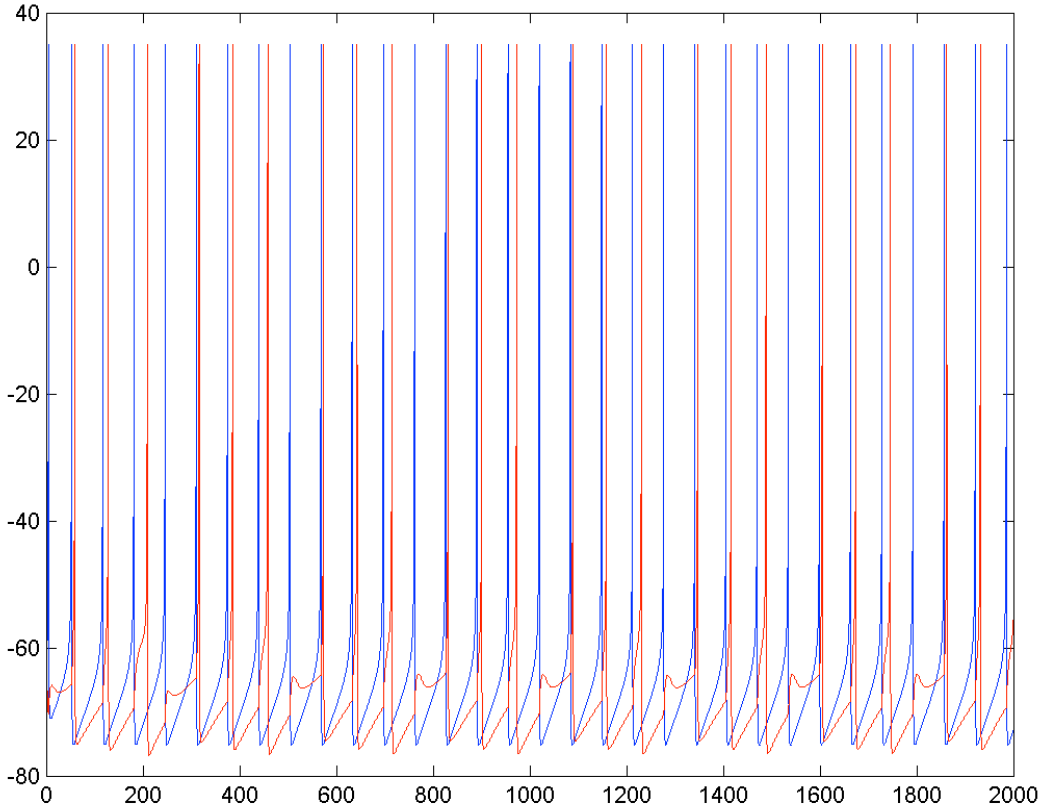
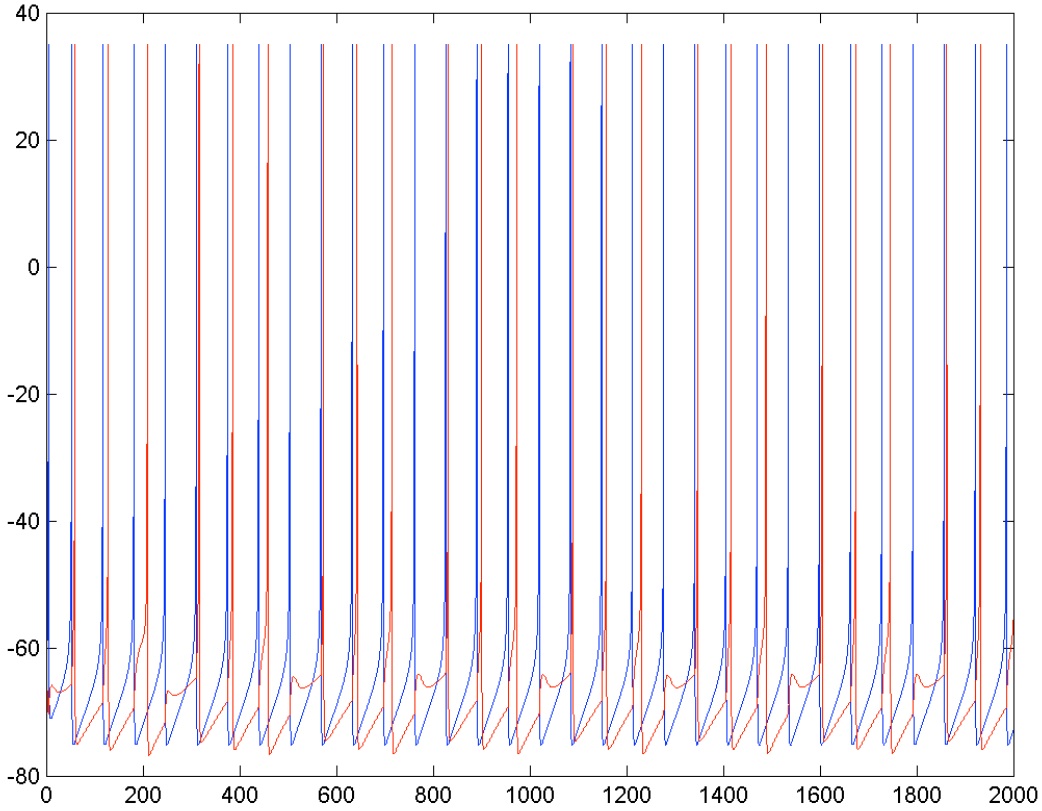
1a.

```
% q1a
% m:n integer divisor found, I1=4
% 1:1
% m:n integer divisor found, I1=5
% 1:1
% m:n integer divisor found, I1=6
% 1:1
% m:n(1:2), I1=7
% m:n integer divisor found, I1=9
% 2:1
% m:n integer divisor found, I1=10
% 2:1
% m:n integer divisor found, I1=13
% 2:1
% m:n(2:3), I1=14
% m:n integer divisor found, I1=18
% 3:1
```

