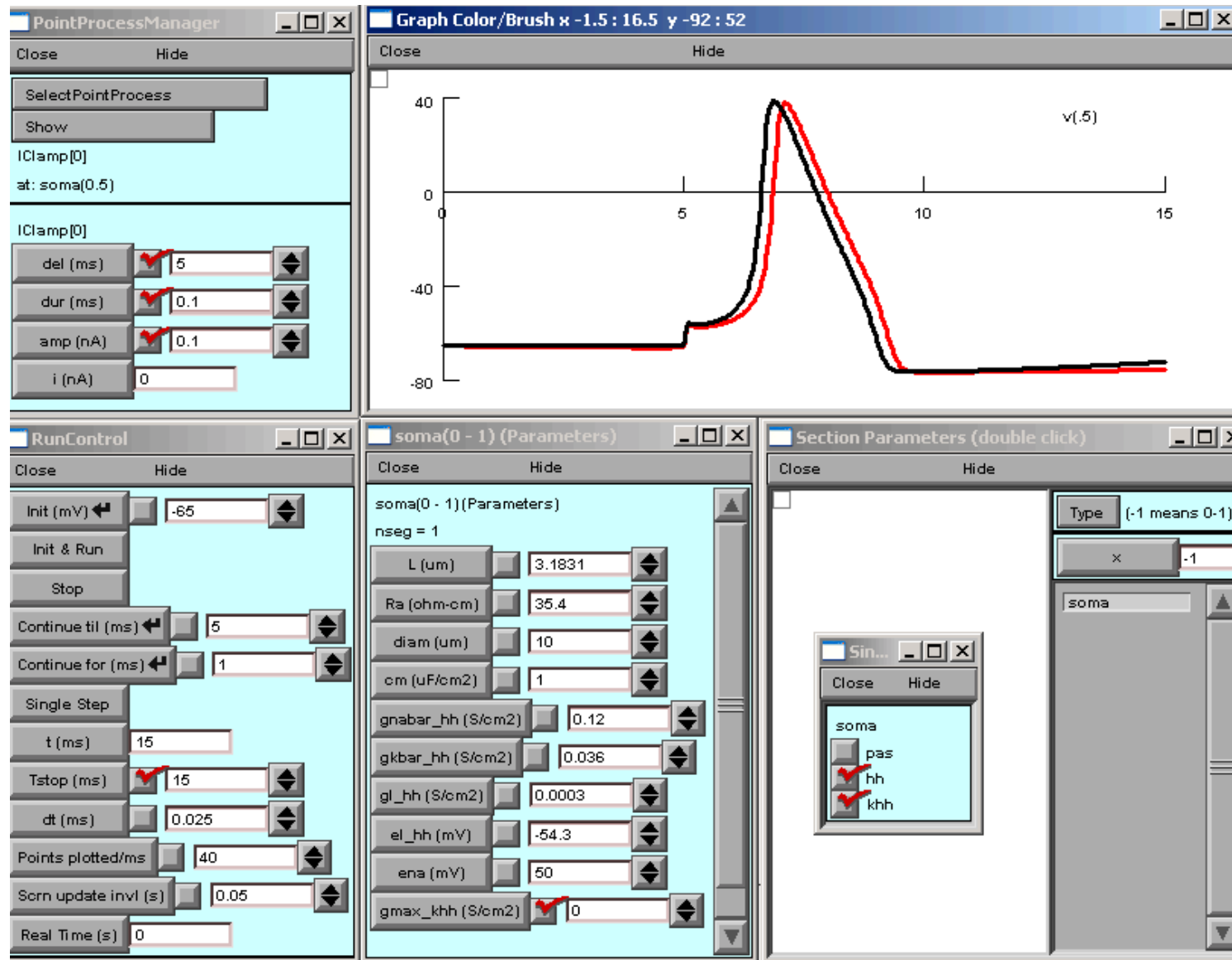


# Lab V

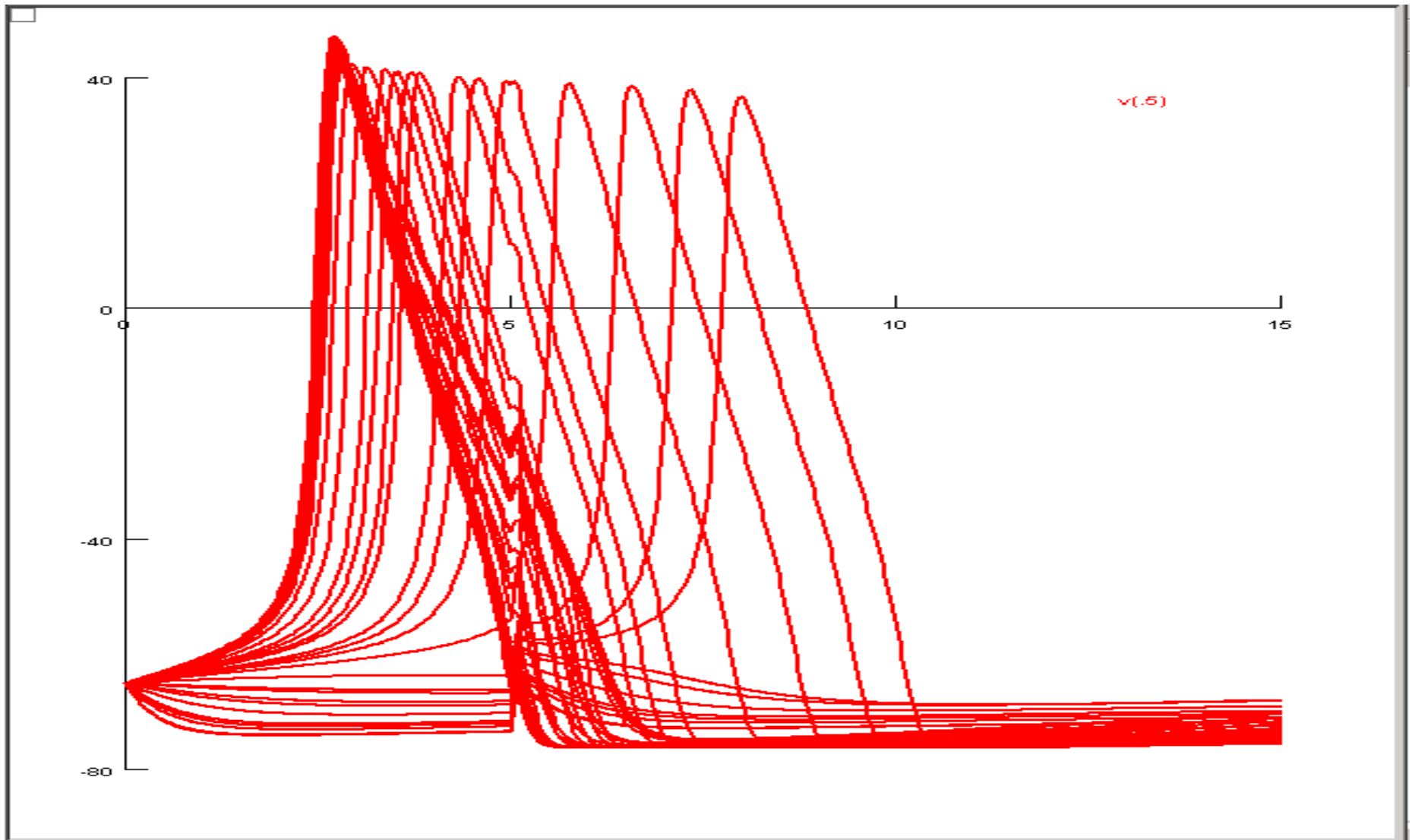
Kinetic Scheme

Below is a graph of the action potentials resulting from both the standard hh channel (black) and the channel built in the tutorial. (red)



