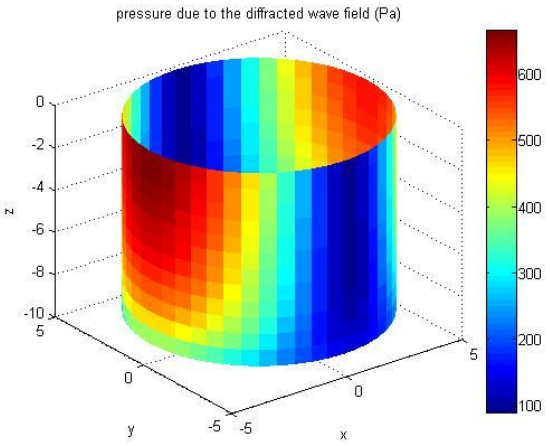
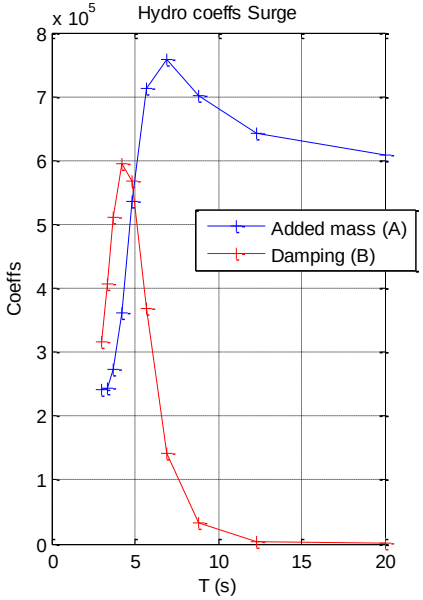
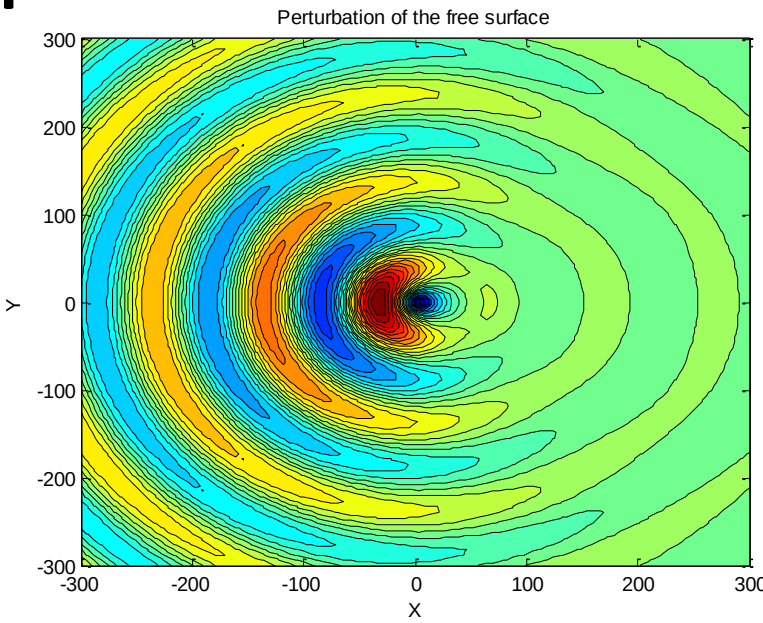
NEMOH: a tutorial using the Matlab wrapper







