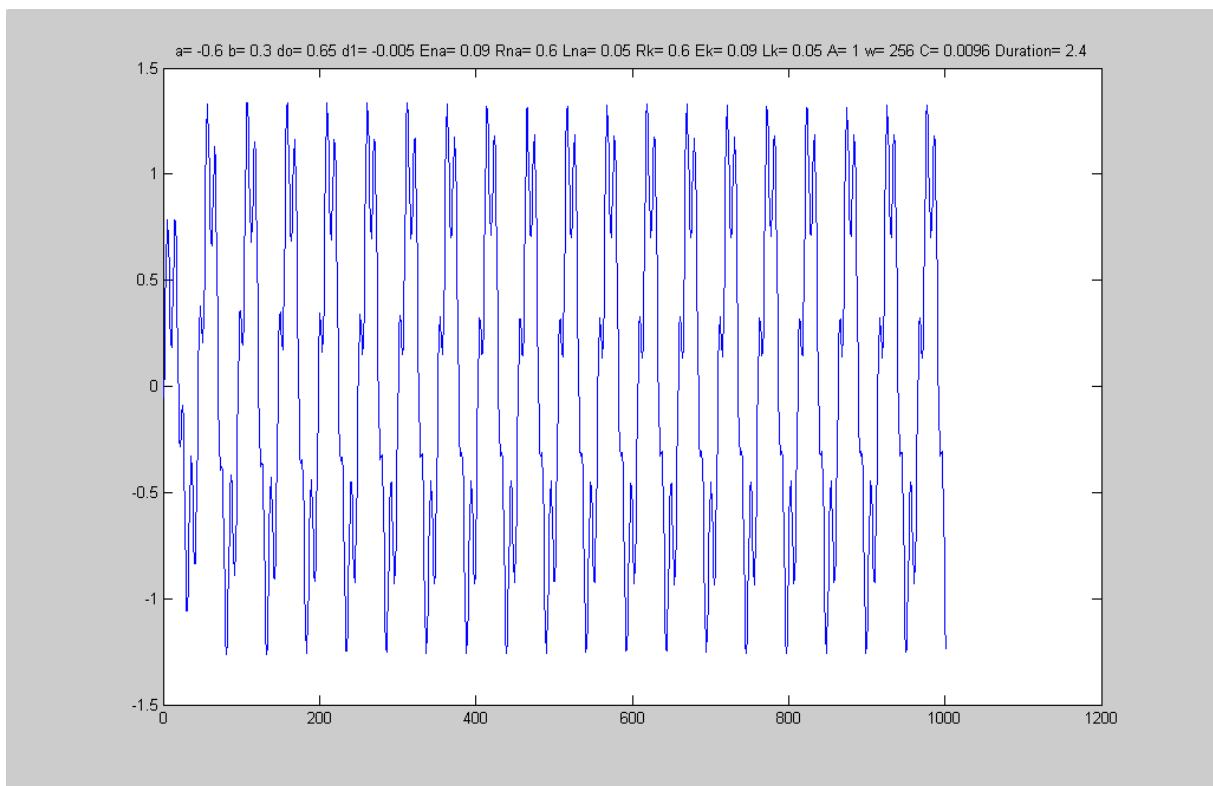
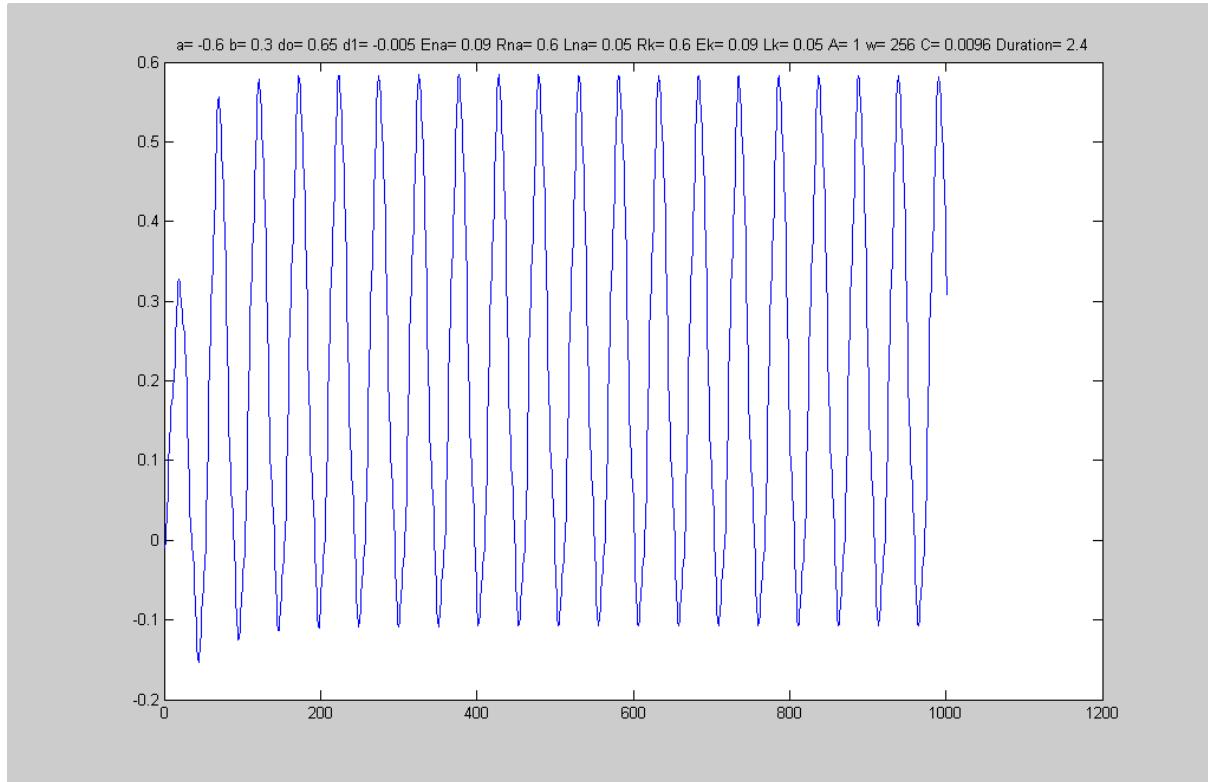