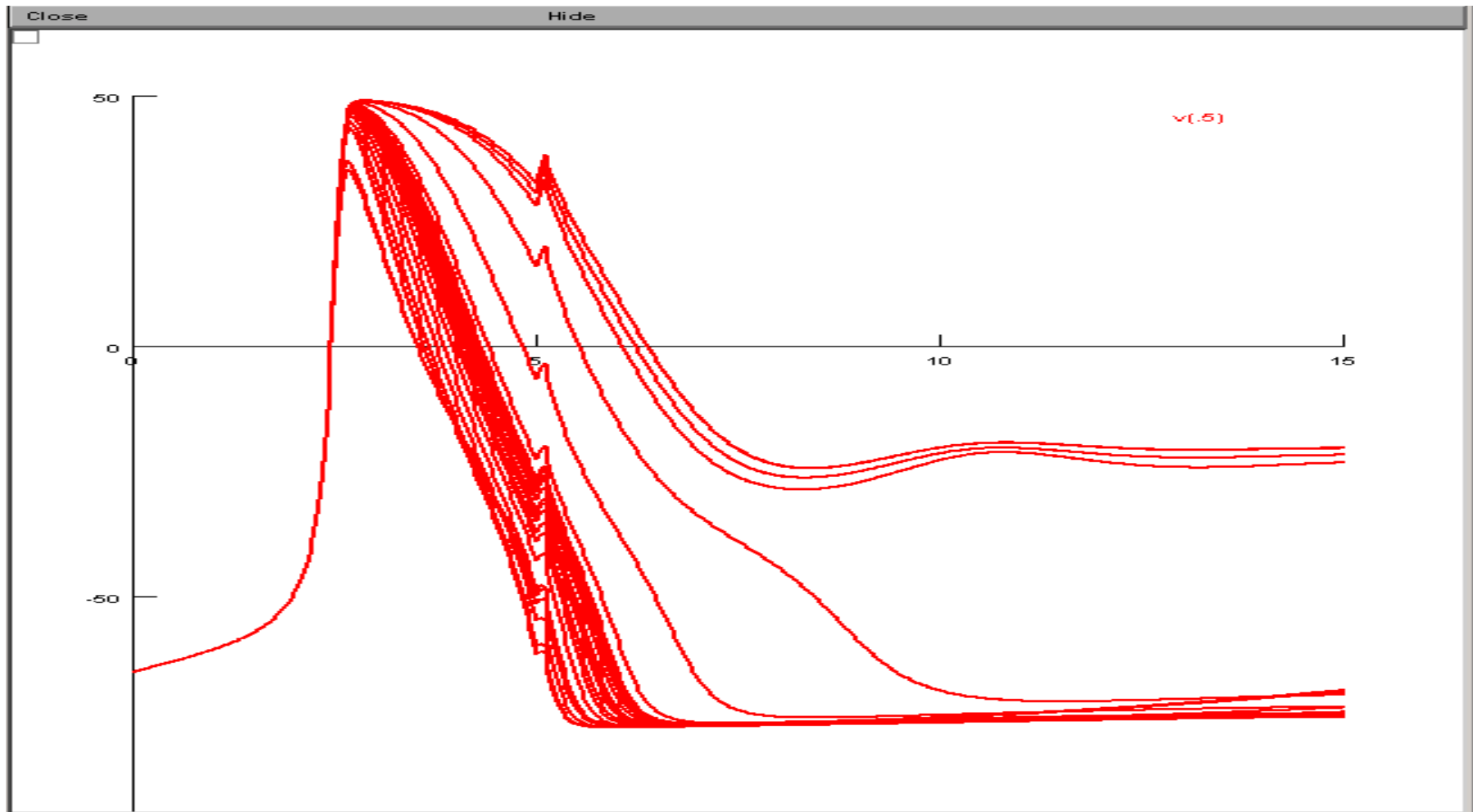
# Effect of Changing inf parameters

Below is the result of changing the control point for inf from  $d=40$  to  $d=-60$ . Two important points emerge from this. Up until  $d = -25$ , the action potential occurs at approximately the same time, with larger 'd's only changing the amplitude (making it larger.) After  $-25$ , the action potential occurs progressively later, until  $d=-50$  and lower,



# Effect of Changing tau parameters

Below is the effect of manipulating the control point of tau. Beginning at 0,0, tau was first moved along the vertical axis (increasing A) This resulted in successively larger action potentials. (slightly wider as well) However, as tau was moved in the positive x direction, tau(d) became significantly larger, resulting in slower termination of the action potential. Ultimately, high d values resulted in a much higher resting membrane potential.



Without expressing the present mykhh channel, the cell fires an action potential as expected

The screenshot displays the NEURON software interface. The central window shows a voltage trace labeled `v(.5)` over a 15 ms period. The y-axis ranges from -80 mV to 40 mV. The trace shows a resting potential at approximately -70 mV, followed by a sharp spike (action potential) peaking at about 40 mV around 7 ms, and then a slow afterdepolarization (sADP) that reaches a new steady state at approximately -75 mV by 15 ms.