SUMMARY

I. Computation by Nemoh

II. Running an example : a vertical cylinder

III. Structure of some output files

IV. Troubleshooting

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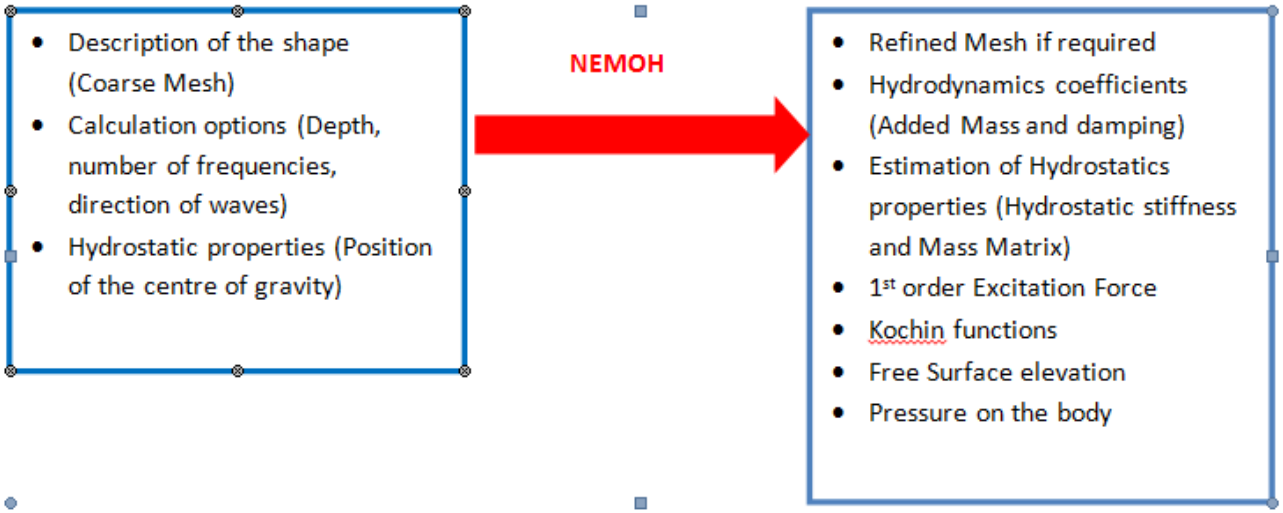
Computation by Nemoh

It is quite easy to use NEMOH with Matlab and Tecplot. However, it is also possible to use NEMOH in command lines, and it could be required for specific calculations

The following drawing recap the main inputs and outputs of NEMOH



As a result, a step-by-step procedure could be:

I. ***Define the location of the working folder and some characteristics of the Mesh file and Mesh the Body***
II. ***Define Calculation options and launch the computation***
III. ***Calculate the motions RAOs / Use the different output files***

Running an example : a vertical cylinder

I. Specify mesh file characteristics and mesh the body

A vertical cylinder is an axisymettric shape. As a result, the Matlab routine Aximesh.m could be used for the purpose.

Only the submerged part needs to be meshed, and because of the revolution, only 3 points are required (points 1,2 and 3 on the drawing next page).

Preparation of the input mesh file for Mesh.exe

Working folder

Target number of panels for the refined mesh and final mesh characteristics created by Mesh.exe

```
- Enter number of points for angular discretisation : 25

--> Number of nodes             : 75
--> Number of panels (max 2000) : 48

- Directory name for storage of results : 'Folder with mesh and results'
- Vertical position of gravity center : -2
- Target for number of panels : 250

Characteristics of the mesh for Nemoh

--> Number of nodes : 576
--> Number of panels : 240
```

```
--- Environment ------------------------------------------------------------
1000.0              ! RHO              ! KG/M**3   ! Fluid specific volume
9.81                ! G          ! M/S**2    ! Gravity
0.                ! DEPTH          ! M     ! Water depth
0.  0.              ! XEFF YEFF      ! M     ! Wave measurement point
--- Description of floating bodies -----------------------------------------
1                 ! Number of bodies
--- Body 1 -----------------------------------------------------------------
Folder_with_mesh_and_results\mesh\axisym.dat        ! Name of mesh file
576 240           ! Number of points and number of panels
6                 ! Number of degrees of freedom
1 1. 0. 0. 0. 0. 0.      ! Surge
1 0. 1. 0. 0. 0. 0.      ! Sway
1 0. 0. 1. 0. 0. 0.      ! Heave
2 1. 0. 0. 0. 0. -2      ! Roll about a point
2 0. 1. 0. 0. 0. -2      ! Pitch about a point
2 0. 0. 1. 0. 0. -2      ! Yaw about a point
6                 ! Number of resulting generalised forces
1 1. 0. 0. 0. 0. 0.      ! Force in x direction
1 0. 1. 0. 0. 0. 0.      ! Force in y direction
1 0. 0. 1. 0. 0. 0.      ! Force in z direction
2 1. 0. 0. 0. 0. -2.         ! Moment force in x direction about a point
2 0. 1. 0. 0. 0. -2.         ! Moment force in y direction about a point
2 0. 0. 1. 0. 0. -2.         ! Moment force in z direction about a point
0                 ! Number of lines of additional information
--- Load cases to be solved ------------------------------------------------
1   0.8 0.8       ! Number of wave frequencies, Min, and Max (rad/s)
1   0.  0.        ! Number of wave directions, Min and Max (degrees)
--- Post processing --------------------------------------------------------
1   0.1 10.       ! IRF                ! IRF calculation (0 for no calculati
0                 ! Show pressure
0    0. 180.          ! Kochin function       ! Number of directions of cal
0    50 400.    400.     ! Free surface elevation    ! Number of points in
---
```

