Assignment 5

Help

The **due date** for this quiz is **Fri 23 May 2014 8:59 PM PDT**.

☐ **In accordance with the Coursera Honor Code, I (Gene Cho) certify that the answers here are my own work.**

Question 1

Download these Matlab files:

hh.m : Master program for solving Hodgkin-Huxley model

dydt_hh.m : Function that computes derivatives of Hodgkin-Huxley state variables

In the lectures, it was shown that the Hodgkin-Huxley model was able to reproduce the phenomenon of "anode break" excitation. Using the program hh.m, test different cathodal (depolarizing) and anodal (hyperpolarizing) stimuli. The duration of the stimulus is currently set to be 3 ms (line 50 in the code) and the stimulus strength and polarity are set on line 51 in the code. According to the convention used in this program, a negative stimulus depolarizes the cell membrane.

Which of the following values for stimulus will induce an action potential if the stimulus duration is 3 ms?

- ○ 1
- ○ 5
- ○ -3
- ○ -1

Question 2

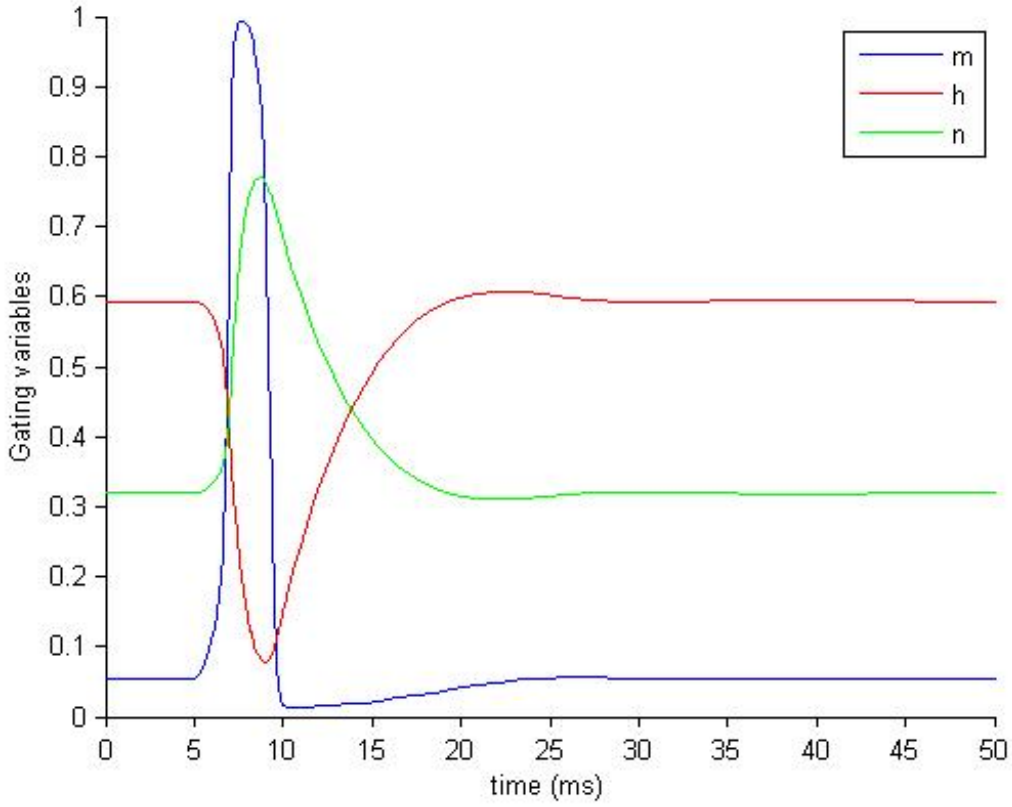
Which of the following stimulus strength values and stimulus durations will lead to "anode break"

