Practicum OT4620, Offshore Hydromechanics

Student Assignments

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Assignments compulsory for ALL students:

As mentioned in the practicum manual, three kinds of experiments will be carried out involving the spar bouy. With the results of experiment 1 and 2 (hydrodynamic coefficients and exciting wave force), the result of experiment 3 (heave response) can be predicted. This is what we will do during the practicum.
In the following exercise problems you will make the same kind of calculation, this time using the hydrodynamic coefficients and exciting force calculated by the linear diffraction program **DELFRAC**, instead of experimental data.
The required data can be found on blackboard: The file **SPAR.OUT** contains the added mass and damping coefficients, given in kg and kg/s respectively) and the wave force amplitudes, given in N for 1 m wave height, for a range of wave frequencies.
The DELFRAC calculations were made using real scale dimensions. However, the experiments to be carried out during the practicum are of course on model scale. The model scale is 1:100.

1. In order to simplify the comparison between the calculations you are going to make and the experimental results that we will obtain during the practicum, translate the real scale DELFRAC data (frequency, added mass, damping and exciting wave force) to model scale (NB: be careful to scale from real to model scale instead of the other way around!) and plot the added mass, damping and exciting force against wave frequency on model scale. (As mentioned the DELFRAC values for the wave force are given in units per **meter** wave height. You should give the model scale wave force in units per **centimeter** wave height.)

2. Write down the uncoupled equation of motion for the heave motion of the spar, supposing that $z = z_a \cos\left(\omega t + \varepsilon_{zF}\right), \varepsilon_{zF}$ being the phase angle of the heave motion **with respect to the exciting wave force !! (**NB: in general the wave force phase angle is given with respect to the incedent wave height at the COG of the concerning body. However, for the sake of simplicity we define all phase angles with respect to the wave force in these assignments. So the phase angle for the excting wave force itself is zero. To bad you will not be able to exactly copy-paste from your text book or practicum manual now...**)**

3. What are the contributions to 'the right hand side' of your answer to the previous question ? (i.e. what are the different componentsof the exciting force ?)

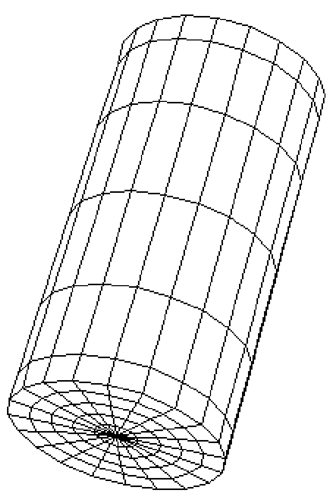

Figure 1 Panel model of Spar

The main dimensions of the spar having a circular X-Y-section are (on model scale):

Diam.	0.20m
T	0.41 m
Δ	12.74 kg

The waterdepth in the towing tank is 1.25 m

Answers to the next quesions should all be given on model scale

4. Determine the spring coefficient for the heave motion of the spar

5. What will be the resonance frequency for the heave motion ?

6. Pick a few frequencies around this resonance frequency and calculate the wave number k (for the given water depth of 1.25 m !) (TIP: you 'll have no choice but using an iterative sollution method, e.g. the 'Solver...' or 'Goal Seek...' option under the Tools menu in MS Excel might be very useful !)

7. Give the expression for the pressure due to the incident wave (Froude – Krilov pressure) at the bottom of the spar (z = -0.41 m) and calculate the heave force amplitude by integrating the Froude- Krilov pressure over the bottom of the spar for the case of 1 cm wave height. (You can assume constant pressure over the bottom area of the spar.) Plot the values in the same figure as you plotted the exciting force in question 1.

8. Solve for the same frequencies the equation of motion for the uncoupled heave motion using the exciting force and hydrodynamic coefficients from DELFRAC and the spring coefficient from question 4. Calculate the amplitude of the heave motion (again per meter wave height) and its phase angle **with respect to the exciting force !! (**see also question 2**).**
   Plot the results against wave frequency.
   NB make sure the sign for the spring term in the motion equation is correct: if the spring coefficient is defined to give the force resulting from a positive displacement, then a minus sign should appear before the spring term if you consistently apply Newton's second law (F=m*a).
   (So the correct equation to solve in that case is: $(M+a)\ddot{z}+b\dot{z}-cz=F_{z,wave}$)

See Figure 2 for (fictive) time traces of wave force on a floating structure and resulting heave motion.

9. What is the wave number in case of infinite water depth ?

For conventional reasons in hydrodynamics, the phase angle of an harmonic signal is supposed to be positive when the concerning signal is ahead of the reference signal with respect to which the phase angle is defined.

10. What is the phase angle of the motion with respect to the wave force in Figure 2 according to this convention ? (mention the sign!)

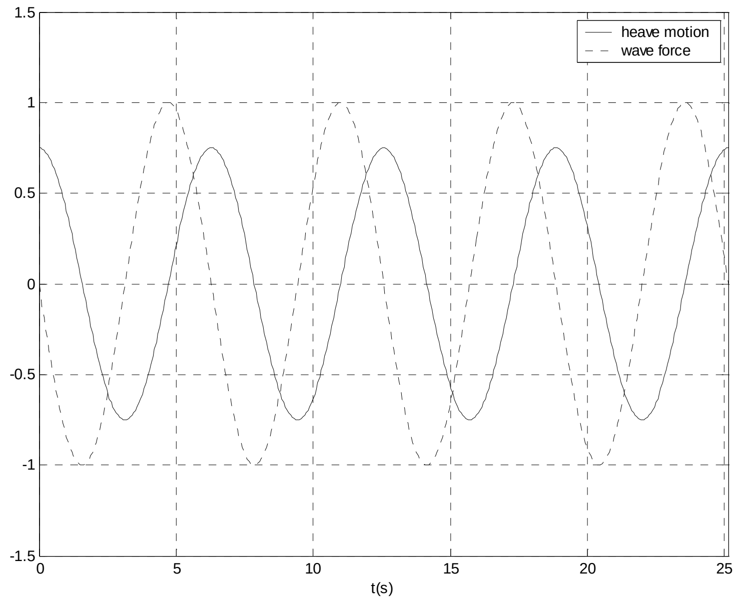

Figure 2