On the left, the **RunControl** panel is visible with the following settings:

- Init (mV): -65
- Continue til (ms): 5
- Continue for (ms): 1
- t (ms): 15
- Tstop (ms): 15 (checked)
- dt (ms): 0.025
- Points plotted/ms: 40
- Scrn update invl (s): 0.05
- Real Time (s): 0.01

Below it, the **PointProcessManager** panel shows:

- SelectPointProcess: soma(0.5)
- IClamp[0] at: soma(0.5)
- IClamp[0] del (ms): 5 (checked)
- IClamp[0] dur (ms): 0.1 (checked)
- IClamp[0] amp (nA): 0.1 (checked)
- IClamp[0] i (nA): 0

On the right, a parameter table is shown:

gl_hh (S/cm2)	0.0003
el_hh (mV)	-54.3
ena (mV)	50
ek (mV)	-77

At the bottom right, a **Sin...** window shows a list of channels for the `soma` compartment:

- pas
- hh (checked)
- mykhh (checked)

At the bottom left, the text "dd notes" is partially visible.

Replacing the HH K channel with mykhh channel, the cell fires a similar action potential as expected.

Close Hide

Init (mV)

Init & Run

Stop

Continue til (ms)

Continue for (ms)

Single Step

t (ms)

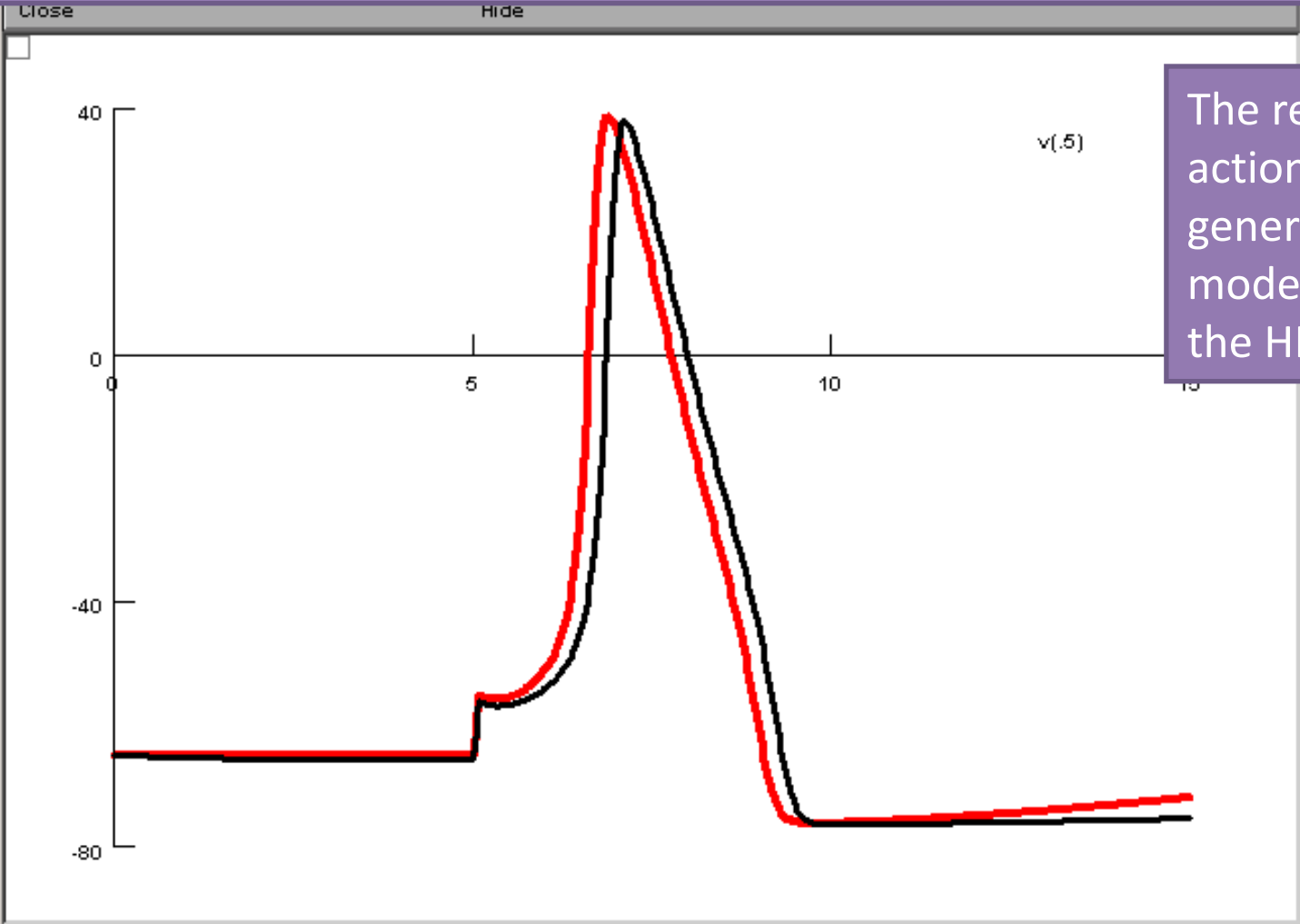
Tstop (ms)

dt (ms)

