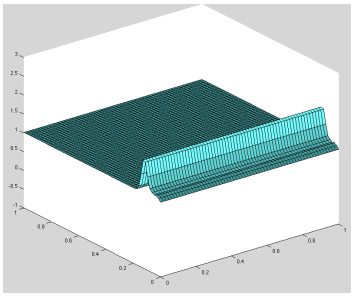
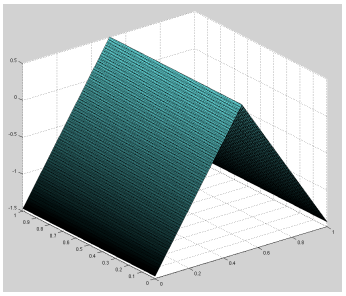
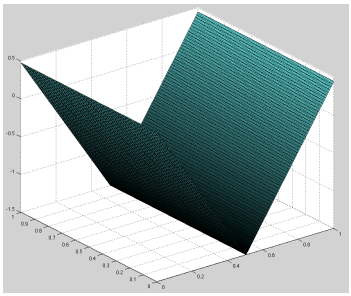
Student name: ***Enter your name here***

Homework 10: Shallow Water Waves

This homework is again very much based on the computer lab where we ran Cleve Moler's code to simulate shallow water waves travelling over a perfectly flat ocean floor. An updated version of his code that can handle variable ocean floor profile has been added to this assignment. You are asked to program different ocean topographies and study their effect on the resulting wave propagation. Wave propagation speed depends on depth: $v = \sqrt{gh}$.


(a) Initial wave profile


(b) Mid-ocean ridge model


(c) Model for ocean trench

1) Run the attached code that should produce the wave profile shown in figure (a). Increase the spatial resolution by a factor of 2 and then adjust the number of steps to that the wave travel 90% across the simulation cell during the simulation. (If the resolution increase makes the wave appear black then you do not have enough pixels on your screen. In this case run with the original resolution or 1.5 times of it.)

2) Now we want to study the effect of mid-ocean ridges using an admittedly rather primitive ocean floor shown in the figure (b). Modify the ocean floor profile on line 36 to reproduce figure (b) in shape and magnitude. Because the water level, *H*, is set to 1, your ocean floor variable, *G*, cannot be larger than 1 (no islands allowed) and should probably not be much less than -2 to the code to work smoothly. Run the code and submit a 3D figure of the final wave profile just before it reaches the opposite wall. Discuss changes in wave amplitude, direction, and speed.

3) Study model (c) for an ocean trench. Include a 3D figure and discuss changes in wave amplitude, direction, and speed.

4) Finally program your own ocean profile and discuss the implication for the wave propagation. You are encouraged to recycle your landscape from last week. Note that ground has to be submerged everywhere at all times for stable propagation. It may help you to rescale the magnitude of elevation changes to those used in parts 2 and 3 in order to have a meaningful simulation. Discuss the resulting wave in detail! Include a 3D figure of your ocean profile and your final wave profile. Now make a movie showing the wave propagation and include it with homework submission. Also submit your Matlab code for this part.

(Note: I did not succeed demonstrating the steeping of the wave profile during beach run-up. It may take larger cells or carefully chosen initial conditions. I would advise not to pursue this

effect unless you needed a challenge. In principle this is a 1D problem and would better be studied with a 1D code that would be much faster.)