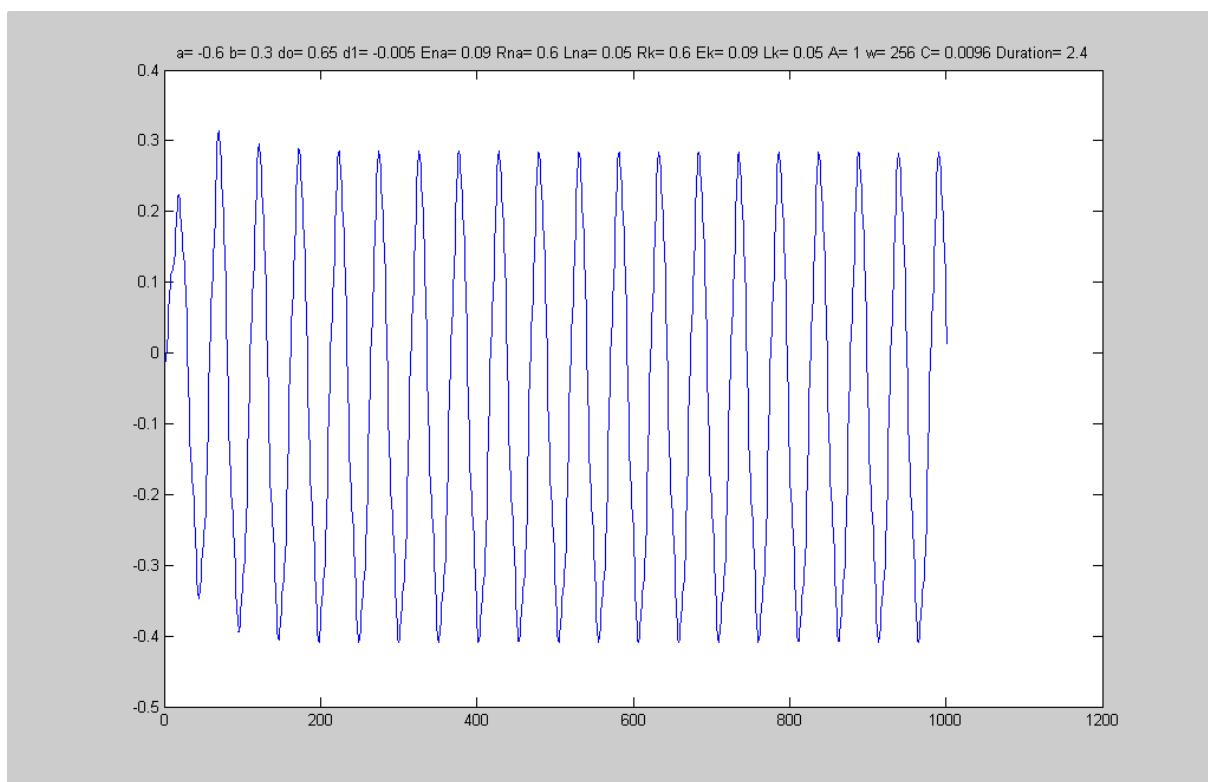