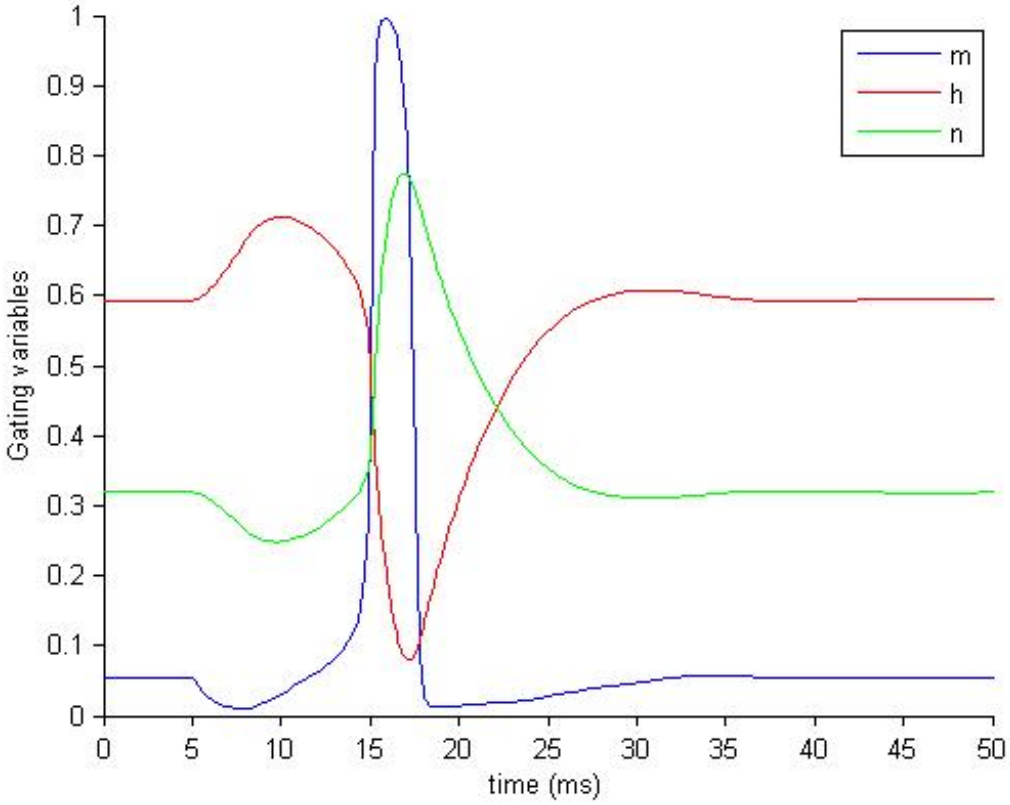
excitation?

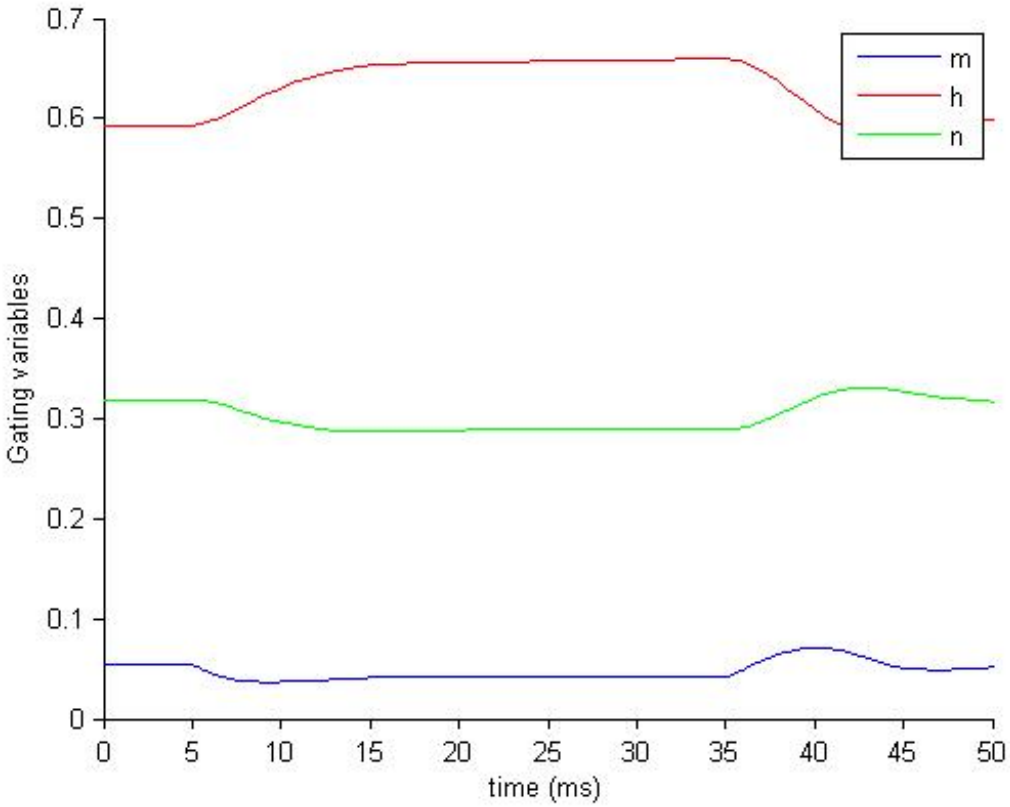
- Stimulus strength=6, Stimulus duration= 2 ms
- Stimulus strength=4, Stimulus duration= 3 ms
- Stimulus strength=5, Stimulus duration= 5 ms
- Stimulus strength=8, Stimulus duration= 1 ms