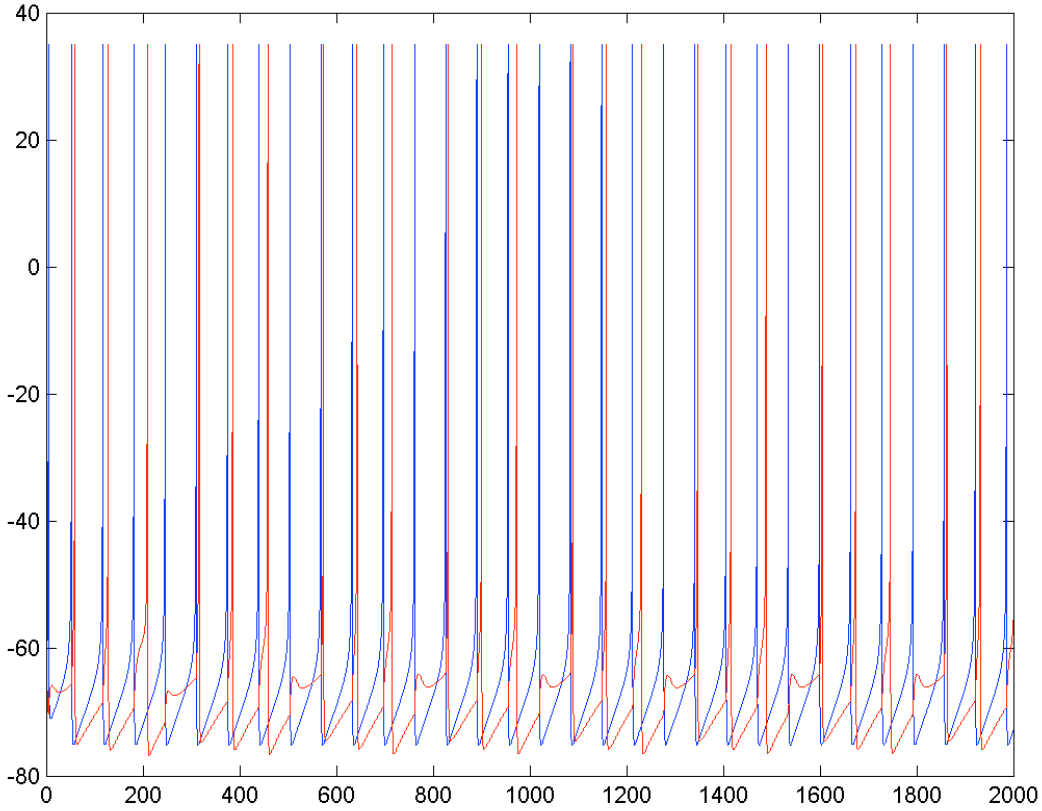
I1=4, I2=4


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

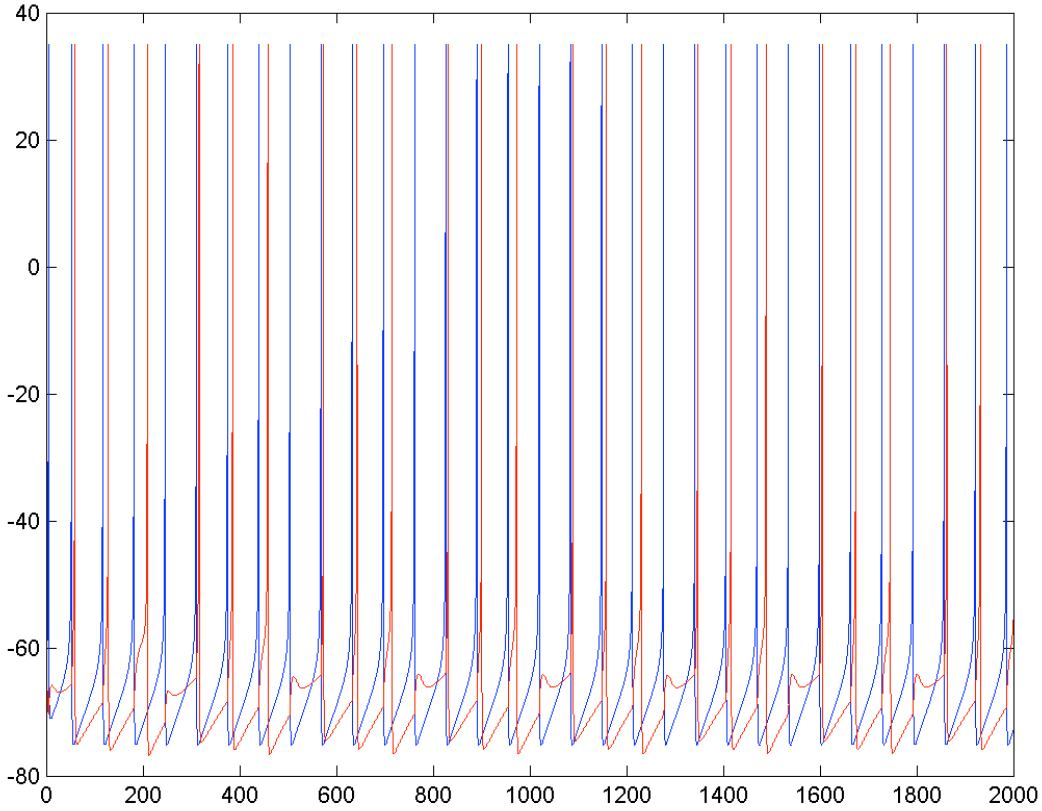
I1=7, I2=4


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

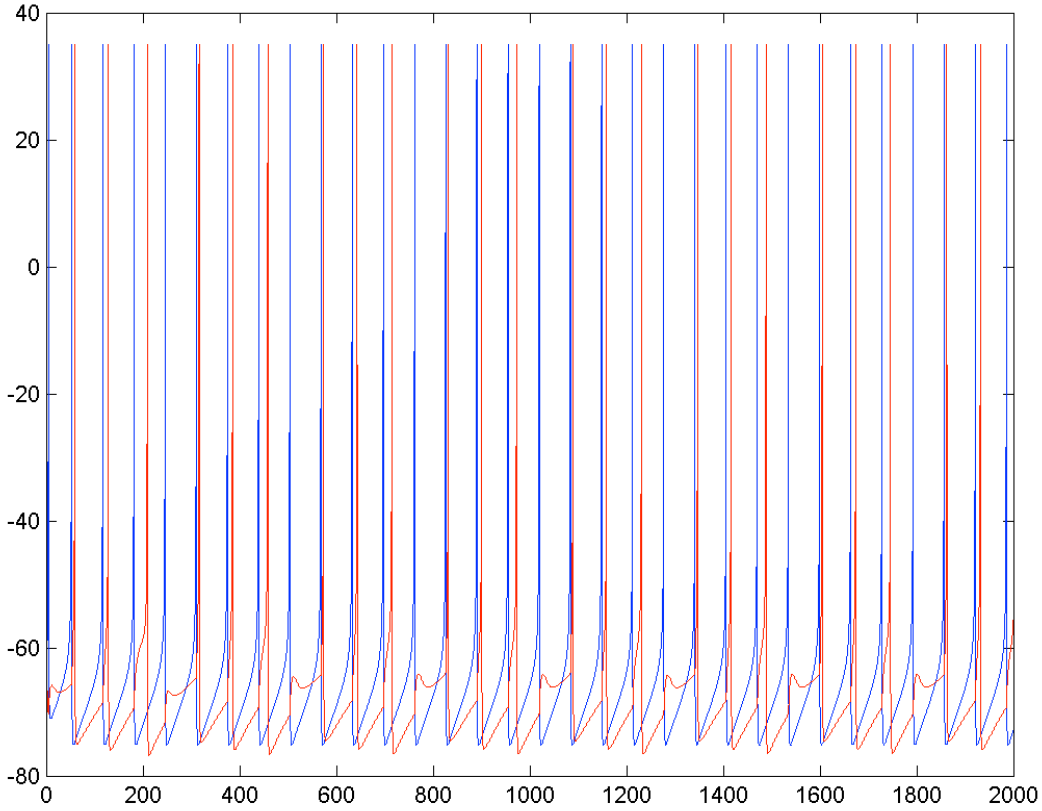
I1=9, I2=4


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

I1=14, I2=4


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

I1=18, I2=4


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

```
parts = [0 0 0];
i=4;
saveDir=uigetdir;
while(true)
    pulsei=[i;4];

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(pulsei);

    cell1spikes = extractSpikes(spiketimes,1,10);
    cell2spikes = extractSpikes(spiketimes,2,10);

    ratio = length(cell1spikes)/length(cell2spikes);
    if(mod(length(cell1spikes),length(cell2spikes))==0)
        disp(['m:n integer divisor found, I1=',num2str(i)]);
        disp([num2str(ratio),':1']);
        if(ratio==3)
            parts(1,1)=1;
        end
    end
    if(ratio>1 && ratio<2 && ~parts(1,2))
        disp(['m:n(1:2), I1=',num2str(i)]);
        parts(1,2)=1;
    end
    if(ratio>2 && ratio<3 && ~parts(1,3))
        disp(['m:n(2:3), I1=',num2str(i)]);
        parts(1,3)=1;
    end

    saveas(1,fullfile(saveDir,
['q1_I1=',num2str(i),'_I2=4','.png']),'png');