Figure:Ina(t)**Figure:Ik(t)**

8) w=512
figure:plan(V,Ia,Ik)

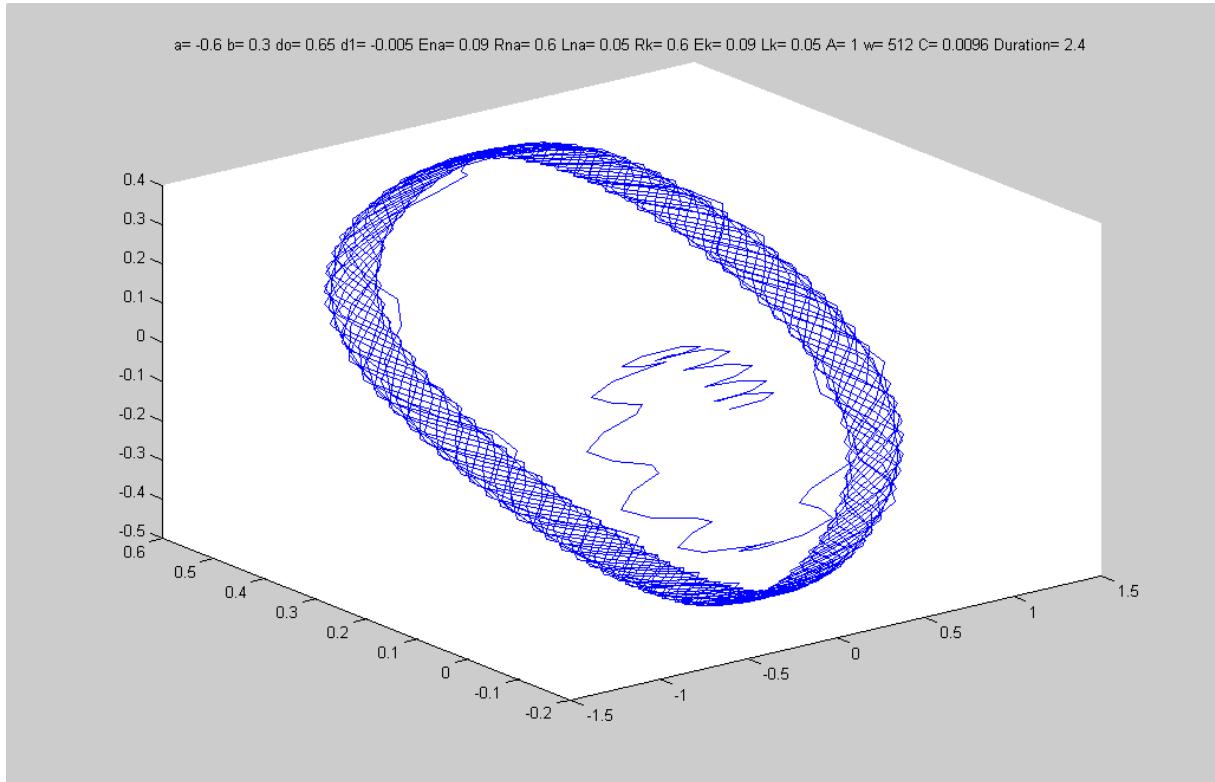
