

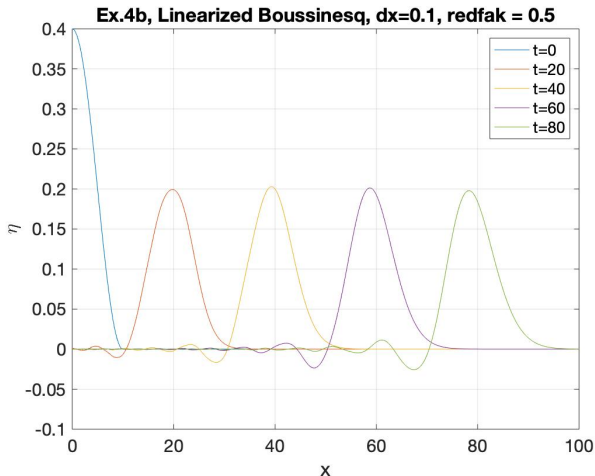
# Assignment 2, Problem 4: Wave Dispersion

MEK4320

Aurora

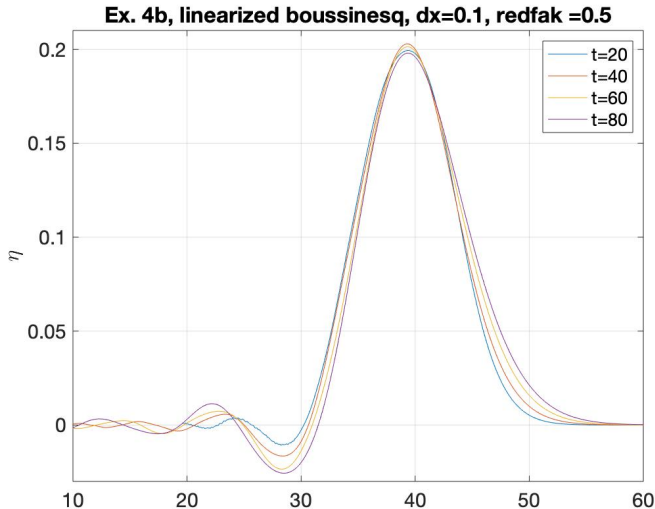
## b) Solving the linearized Boussinesq equations.

The simulation is run until  $t = 80$ , with the same parameters and initial conditions as in a).

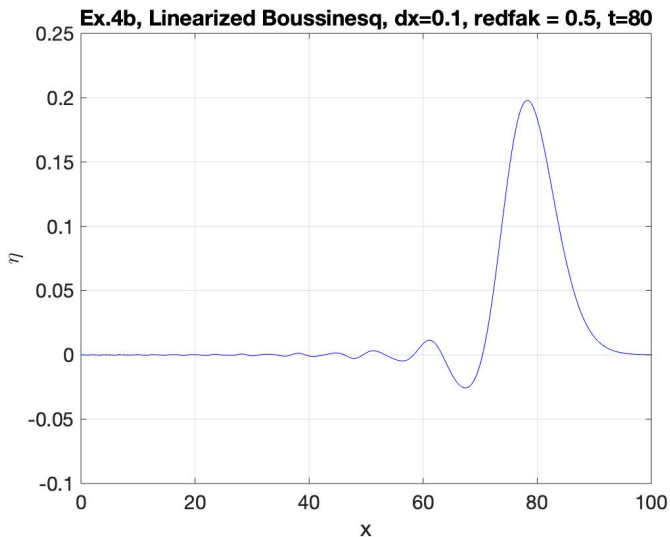


## b) Solving the linearized Boussinesq equations.

Wave train is developing behind wave front. As time increases, waves behind front increase in amplitude and in wavelength. Slower variation for larger times. Wave spreading.