Modified by Nemoh.m or by hand

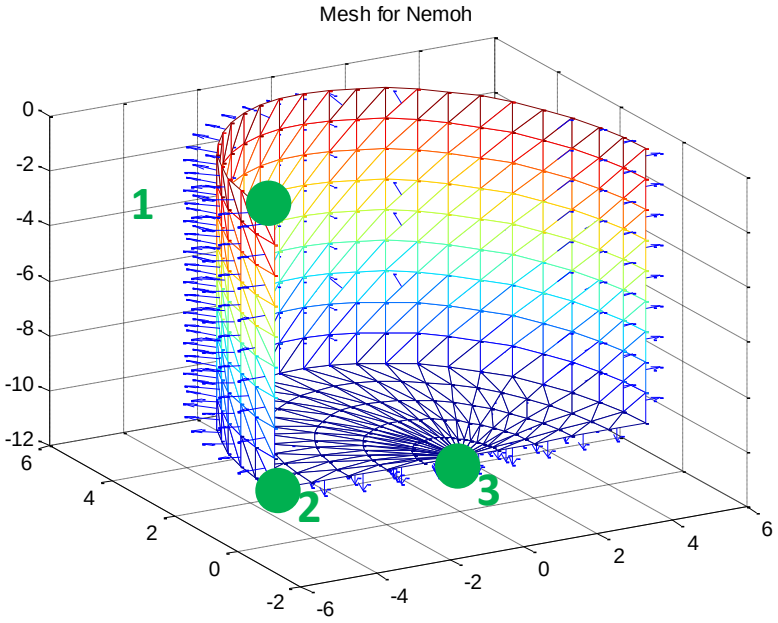
Nemoh.cal created

```
%% VERTICAL CYLINDER
clc
clear all
close all

n=3; % 3 points are required for describing the shape
Radius =5; % Radius of the cylinder
Draft=-10; % Height of the submerged part
r=[Radius Radius 0]; % r is the first coordinates of the
z=[0 Draft Draft];
[Mass,Inertia,KHyd,XB,YB,ZB]=axiMesh(r,z,n);% Call the function axiMesh.m
M=Inertia; % Mass Matrix

save('Mesh_outputs','KHyd','M')
```

Example of matlab routine

Running an example : a vertical cylinder

I. Specify mesh file characteristics and mesh the body



- ✓ The blue pointers have to be oriented outward the body
- ✓ Only half of the body is described
- ✓ The Hydrostatic outputs are especially the hydrostatic stiffness and the approximated mass matrix.
- ✓ Nemoh.cal and ID.dat are modified each time the Mesh routines are launched

Aximesh.m can mesh only 1 body, but Mesh.m can mesh several. For more sophisticated bodies, one should use a CAD software and adapt the Mesh file in the good format

Running an example : a vertical cylinder

II. Define calculation options and launch computation

The water depth (m), the wave frequency (rad/s) and the direction of the incident waves have to be written in Nemoh.cal.

Added options (for free surface visualisation, pressure and drift force) could also be written in Nemoh.cal, see the post « Matlab routine for using pressure, free surface elevation and kochin functions output files: flags in Nemoh.cal + reading" on the forum.