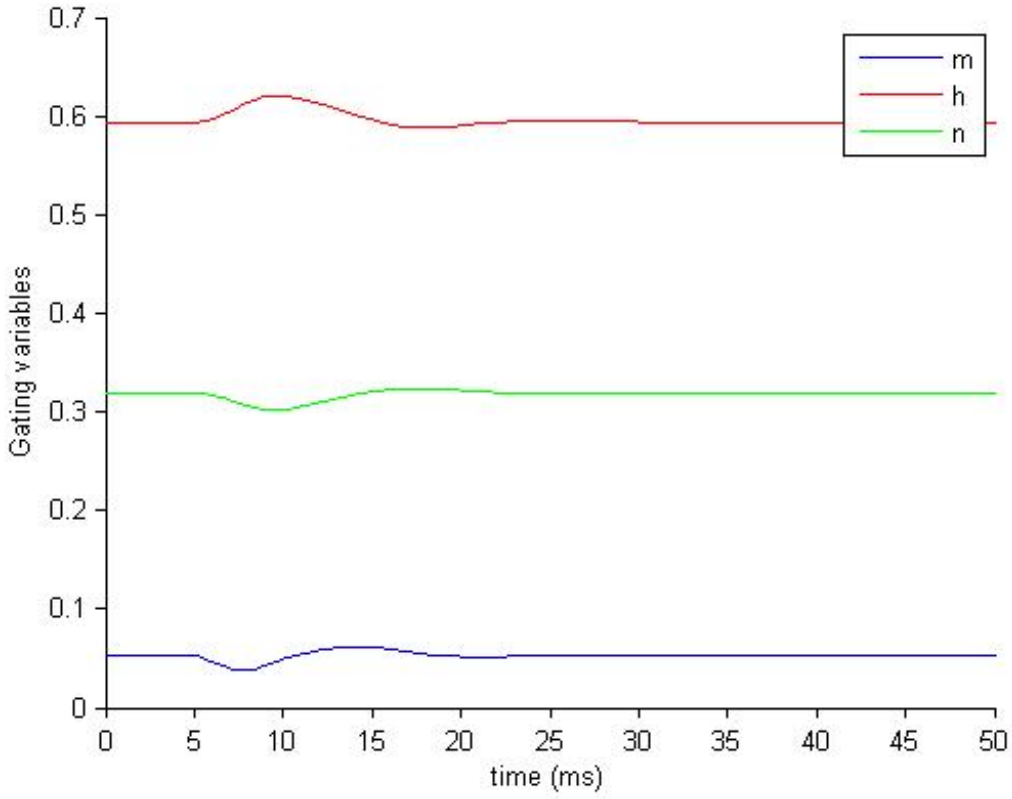
Question 3

Which of the following plots does show the time course of gate variables after a cathodal stimulus?




m
h
n
Gating variables
time (ms)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20
25
30
35
40
45
50


m
h
n
Gating variables
time (ms)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
5
10
15
20
25
30
35
40
45
50



Question 4

Now let's consider the simulation of the refractory period shown in the lectures. Expand the script hh.m to simulate this experiment, and determine the duration of the refractory period for a 1 ms depolarizing stimulus with amplitude of -10. Thus your code will need to simulate an initial stimulus to induce an action potential, then a second stimulus that may or may not induce an action potential, depending on when it is delivered. Some hints on how to modify the code to achieve this:

a. First change the initial duration to 1 ms, and the initial stimulus amplitude to -10.

b. The program already contains a for loop, which covers the 3 intervals of the simulation (more on these intervals below). You will need to enclose this within a second for loop, covering the different intervals between the two stimuli. An appropriate range to test is from 5 to 20 ms. Since the existing loop is defined for i=1:simints, the outer loop will have to be for a different variable.

c. Right now the code defines an initial delay called stimdelay, and variables called stim_start

and stim_end that depend on the delay and the stimulus duration. Your new program will need to include variables defining two such stimuli. Remember that each time you test a different interval between stimuli, the first stim_start and stim_end will stay the same, but the second stim_start and stim_end will change.

d. Currently the code divides time into 3 intervals: (1) before the stimulus, (2) during the stimulus, (3) after the stimulus. Now you need to divide time into 5 intervals, and figure out how to define these appropriately with respect to the first and second stimuli. Also, the variable simints defines the number of intervals, and this will need to be changed.

e. Once you correctly define the five intervals (i.e. intervals(1,:) through intervals(5,:)), you will need to correctly define the 5 values of Istim.

f. When your program is looping through many different intervals, there is no need to pop up a new figure containing 4 subplots each time. Better to pop up a single figure, use the hold on command, and superimpose the different voltage traces. You can use the command

colors = repmat('krgmbc',1,500)

if you want to plot results in a particular repeating order of different colors.

Applying the second stimulus within which of the following time intervals can not induce an action potential? (Second stimulus has the same strength and duration as the first one: 1 ms depolarizing stimulus with amplitude of -10. For this case assume that the first stimulus is applied after 1 ms, initial delay or stimdelay=1)

- ○ $8 < t < 19$
- ○ $7 < t < 11$
- ○ $13 < t < 20$
- ○ $6 < t < 21$

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