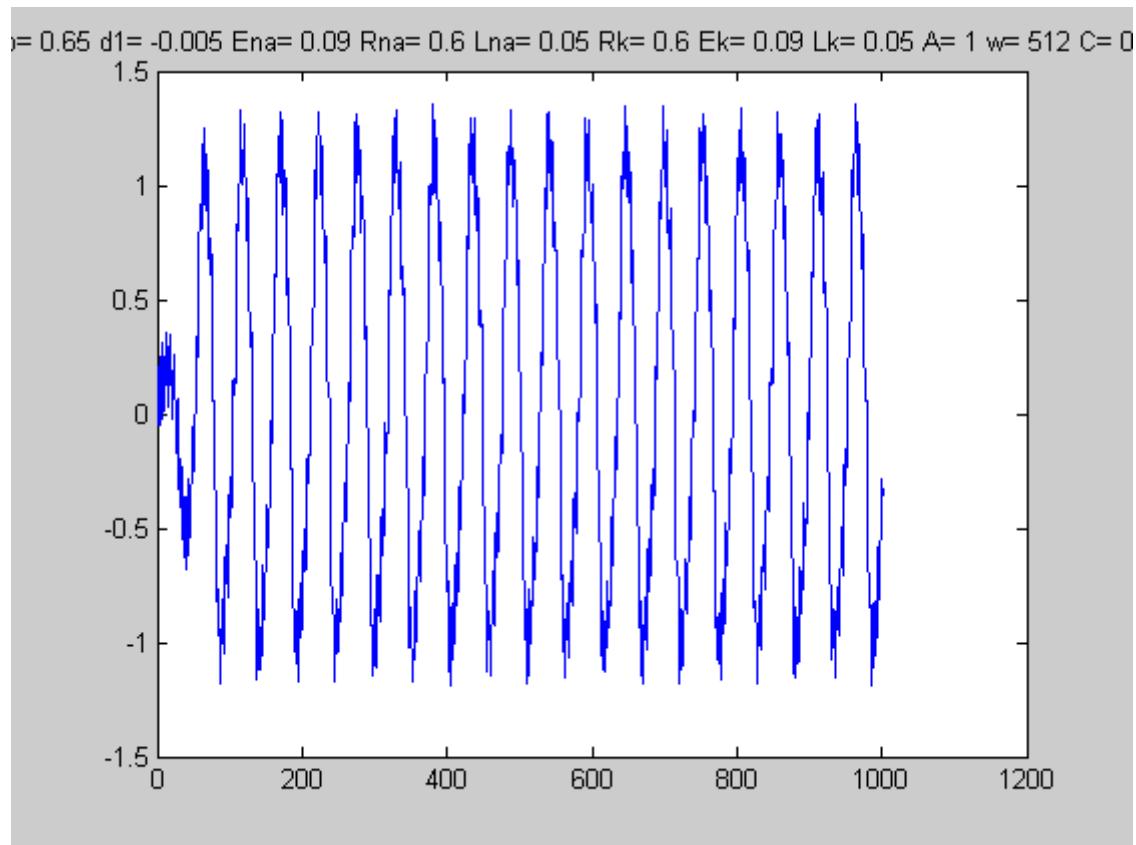
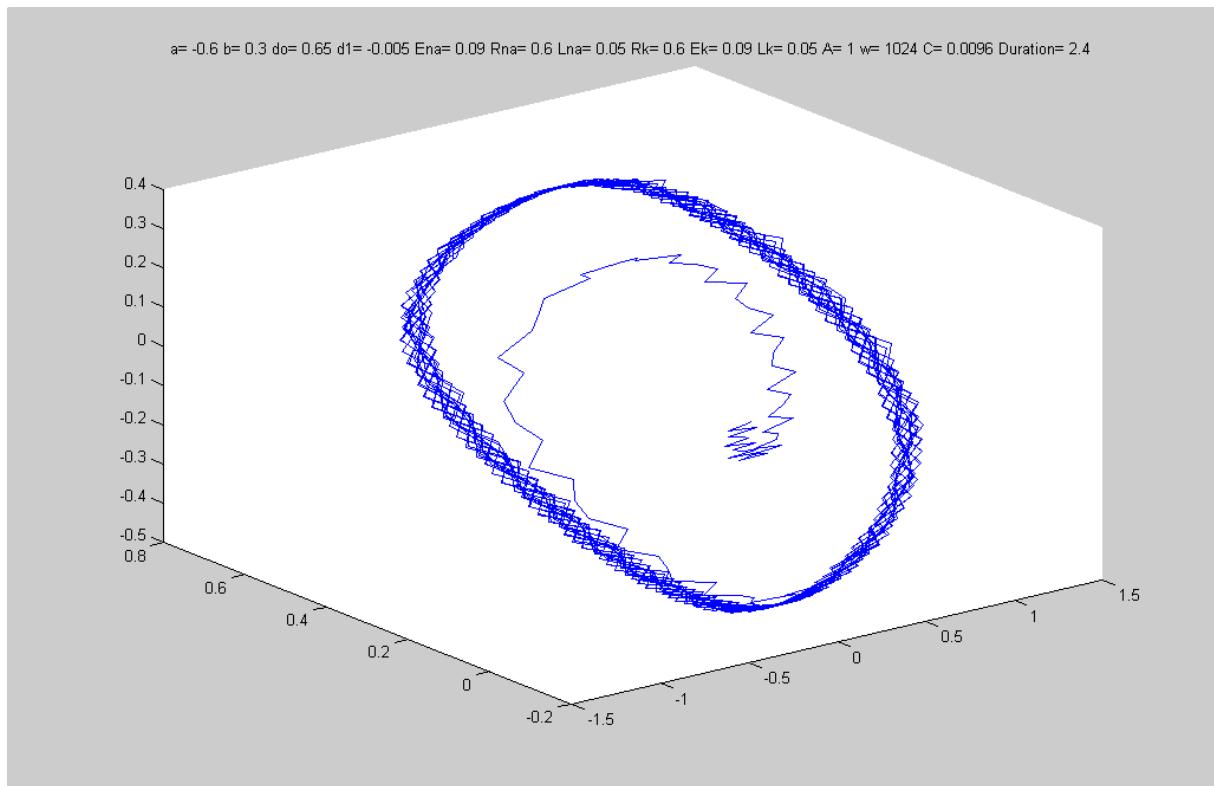


