Assignment #1

A) Implement perceptron models with TLU, linear and logistic (sigmoid) activation functions. Plot each perceptron's response curve (output vs input) for monotonically increasing and decreasing input as well as input with some random up-swing and down-swings.

B) Download Matlab source file "hodgkin_huxley_model.m" from Itslearning. In it you are given an implementation of the Hodgkin-Huxley model of a spiking neuron. The parameter *current* is the external current that is the input to the model. The default value of *current* is 10 mA/cm^3.

Explore the firing characteristics of the model in the following manner –

1. The parameter *switch_current*, when set to 1, turns the external current off at t=100,200,... and so on for 50 time steps and then turns it on again. Set this parameter to 1 and identify the various stages of a spike – resting level, depolarisation and hyperpolarisation. For the remainder of this assignment, set *switch_current* to 0.

2. Execute the code with *current* = 10 mA/cm^3 and observe the model's response. Determine the spike frequency (number of spikes per time step) for an uninterrupted spike train. Vary the parameter *current* between 0-100 mA/cm^3 in steps of 1 mA/cm^3 and determine the spike frequency for each value of *current*. Plot spike frequency vs. *current*. Compare this curve to the sigmoid activation function used in perceptron models. Document your observations.

3. The parameters E(1), E(2) and E(3) respectively define the channel-specific battery voltages E_K, E_{Na} and E_L in the model. Vary the values of these 3 parameters for *current* = 10 mA/cm^3. How and why does the spike train change in terms of the resting potential level, maximum spike voltage level and hyperpolarisation voltage level? Can you generate spikes irrespective of the values of E(1), E(2) and E(3)? If not, change the value of *current* to see whether spikes can be generated or not.

4. Vary parameters E(1), E(2) and E(3) to generate spikes with a similar scale with respect to the resting potential level, maximum spike voltage level and hyperpolarisation voltage level as shown in slides #14.