Nemoh.m modifies Nemoh.cal, launchs the code and reads the relevant output files.

```
%------------Define calculation options-------------
nbfreq=10; % number of calculations = (number of BVP per frequency*number of frequencies)
w= linspace(2*pi/20,2*pi/3,nbfreq)'; % Periods from 3s to 20s for waves for instance
dir=0;% angle of the incident waves
depth=60; % water depth (m)
%-------Launch Calculation------------
[A,B,Fe]=Nemoh(w,dir,depth); % Call the function Nemoh.m
save('Nemohresult_test','A','B','Fe','w')
```

- ✓ One should see the BVPs solved by NEMOH

```
------ Starting NEMOH -----------

  Summary of calculation

  ->  Water depth =   60.00 m
  ->   10 wave frequencies from  0.3142 to  2.0944
  ->    1 wave directions from   0.0000 to  0.0000
  ->    6 radiation problems
  ->    6 forces

------ Solving BVPs -------------

  -> Initialisation . . Done !

  -> Solve BVPs and calculate forces

 Problem      1 /    70 . . Done !
 Problem      2 /    70 . . Done !
 Problem      3 /    70 . . Done !
 Problem      4 /    70 . . Done !
 Problem      5 /    70 . . Done !
```

- ✓ Infinite frequency and 0 frequency couldn't be solved.
  For the infinite added mass, see IRF.tec

Running an example : a vertical cylinder

II. Calculate the motions RAOs

NEMOH could be used for several purposes in Hydrodynamics. One of them is the response of a floating body subjected to waves, this is the one which is The Hydrodynamic equation could be written as:

$$M\ddot{X} = F_{W/S} + F_{gravity} + F_{others}$$

NEMOH gives an approximation of a certain part of the Wave-structure interaction : Approximated buoyancy force, radiation force and excitation force.

From these outputs, it is thus easy to calculate a linearised and approximated 1st order motion RAO. With the Cummins equation in frequency domain, one can obtain:

$$X(\omega) \approx \frac{F_e(\omega)}{(-\omega^2(M + A(\omega)) - i\omega(B(\omega)) + K_H)}$$

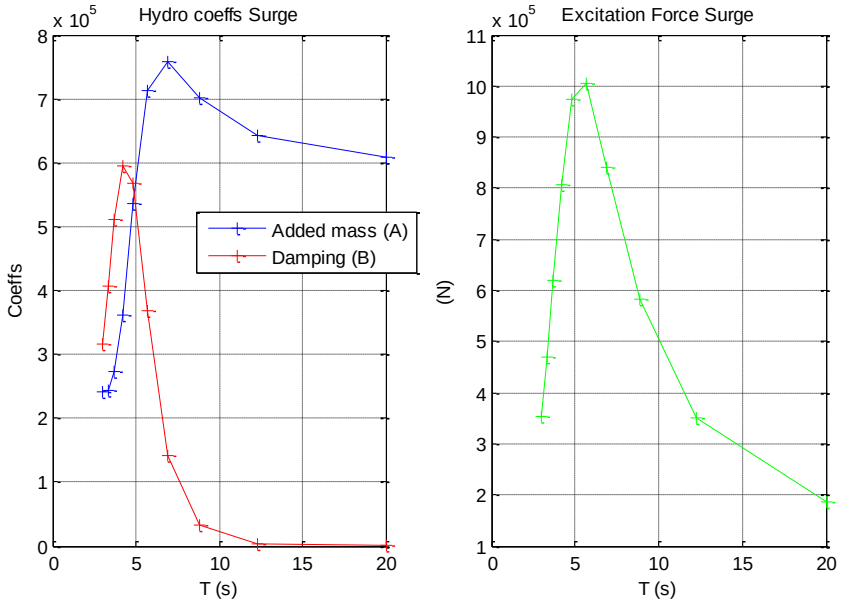
With A the added mass, B the radiation damping, Fe the excitation force, and Kh the hydrostatic stiffness.

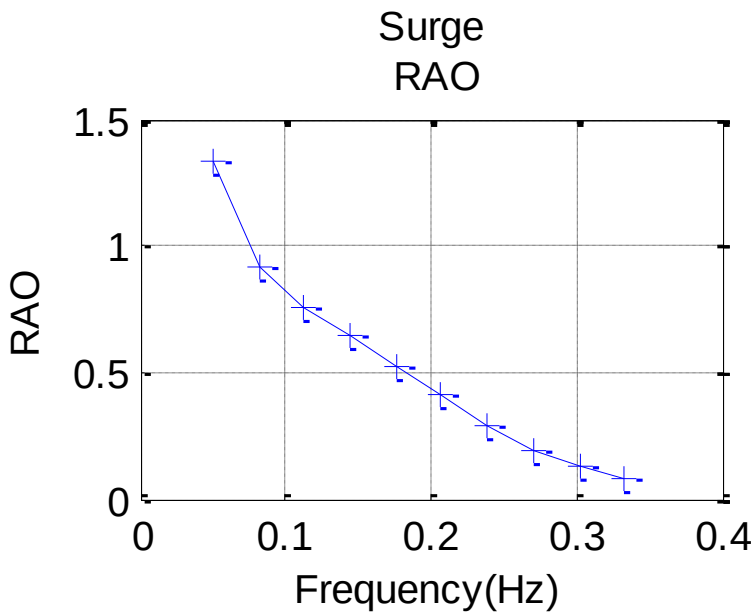
After this first step, one can develop an analysis in frequency or time domain, with additional forces (for example viscous forces, moorings restoring force,…)