Figure:V(t)



9) $w=1024$
figure:plan(V,I_{na},I_k)



GENERAL CONSIDERATIONS ABOUT MY CHAO JOURNAL DATABASE

**The fundamental results of chao theory are these problems:
order of chao(polynoms of jones),natures of attractors;the
coefficients of Ijapunov,the correlative dimension,mandelbrot.**

One theorem of chao is :

**suppose to have one signal $X(t)$ sampled, $X(tj)$,we the define
heaver side function $H(\varepsilon)$,**

A)when $\varepsilon > 0$ $H(\varepsilon)=1$

B) when $\varepsilon < 0$ $H(\varepsilon)=0$

If we set the heaver side function with r dimension vectors

$X(tj-1),\dots,X(tj-r)$

The correlative function $C(\varepsilon) = \lim (1/n^2)H(\varepsilon - (X_j - X_{j+1}))$

$C(\varepsilon) = \varepsilon^d$

A)closed curve $C=1$

B)C integer example $C=2$ torus

C)C is no integer is case of strange attractor

**I would like to apologize to the prestigious workers in chao
theory.**

**I would like to express my great thanks to mathworks corp
Usa,who offer me licence of matlab and simulink R2007a,
R2007b,licence number 352210 in book program from
Meg Vuillez.**

**The next serie of my chao and heart database will be published
The next year,I want to say in 2010.**