Points plotted/ms

Screen update interval (s)

Real Time (s)



The red trace is the action potential generated with the model having only the HH K channel.

POINTPROCESSMANAGER

Close Hide

SelectPointProcess

Show

IClamp[0]

at: soma(0.5)

IClamp[0]

del (ms)

dur (ms)

amp (nA)

i (nA)

...re's control point (it only moves left and right).  
 ...k parameters by clicking near the control points, but it's tricky -- you'll have much  
 ...using the adjacent spinners.  
 ...you can use to recreate this figure (it's actually a session file, but its extension has be  
 ...fully configured [mykhh.se](http://mykhh.se) are packaged with the zipped archive of this tutorial.

cm (uF/cm2)

gnabar\_hh (S/cm2)

gkbar\_hh (S/cm2)

gl\_hh (S/cm2)

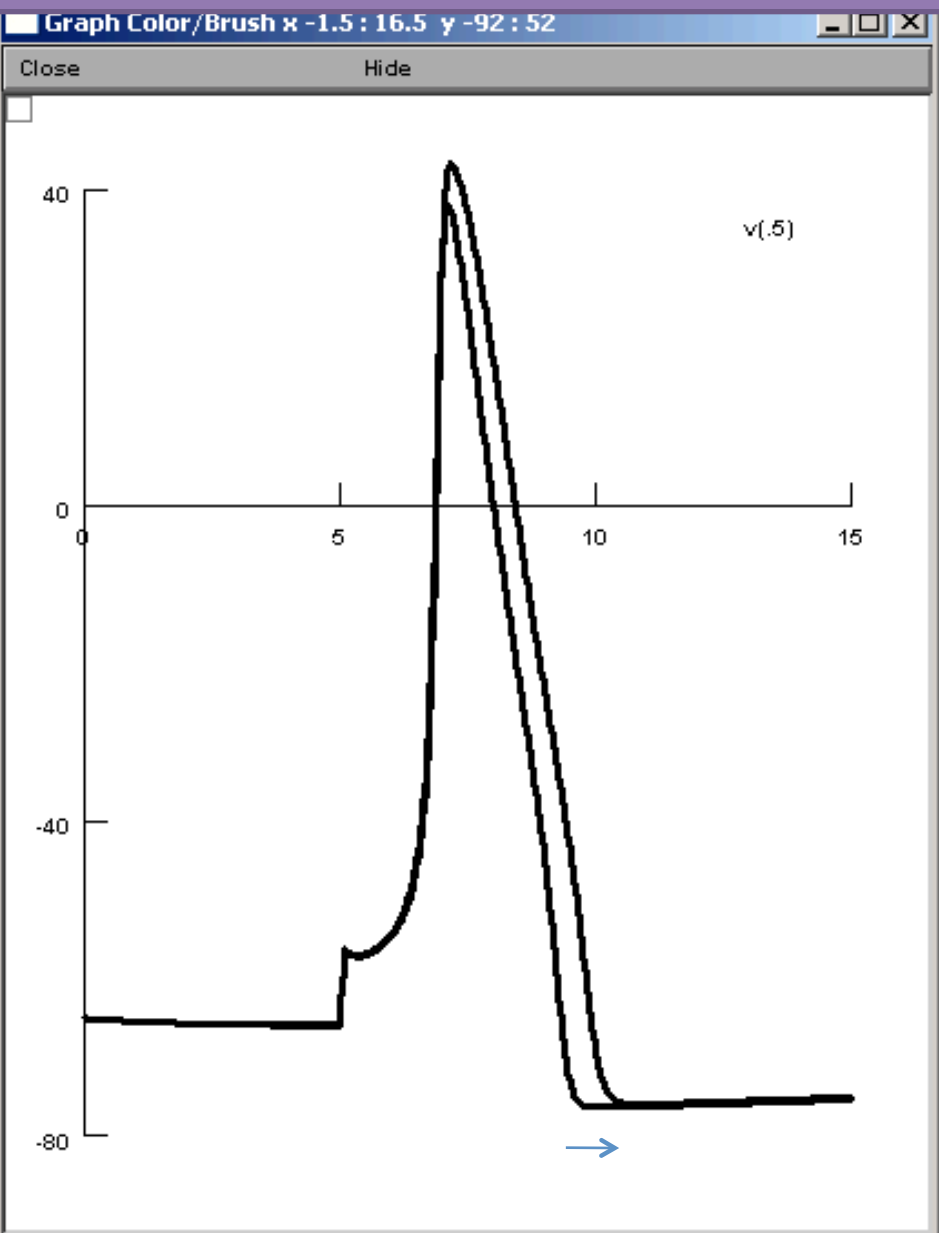
el\_hh (mV)