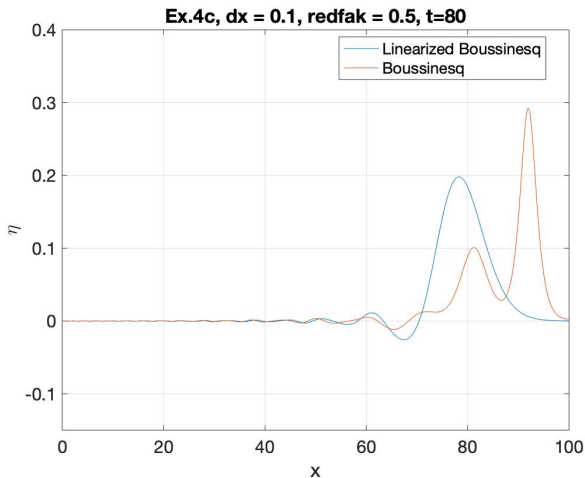


## b) Solving the linearized Boussinesq equations.



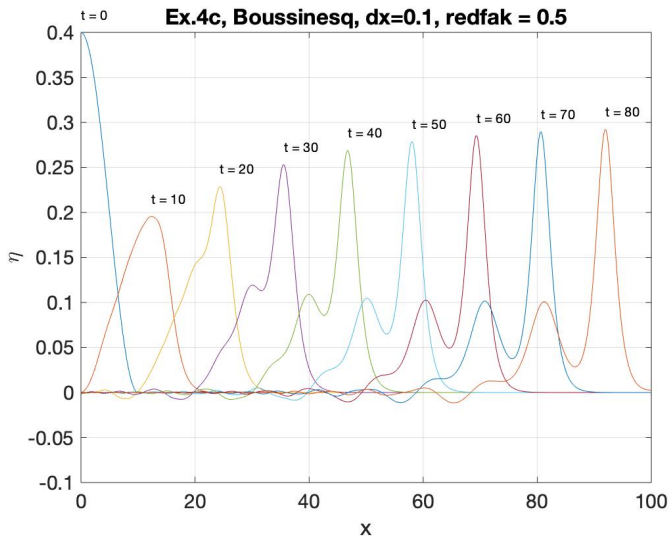
### c) Solving the full Boussinesq equations.

What is the difference from the previous case? What may the leading wave be? Difference from previous case: We still have wave train developing behind the wave front, but the shape and size of leading wave and second wave is different.



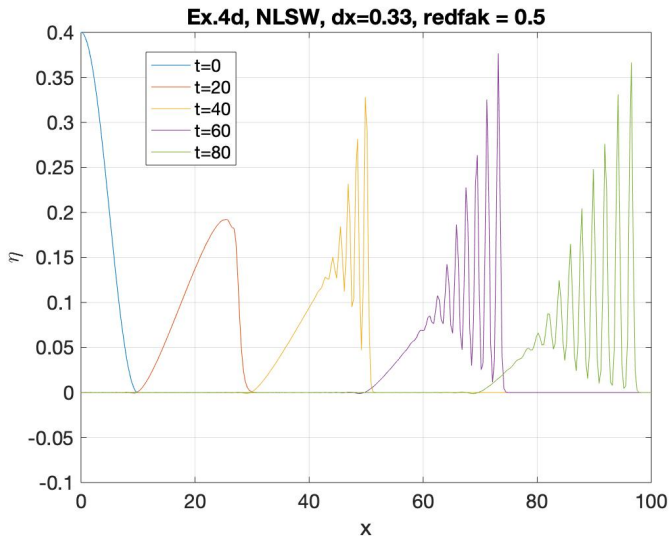
### c) Solving the full Boussinesq equations.

Figure below shows solution developing over time. It seems like leading wave separates into two waves over time. Is this an effect of nonlinearity ?