    if(all(parts))
        break;
    end
    i=i+1;
end
```

1b. 1:1 firing stable when I1=4,5,6

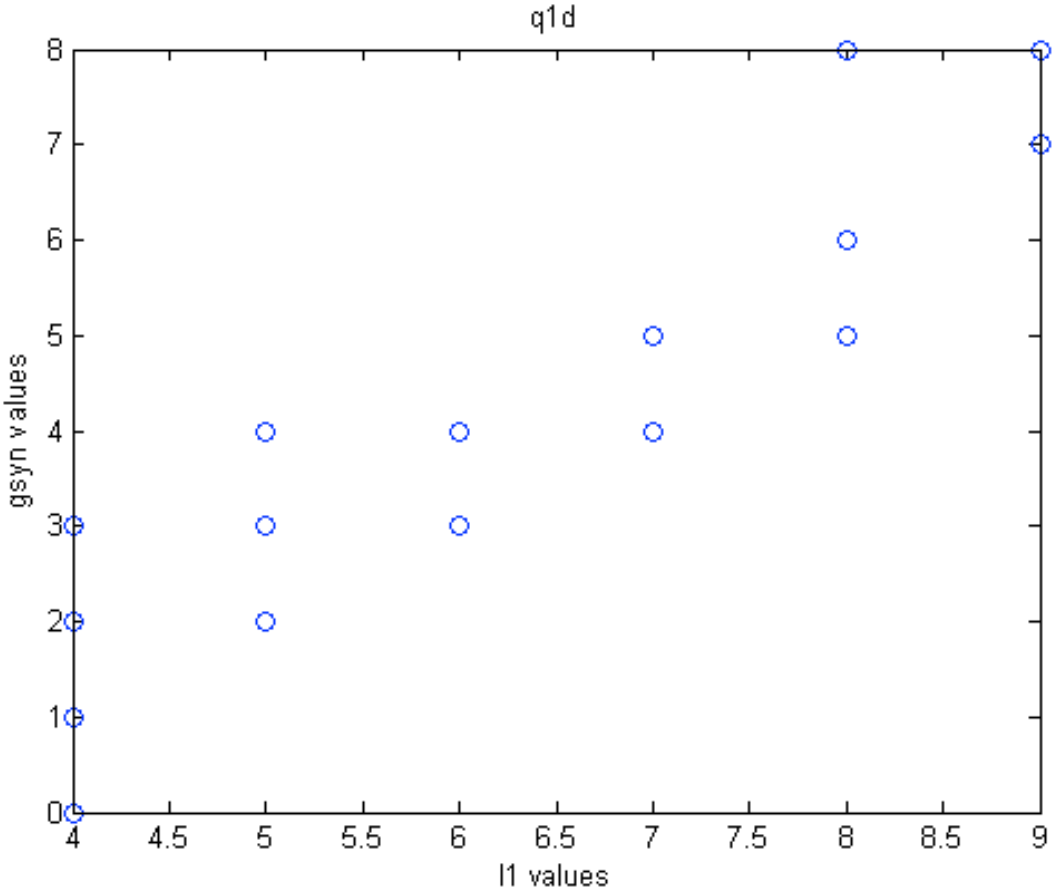
1c.

```
% >> q1c
% 1:1 Firing: gsyn=2,I1=4,I2=4
% 1:1 Firing: gsyn=2,I1=5,I2=4

% >> q1c
% 1:1 Firing: gsyn=5,I1=7,I2=4
% 1:1 Firing: gsyn=5,I1=8,I2=4

% >> q1c
% 1:1 Firing: gsyn=8,I1=8,I2=4
% 1:1 Firing: gsyn=8,I1=9,I2=4
```

```
% set gsyn=2,5,8
i=4;
while(true)
    pulsei=[i;4];

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(pulsei);

    cell1spikes = extractSpikes(spiketimes,1,10);
    cell2spikes = extractSpikes(spiketimes,2,10);

    ratio = length(cell1spikes)/length(cell2spikes);
    if(ratio==1)
        disp(['1:1 Firing: gsyn=8,I1=',num2str(i),',I2=4']);
    end
    if(ratio>1)
        break;
    end
    i=i+1;
end
```

1d.

```
% >> q1d
% 1:1 Firing: gsyn=1,I1=4,I2=4
% 1:1 Firing: gsyn=2,I1=4,I2=4
% 1:1 Firing: gsyn=2,I1=5,I2=4
% 1:1 Firing: gsyn=3,I1=4,I2=4
% 1:1 Firing: gsyn=3,I1=5,I2=4
% 1:1 Firing: gsyn=3,I1=6,I2=4
% 1:1 Firing: gsyn=4,I1=5,I2=4
% 1:1 Firing: gsyn=4,I1=6,I2=4
% 1:1 Firing: gsyn=4,I1=7,I2=4
% 1:1 Firing: gsyn=5,I1=7,I2=4
% 1:1 Firing: gsyn=5,I1=8,I2=4
% 1:1 Firing: gsyn=6,I1=8,I2=4
% 1:1 Firing: gsyn=7,I1=9,I2=4
% 1:1 Firing: gsyn=8,I1=8,I2=4
% 1:1 Firing: gsyn=8,I1=9,I2=4
```