ena (mV)

gmax\_mykhh (S/cm2)

ek (mV)

# Changing d from -65 to 0 increases the width and amplitude of the action potential



States Transitions Properties

Select hh state or ks transition to change properties

$c1 \xleftrightarrow{v} c2 \xleftrightarrow{v} 0$

Adjust  Run

Graph showing  $infC1C2$  (red curve) and  $tauC1C2$  (black curve) versus voltage. The y-axis ranges from 0 to 6.5, and the x-axis ranges from -90 to 60 mV. A red box highlights the value at 0 mV, and a blue box highlights the value at -65 mV.

$C1 \leftrightarrow C2$  (inf, tau) (KSTra)

Display inf, tau

$infC1C2 = A(1 + \exp(-k*(v - d)))$

$tauC1C2 = A*\exp(k*(v - d))$

A (1)	1
k (/mV)	-0.164
d (mV)	-48.8
A (ms)	4.4
k (/mV)	-0.024
d (mV)	<input checked="" type="checkbox"/> 0

amp (nA)  0.1

i (nA)

fully configured [mykhh.se](http://mykhh.se) are packaged with the zipped archive of this tutorial.

gr\_hh (S/cm2)

el\_hh (mV)

ena (mV)

gmax\_mykhh (S/cm2)

ek (mV)

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# Changing a from 4.4 to 2 decreases the amplitude of the action potential

The image displays a software interface for modeling an action potential. The main plot shows the membrane potential  $v(5)$  over time, with a peak at approximately 40 mV. A blue arrow points to the peak, indicating the effect of changing the parameter  $a$  from 4.4 to 2. The interface includes a state transition diagram, a parameter adjustment panel, and a control panel.

**State Transition Diagram:**

Select hh state or ks transition to change properties

$C1 \xleftrightarrow{v} C2 \xleftrightarrow{v} 0$

**Parameter Adjustment Panel:**

Adjust  Run

**Control Panel:**

- dur (ms): 0.1
- amp (nA): 0.1
- i (nA): 0
- el\_hh (mV): -54.3
- ena (mV): 50
- gmax\_mykhh (S/cm2): 0.02979
- ek (mV): -77

**State Transition Properties:**

$C1 \leftrightarrow C2$  (inf, tau) (KSTra)

Display inf, tau

infC1C2 =  $A(1 + \exp(-k*(d - v)))$

tauC1C2 =  $A*\exp(k*(v - d))$

Parameters for  $C1 \leftrightarrow C2$ :

- A (1): 1
- k (/mV): -0.164
- d (mV): -48.8

Parameters for  $\tau C1C2$ :

