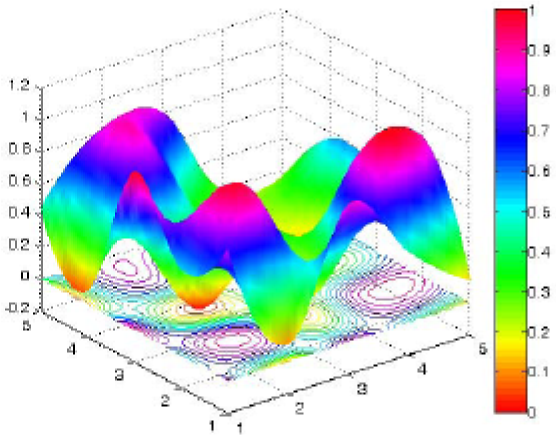
Matbab szintjelző példafeladatok

1.

Interpolation and surface plots. Write a script called `randomSurface.m` to do the following

a. To make a random surface, make Z0 a 5x5 matrix of random values on the range [0,1] (**rand**).
b. Make an X0 and Y0 using **meshgrid** and the vector 1:5 (use the same vector for both inputs into meshgrid). Now, X0, Y0, and Z0 define 25 points on a surface.
c. We are going to interpolate intermediate values to make the surface seem smooth. Make X1 and Y1 using **meshgrid** and the vector 1:.1:5 (again use the same vector for both inputs into meshgrid).
d. Make Z1 by interpolating X0, Y0, and Z0 at the positions in X1 and Y1 using cubic interpolation (**interp2**, specify cubic as the interpolation method).
e. Plot a surface plot of Z1. Set the colormap to hsv and the shading property to interp (**surf**, **colormap**, **shading**).
f. Hold on to the axes and plot the 15-line contour on the same axes (**contour**).
g. Add a colorbar (**colorbar**).
h. Set the color axis to be from 0 to 1 (**caxis**). The final figure should look something like this (if the figure isn't copy/pasting into your document appropriately, try changing the figure copy options to use a bitmap):



2.

Linear system of equations. Solve the following system of equations using ****. Compute and display the error vector

$$3a + 6b + 4c = 1$$
$$a + 5b = 2$$
$$7b + 7c = 3$$

(hiba vektor=|együttható mátrix*megoldásvektor-eredményvektor|)

3.

Hodgkin-Huxley model of the neuron. You will write an ODE file to describe the spiking of a neuron, based on the equations developed by Hodgkin and Huxley in 1952 (they received a Nobel Prize for this work). The main idea behind the model is that ion channels in the neuron's membrane have voltage-sensitive gates that open or close as the transmembrane voltage changes. Once the gates are open, charged ions can flow through them, affecting the transmembrane voltage. The equations are nonlinear and coupled, so they must be solved numerically.

a. Download the HH.zip file from the class website and unzip its contents into your homework folder. This zip folder contains 6 m-files: `alphah.m`, `alpham.m`, `alphan.m`, `betah.m`, `betam.m`, `betan.m`. These functions return the voltage-dependent opening $\alpha(V)$) and closing ($\beta(V)$) rate constants for the h, m, and n gates: $C \underset{\beta(V)}{\overset{\alpha(V)}{\rightleftharpoons}} O$

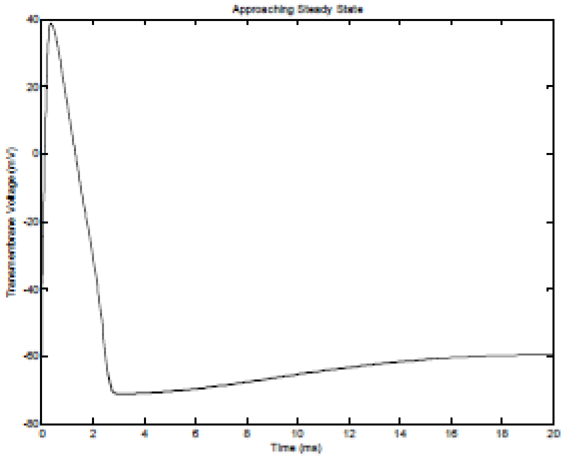
b. Write an ODE file to return the following derivatives

$$\frac{dn}{dt} = (1-n)\alpha_n(V) - n\beta_n(V)$$
$$\frac{dm}{dt} = (1-m)\alpha_m(V) - m\beta_m(V)$$
$$\frac{dh}{dt} = (1-h)\alpha_h(V) - h\beta_h(V)$$
$$\frac{dV}{dt} = -\frac{1}{C}\left(G_K n^4 (V-E_K) + G_{Na} m^3 h (V-E_{Na}) + G_L (V-E_L)\right)$$

and the following constants (C is membrane capacitance, G are the conductances and E are the reversal potentials of the potassium (K), sodium (Na), and leak (L) channels):

$$C = 1$$
$$G_K = 36$$
$$G_{Na} = 120$$
$$G_L = 0.3$$
$$E_K = -72$$
$$E_{Na} = 55$$
$$E_L = -49.4$$

c. Write a script called `HH.m` which will solve this system of ODEs and plot the transmembrane voltage. First, we'll run the system to steady state. Run the simulation for 20ms (the timescale of the equations is ms) with initial values: $n = 0.5; m = 0.5; h = 0.5; V = -60$ (**ode45**). Store the steady-state value of all 4 parameters in a vector called `ySS`. Make a new figure and plot the timecourse of $V(t)$ to verify that it reaches steady state by the end of the simulation. It should look something like this:



d. Next, we'll explore the trademark feature of the system: the all-or-none action potential. Neurons are known to 'fire' only when their membrane surpasses a certain voltage threshold. To find the threshold of the system, solve the system 10 times, each time using `ySS` as the initial condition but increasing the initial value of V by 1, 2, ... 10 mV from its steady state value. After each simulation, check whether the peak voltage surpassed 0mV, and if it did, plot the voltage with a red line, but if it didn't, plot it with a black line. Plot all the membrane voltage trajectories on the same figure, like below. We see that if the voltage threshold is surpassed, then the neuron 'fires' an action potential; otherwise it just returns to the steady state value. You can zoom in on your figure to see the threshold value (the voltage that separates the red lines from the black lines).