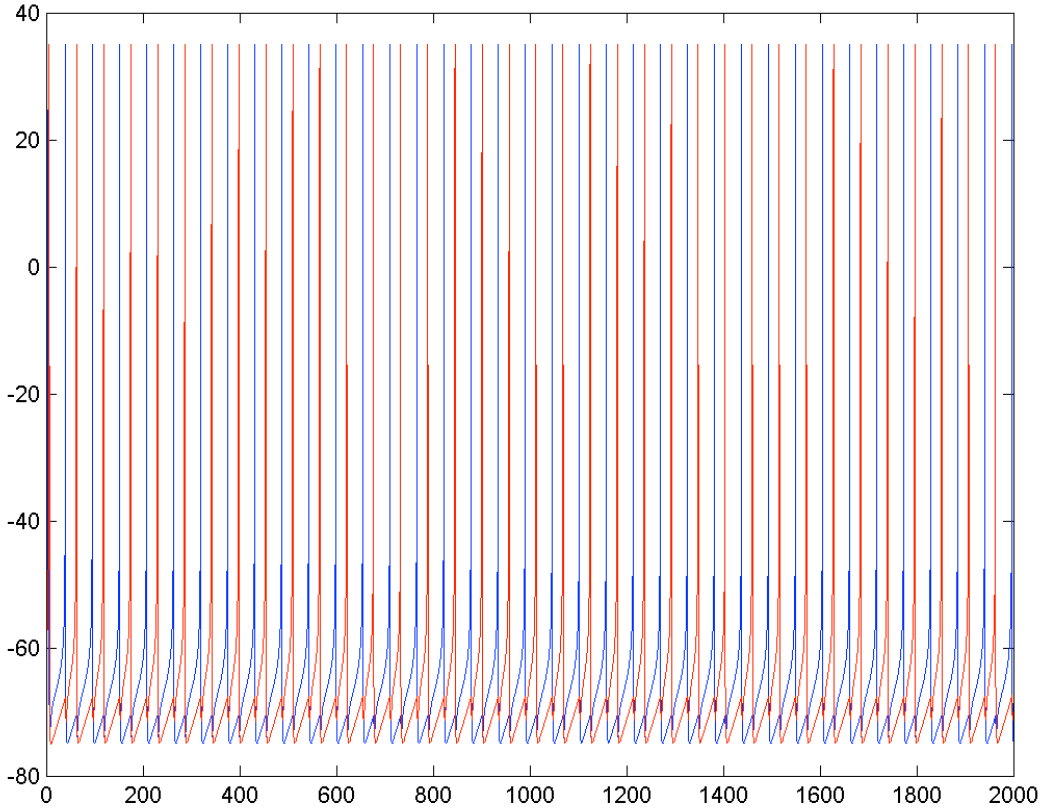

q1d
gsyn values
I1 values
0
1
2
3
4
5
6
7
8
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9

```
data=[0 4]; %stated in q1d
for gsyn=1:8
    i=4;
    while(true)
        pulsei=[i;4];
        %temporarily modified to accept gsyn

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(pulsei,gsyn);

        cell1spikes = extractSpikes(spiketimes,1,10);
        cell2spikes = extractSpikes(spiketimes,2,10);

        ratio = length(cell1spikes)/length(cell2spikes);
        if(ratio==1)
            disp(['1:1 Firing: gsyn=',num2str(gsyn),',I1=',num2str(i),',I2=4']);
            data = [data;[gsyn i]];
        end
        if(ratio>1)
            break;
        end
        i=i+1;
    end
end
figure;
plot(data(:,2),data(:,1),'o');
ylabel('gsyn values');
xlabel('I1 values');
title('q1d');
```

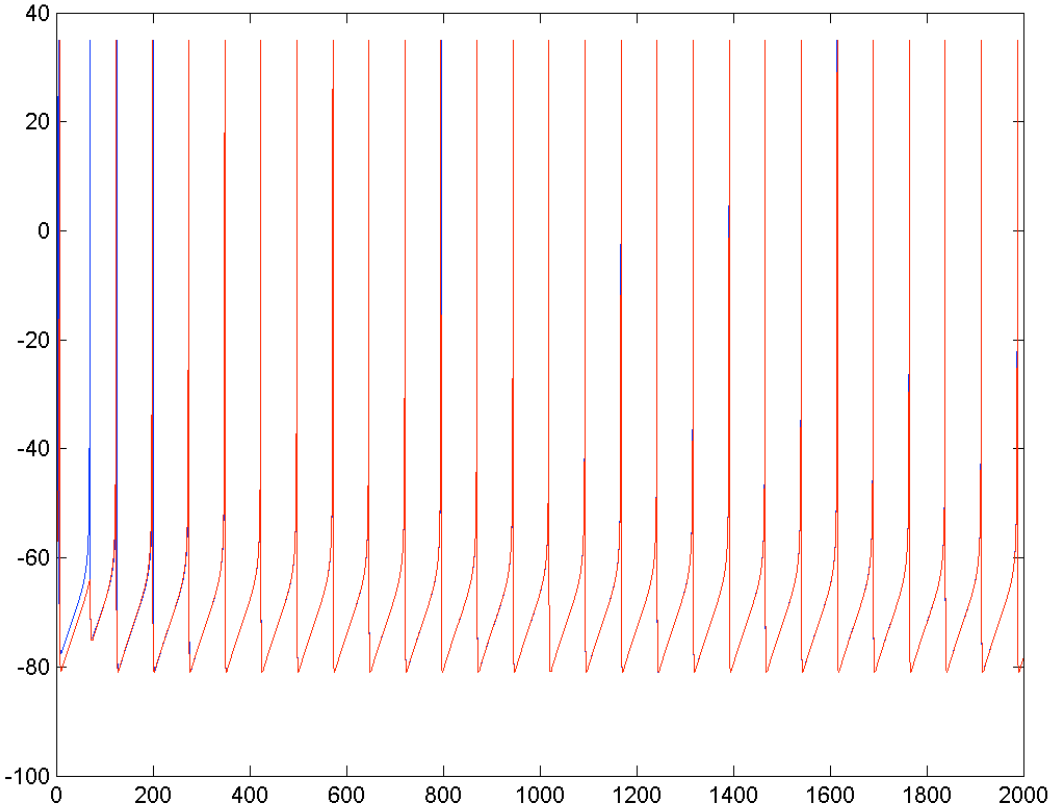
2a.

```
% >> q2a
% anti-synchrony @ taus:1
% anti-synchrony @ taus:2
% anti-synchrony @ taus:3
% anti-synchrony @ taus:4
% anti-synchrony @ taus:6
% anti-synchrony @ taus:10
% anti-synchrony @ taus:13
% anti-synchrony @ taus:15
% anti-synchrony @ taus:17
% anti-synchrony @ taus:19
% anti-synchrony @ taus:21
% anti-synchrony @ taus:23
% anti-synchrony @ taus:24
% anti-synchrony @ taus:26
% anti-synchrony @ taus:28
% anti-synchrony @ taus:30
% anti-synchrony @ taus:31
% anti-synchrony @ taus:33
% anti-synchrony @ taus:34
% anti-synchrony @ taus:37
% anti-synchrony @ taus:38
% anti-synchrony @ taus:41
% anti-synchrony @ taus:42
% synchrony @ taus:45
% synchrony @ taus:46
% synchrony @ taus:47
% synchrony @ taus:48
% synchrony @ taus:49
% synchrony @ taus:50
% suppression @ taus:53
% suppression @ taus:54
% suppression @ taus:55
% suppression @ taus:56
% suppression @ taus:57
% suppression @ taus:58
% suppression @ taus:59
% suppression @ taus:60
```