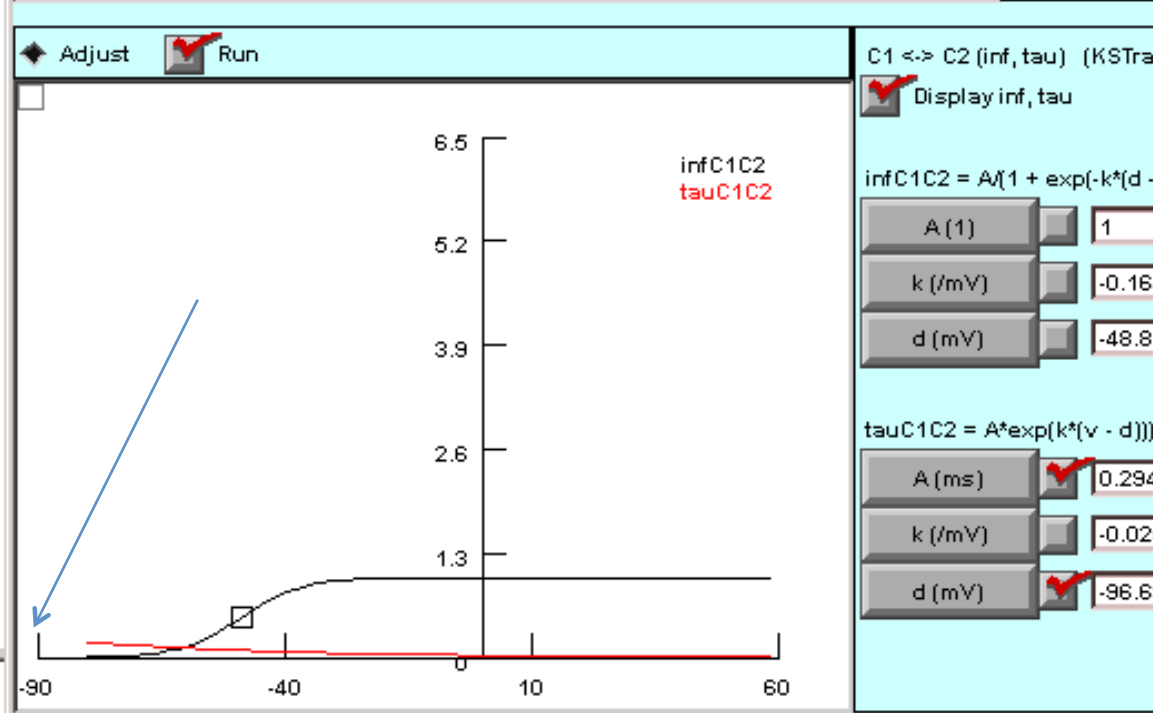
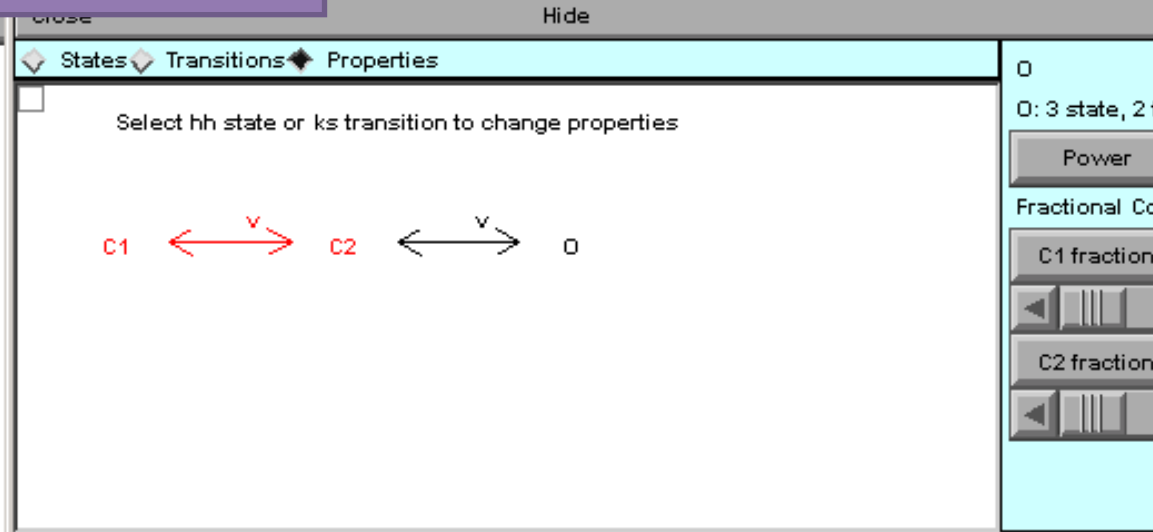
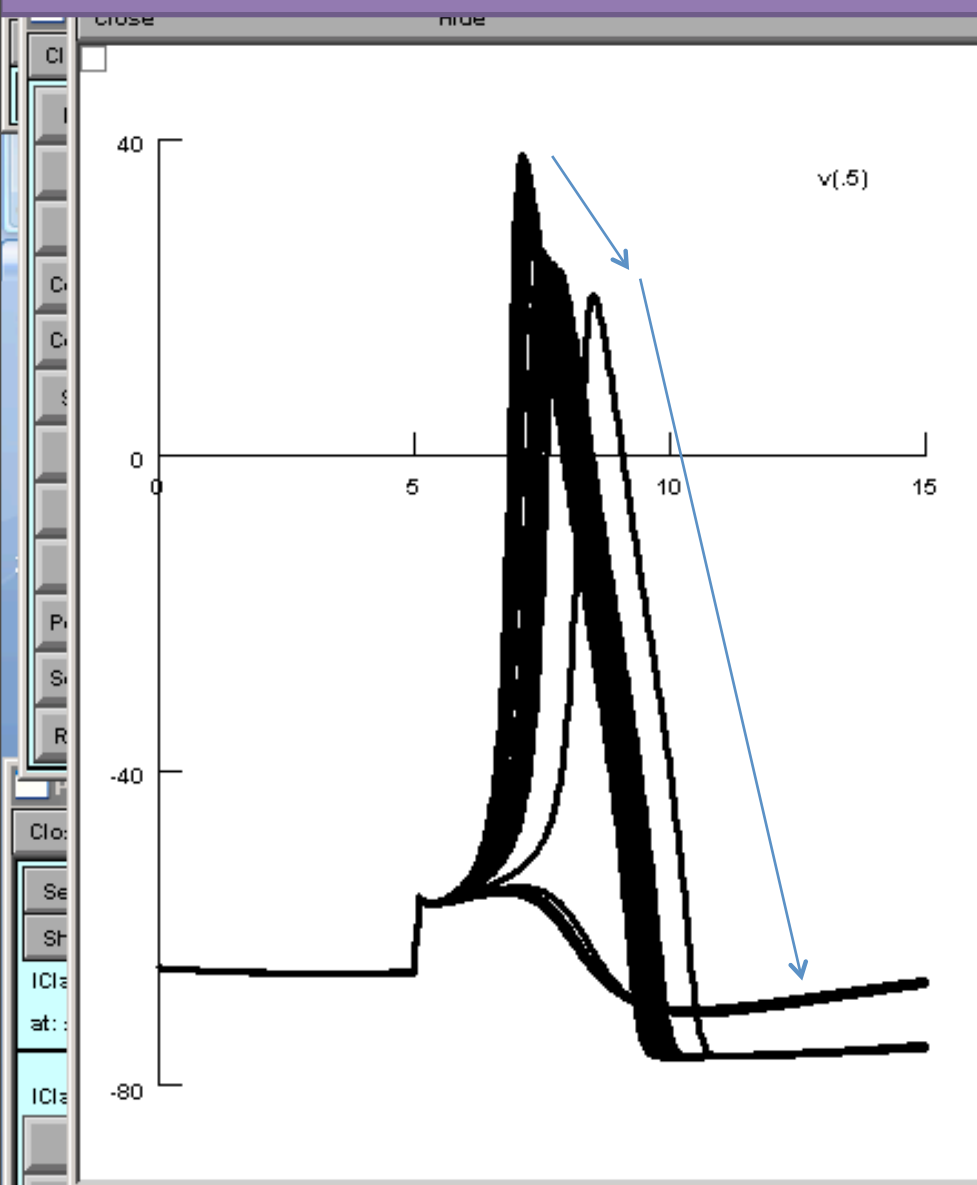
- A (ms): 2
- k (/mV): -0.024
- d (mV): -65

**Plot Details:**

The plot shows the membrane potential  $v(5)$  over time. The x-axis ranges from 0 to 15 ms, and the y-axis ranges from -80 to 40 mV. A blue arrow points to the peak of the action potential at approximately 4.4 ms. A red box highlights the peak, and a blue box indicates the time to reach the peak is 4.4 ms. A blue box indicates the time to reach the peak is 2 ms.



# Changing a and d of tauC1C2 by dragging the control point [0] for ChannelBuild[0]



**C1 <-> C2 (inf, tau) (KSTra)**

Display inf, tau

$infC1C2 = A(1 + \exp(-k*(d - v)))$

A (1)

k (/mV)

d (mV)

$tauC1C2 = A*\exp(k*(v - d))$

A (ms)

k (/mV)

d (mV)

dur (ms)

amp (nA)

i (nA)

amp (nA)

i (nA)

add notes

gr\_hh (S/cm2)

el\_hh (mV)

ena (mV)

gmax\_mykhh (S/cm2)

ek (mV)

# Changing d of infC1C2 by dragging the control point – increasing it (shifting the curve to the right) makes the depolarization and action potential occur earlier