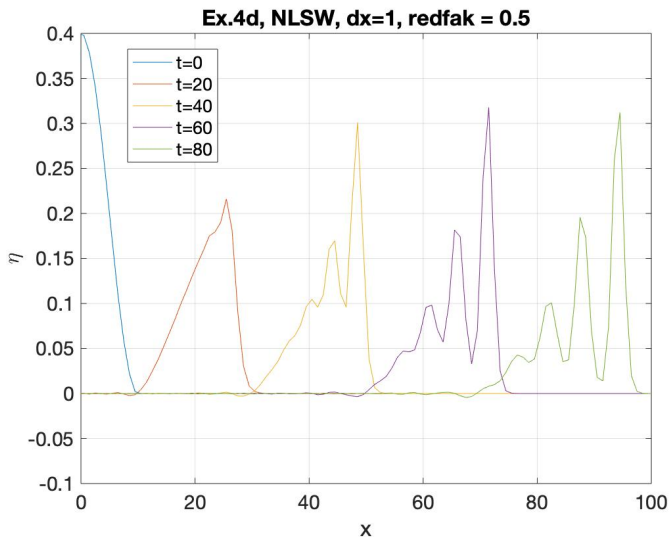
## d) Solving the NLSW equations.

Short features: Small dent in crest for  $t=20$ . Oscillations at end of crests from  $t=40$ .



## d) Solving the NLSW equations.

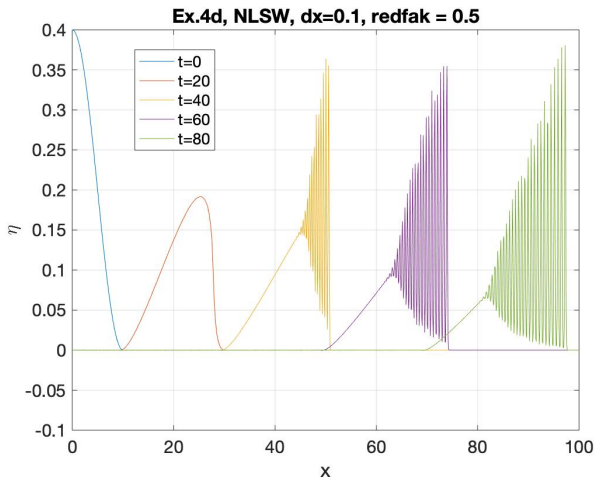
Grid refinement: For  $dx = 1$ , there are fewer oscillations on each crest, and we see wave trains behind leading wave for  $t=20$  and larger.





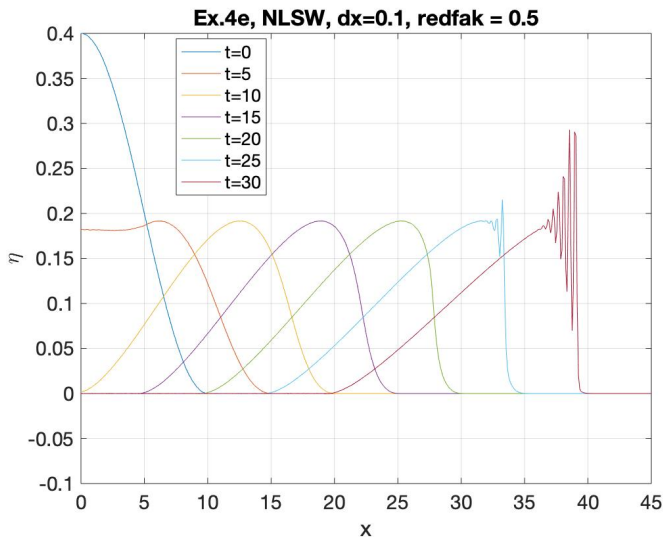
## d) Solving the NLSW equations.

Grid refinement: With fine resolution,  $dx = 0.1$ , oscillations increase but the wave trains behind the leading crests disappear. Crest for  $t=20$  loses 'dent' and is smooth. So solution has changed dramatically with grid refinement, implying that solution is invalid.



## e) NLSW equations before artifacts appear.

What happens to the shape? What may be the physical interpretation of this shape change?



## e) NLSW equations before artifacts appear.

Crests for  $t=10$ ,  $t=15$  and  $t=20$  are shown on top of each other to illustrate the shape change before artifacts appear. We see that the top of the crest moves over to the right in direction of the wave propagation. The physical interpretation of this may be wave on its way to breaking?