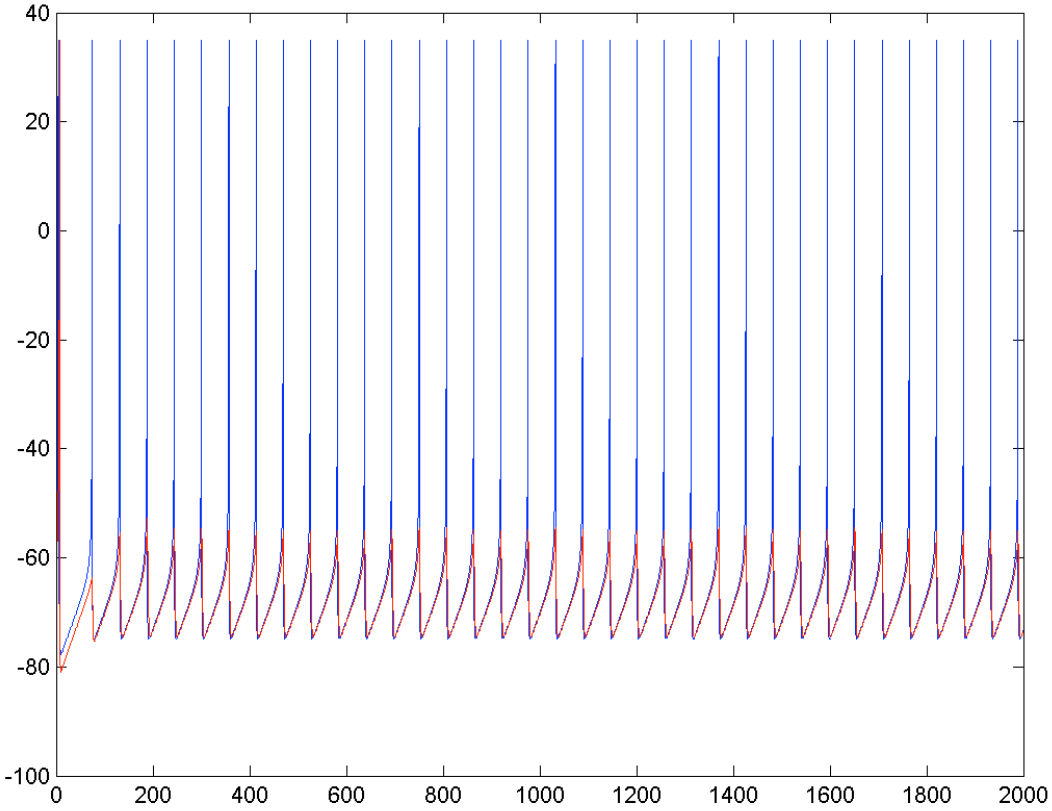
taus=1


40
20
0
-20
-40
-60
-80
0
200
400
600
800
1000
1200
1400
1600
1800
2000

taus=45


40
20
0
-20
-40
-60
-80
-100
0
200
400
600
800
1000
1200
1400
1600
1800
2000

taus=53

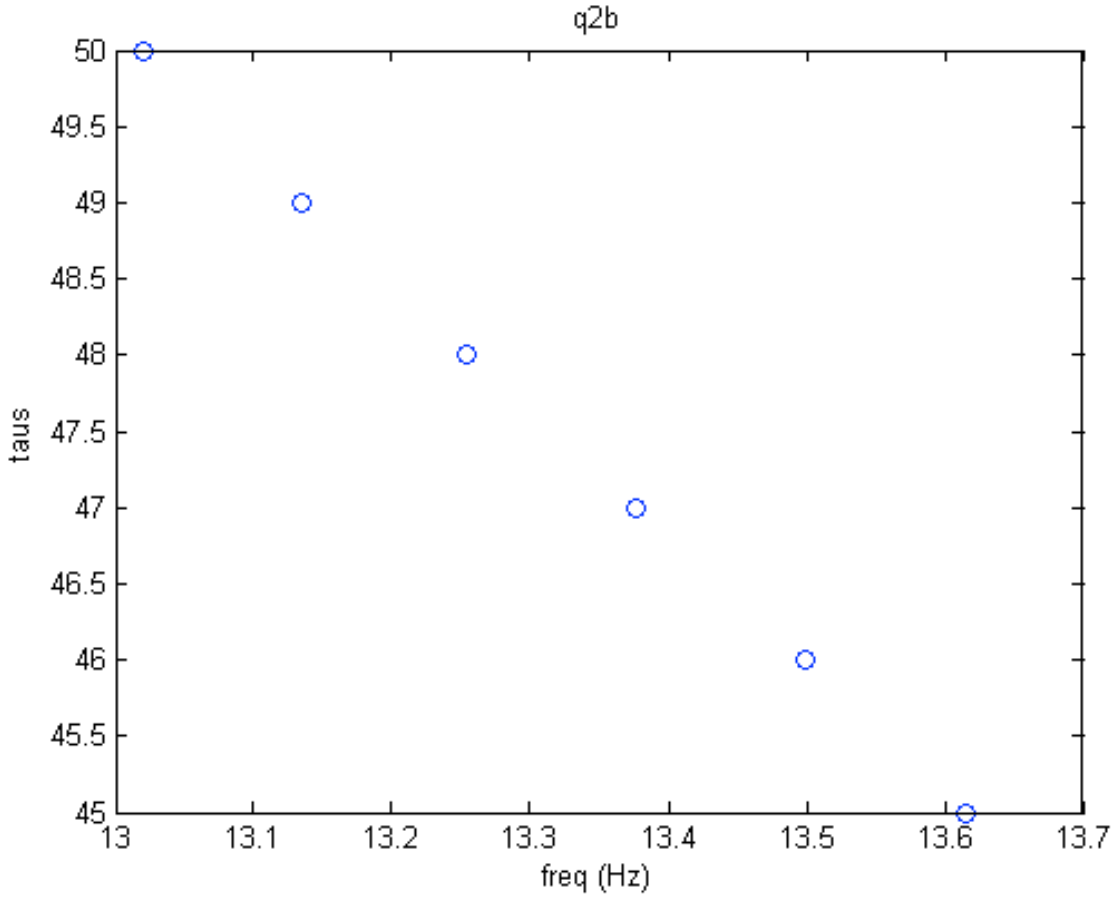

40
20
0
-20
-40
-60
-80
-100
0
200
400
600
800
1000
1200
1400
1600
1800
2000

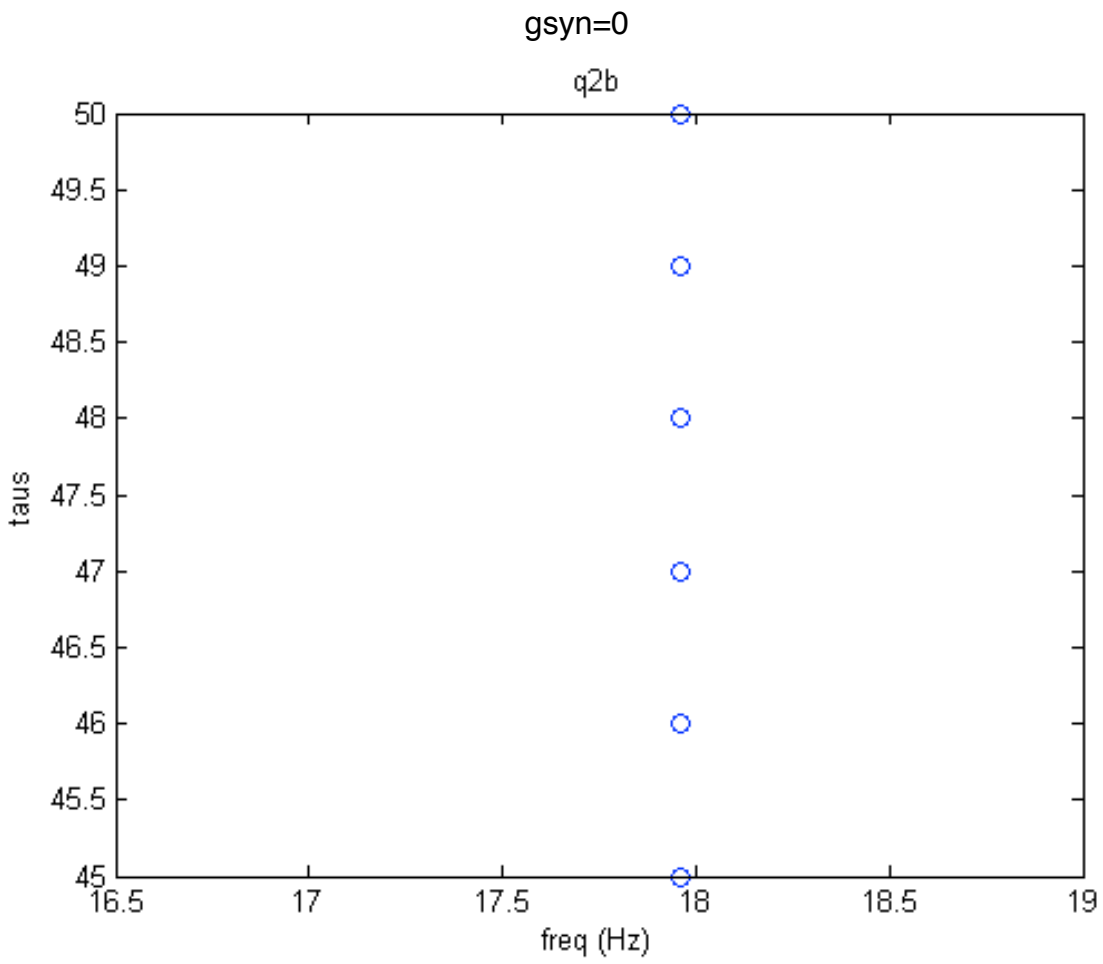
```
saveDir = uigetdir;
for taus=1:60
    %modified to accept taus
    [t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(taus);

    %after 100ms from start (3rd input)
    cell1spikes = extractSpikes(spiketimes,1,100);
    cell2spikes = extractSpikes(spiketimes,2,100);

    %spikes must be within 10ms of eachother for "synchrony"
    if(length(cell1spikes)==length(cell2spikes))
        if(max(abs(cell1spikes-cell2spikes))<10)
            disp(['synchrony @ taus:',num2str(taus)]);
        end
        if(min(abs(cell1spikes-cell2spikes))>25)
            disp(['anti-synchrony @ taus:',num2str(taus)]);
        end
    end
    if(abs(length(cell1spikes)-length(cell2spikes))>10)
        disp(['suppresion @ taus:',num2str(taus)]);
    end
    saveas(1,fullfile(saveDir,
['q2a_taus=',num2str(taus),'.png']),'png');
end
```

2b. As taus increases, frequency decreases. Frequency is constant when gsyn=0.

```
% >> q2b
% gsyn=-8,taus=45,freq=13.615
% gsyn=-8,taus=46,freq=13.4995
% gsyn=-8,taus=47,freq=13.3759
% gsyn=-8,taus=48,freq=13.2545
% gsyn=-8,taus=49,freq=13.134
% gsyn=-8,taus=50,freq=13.0202

% >> q2b
% gsyn=0,taus=45,freq=17.9616
% gsyn=0,taus=46,freq=17.9616
% gsyn=0,taus=47,freq=17.9616
% gsyn=0,taus=48,freq=17.9616
% gsyn=0,taus=49,freq=17.9616
% gsyn=0,taus=50,freq=17.9616
```

gsyn=8

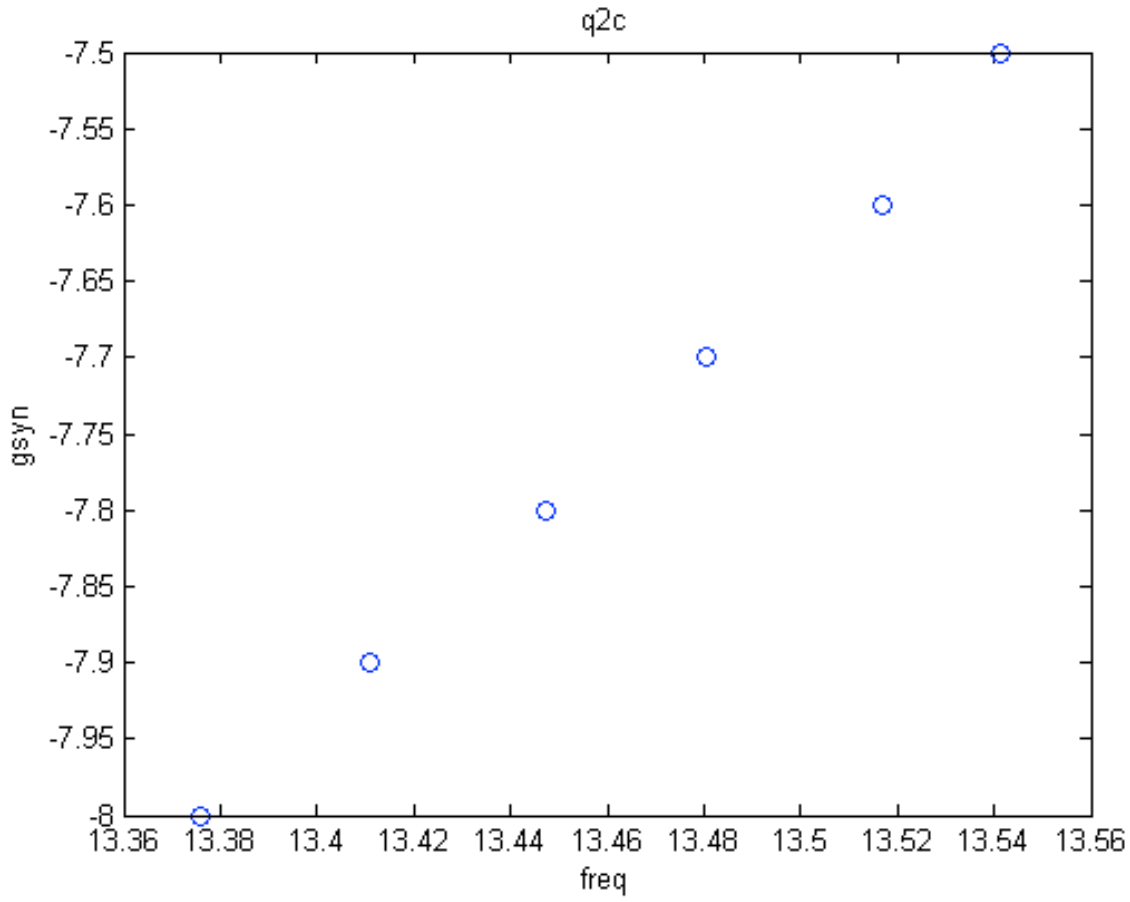

q2b
taus
freq (Hz)
50
49.5
49
48.5
48
47.5
47
46.5
46
45.5
45
13
13.1
13.2
13.3
13.4
13.5
13.6
13.7


gsyn=0
q2b
taus
freq (Hz)
50
49.5
49
48.5
48
47.5
47
46.5
46
45.5
45
16.5
17
17.5
18
18.5
19

```
%values from 2a
figure;
for taus=45:50
    [t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(taus);
    freq=1000/mean(isis1);
    disp(['gsyn=0,taus=',num2str(taus),',freq=',num2str(freq)]);
    plot(freq,taus,'o');
    hold on;
end
title('q2b');
xlabel('freq (Hz)');
ylabel('taus');
```

2c. As synaptic strength become less negative, frequency increases.

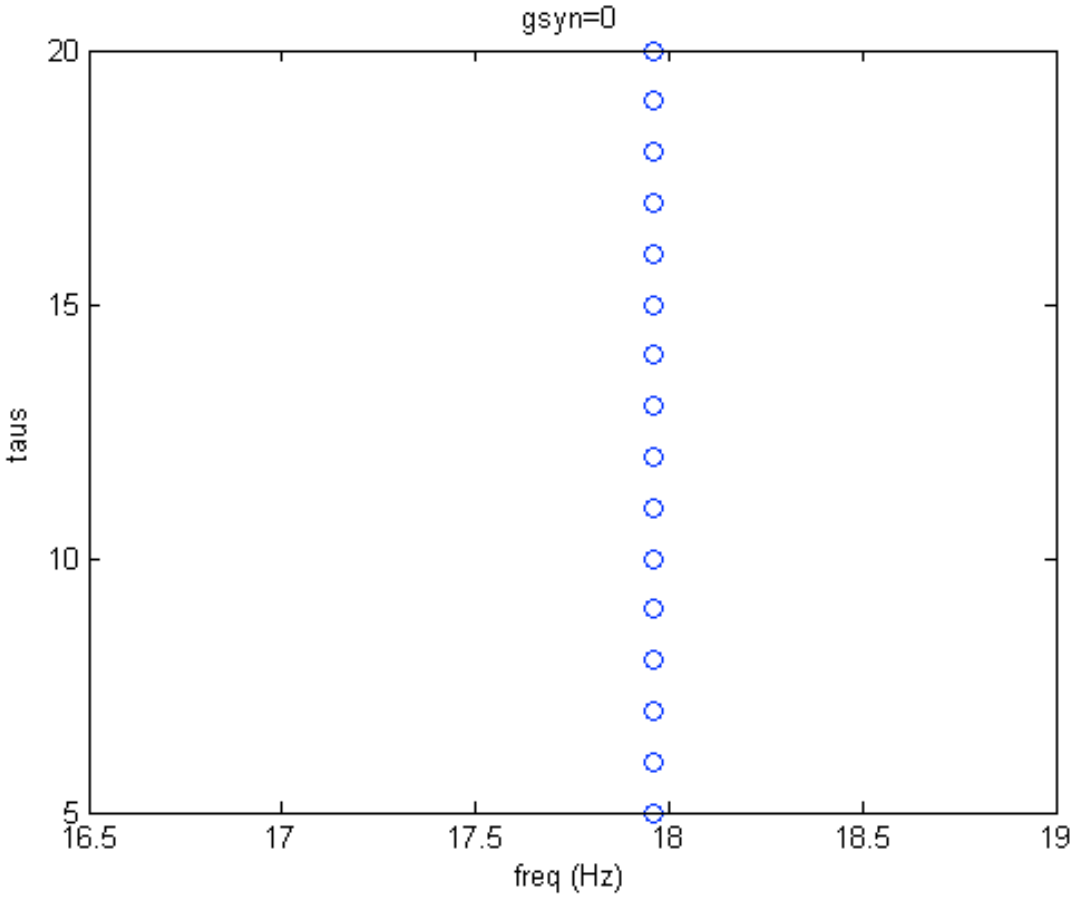
```
% >> q2c
% synchrony @ taus=47,gsyn=-8,freq=13.3759
% synchrony @ taus=47,gsyn=-7.9,freq=13.411
% synchrony @ taus=47,gsyn=-7.8,freq=13.4471
% synchrony @ taus=47,gsyn=-7.7,freq=13.4806
% synchrony @ taus=47,gsyn=-7.6,freq=13.517
% synchrony @ taus=47,gsyn=-7.5,freq=13.5413
```

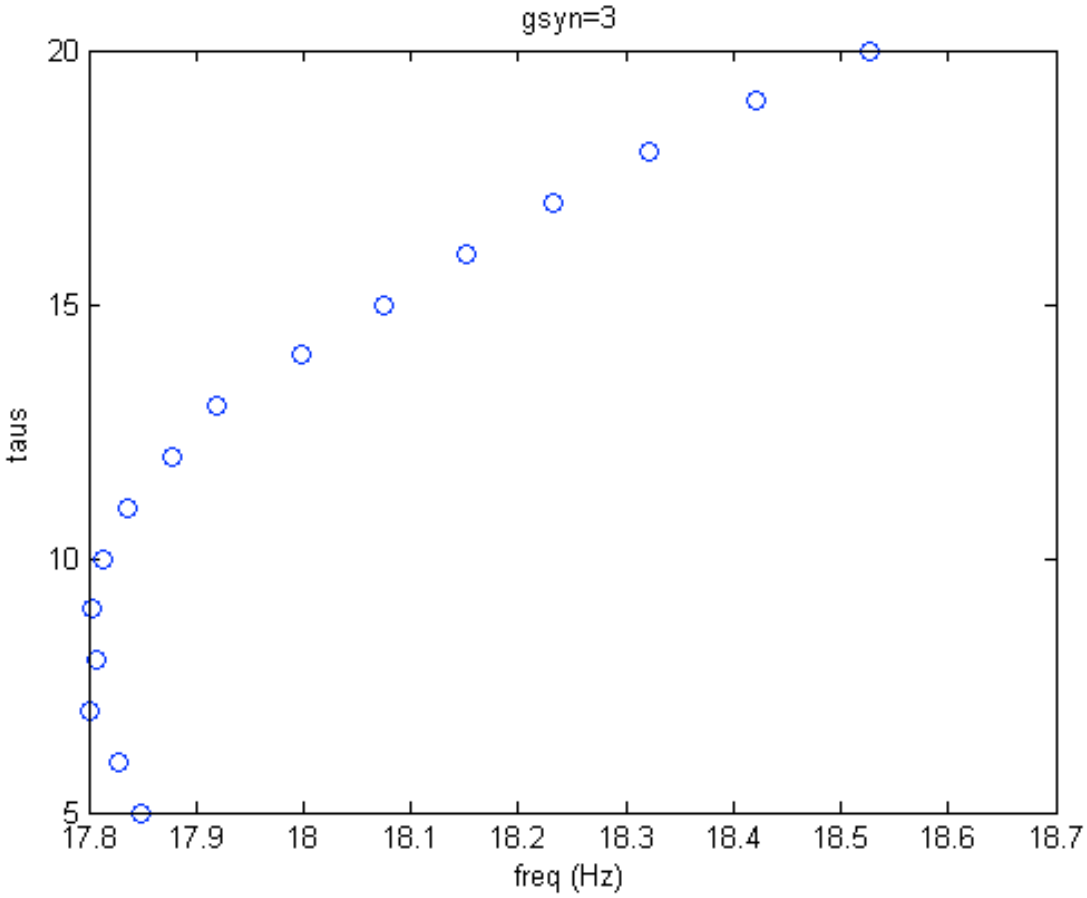

q2c
gsyn
freq
-7.5
-7.55
-7.6
-7.65
-7.7
-7.75
-7.8
-7.85
-7.9
-7.95
-8
13.36
13.38
13.4
13.42
13.44
13.46
13.48
13.5
13.52
13.54
13.56

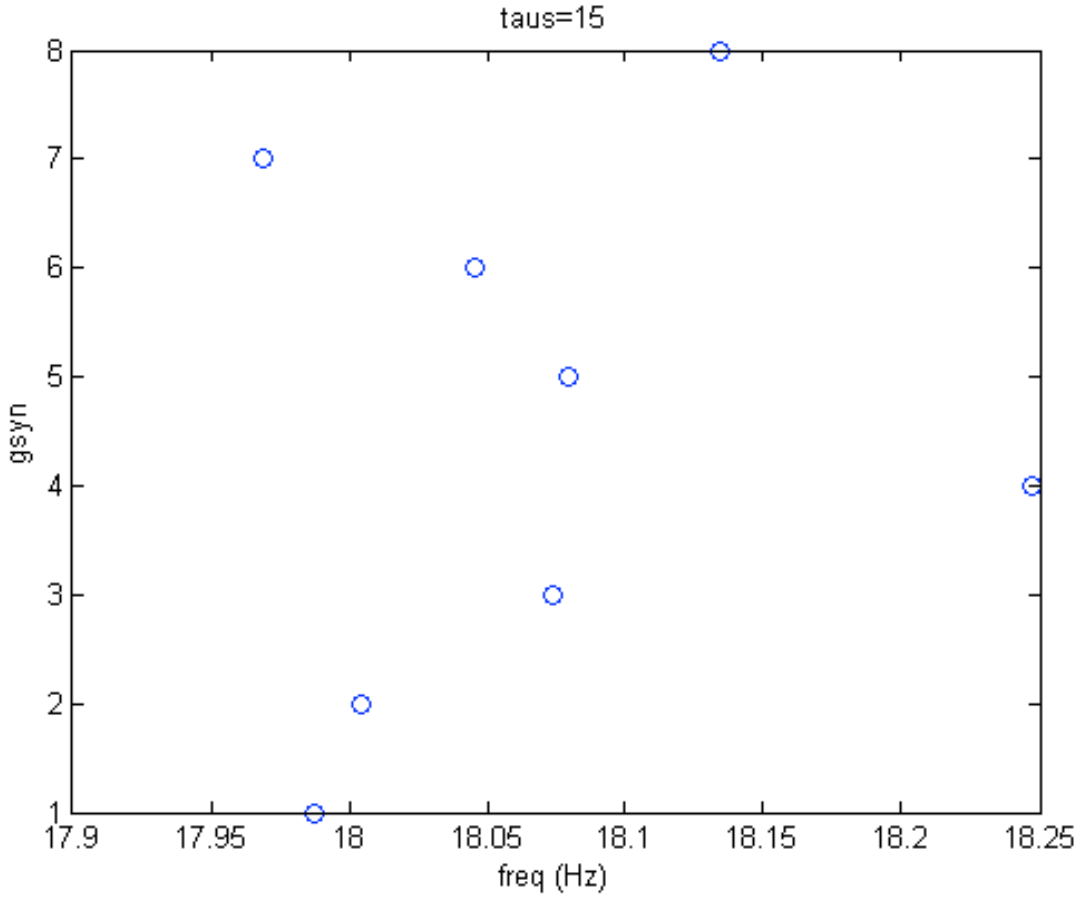
```
figure;
for gsyn=-8:0.1:-7
    %modified to accept gsyn
    [t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(gsyn);

    %after 100ms from start (3rd input)
    cell1spikes = extractSpikes(spiketimes,1,100);
    cell2spikes = extractSpikes(spiketimes,2,100);
    freq=1000/mean(isis1);

    if(length(cell1spikes)==length(cell2spikes))
        if(max(abs(cell1spikes-cell2spikes))<10)
            disp(['synchrony @
taus=47,gsyn=',num2str(gsyn),',freq=',...
                num2str(freq)]);
            plot(freq,gsyn,'o');
            hold on;
        end
    end
end
title('q2c');
xlabel('freq');
ylabel('gsyn');
```

2d. No connectivity (gsyn=0) results in a constant firing frequency. In general, as taus increases (with constant gsyn) firing frequency increases. With a high taus (=15) and constant gsyn, firing frequency bounces around, centered around ~18Hz.

2b.	taus ↓	freq ↑
2c.	gsyn ↑	freq ↑
2d.	taus ↑	freq ↑


gsyn=0
20
15
10
5
taus
16.5
17
17.5
18
18.5
19
freq (Hz)


gsyn=3
20
15
10
5
taus
17.8
17.9
18
18.1
18.2
18.3
18.4
18.5
18.6
18.7
freq (Hz)


taus=15
gsyn
freq (Hz)
8
7
6
5
4
3
2
1
17.9
17.95
18
18.05
18.1
18.15
18.2
18.25

```
gsyn=3;
figure;
for taus=5:20
    %modified to accept gsyn and taus

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(gsyn,taus)
;
    freq=1000/mean(isis1);
    plot(freq,taus,'o');
    hold on;
end
title('gsyn=3');
xlabel('freq (Hz)');
ylabel('taus');

taus=15;
figure;
for gsyn=1:8

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(gsyn,taus)
;
    freq=1000/mean(isis1);
    plot(freq,gsyn,'o');
    hold on;
end
title('taus=15');
xlabel('freq (Hz)');
ylabel('gsyn');

gsyn=0;
figure;
for taus=5:20
    %modified to accept gsyn and taus

[t_tot,v_tot,u_tot,spiketimes,isis1,isis2,s_tot]=ILIF2cells(gsyn,taus)
;
    freq=1000/mean(isis1);
    plot(freq,taus,'o');
    hold on;
end
title('gsyn=0');
xlabel('freq (Hz)');
ylabel('taus');
```