Running an example : a vertical cylinder

II. Calculate the motions RAOs

Below an illustration on a vertical cylinder





- ✓ One should check if there are irregular frequencies
- ✓ Infinite frequency and 0 frequency couldn't be solved. For the infinite added mass, see IRF.tec

Structures of some outputs files

Pressure.XX.dat: Pressure field on the body for each BVP

Coordinates of the nodes and value of the pression (complex numbers)

Number of nodes and number of panels

Links for the FULL Mesh of the body.

```
VARIABLES="X" "Y" "Z" "abs(p) (Pa)" "angle(p) (rad)"
ZONE N=    3648,E =     912,F=FEPOINT,ET=QUADRILATERAL
   4.669705      0.6147784     -9.100000      322.3094      2.062242
   4.669705      0.6147784     -8.341667      322.3094      2.062242
   4.710000      0.0000000E+00 -8.341667      322.3094      2.062242
   4.710000      0.0000000E+00 -9.100000      322.3094      2.062242
   4.669705      0.6147784     -8.341667      390.5927      1.922403
   4.669705      0.6147784     -7.583333      390.5927      1.922403
   4.710000      0.0000000E+00 -7.583333      390.5927      1.922403

3648  -4.037143     0.0000000E+00 -9.100000      302.5531      -2.3
3649  -4.710000     0.0000000E+00 -9.100000      302.5531      -2.3
3650  -4.669705     -0.6147784    -9.100000      302.5531      -2.3
3651        1           2           3           4
3652        5           6           7           8
3653        9          10          11          12
3654       13          14          15          16
3655       17          18          19          20
```

FreesurfaceXX.dat:

Coordinates of the nodes and value of the perturbation potential

Number of nodes and number of panels

Links for the Mesh of the free surface

```
VARIABLES="X" "Y" "abs(eta) (m)" "angle(phi) (rad)" "PRE1" "PRE2"
ZONE N=  10000,E =     9801F=FEPOINT,ET=QUADRILATERAL
 -300.0000      -300.0000      4.3511475E-03  2.621856      3.7765796E-03
-2.1610023E-03
 -300.0000      -293.9394      4.3729371E-03  2.555337      3.6427353E-03
-2.4193097E-03
 -300.0000      -287.8788      4.3944465E-03  2.490232      3.4947244E-03
-2.6642184E-03
 -300.0000      -281.8182      4.4154236E-03  2.426430      3.3335865E-03
-2.8953699E-03

0000  -2.4193113E-03
0001   300.0000      300.0000      4.3511498E-03  2.621857      3.7765824E-03
0002  -2.1610023E-03
0003        1           2          102         101
0004        2           3          103         102
0005        3           4          104         103
0006        4           5          105         104
0007        5           6          106         105
```

Kochin.XX.dat: Kochin functions for each BVP and at different orientations.

Col 1: value (rad) of the angle (Θ) where the Kochin function is estimated

Col 2: abs (Kochin(Θ))

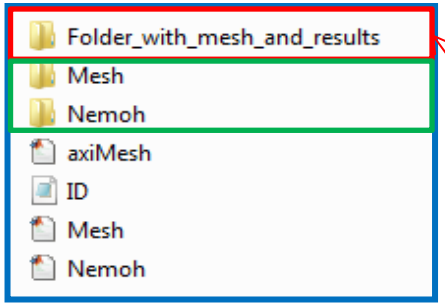
Col3: angle (Kochin(Θ))

```
1   -1.570796      2.429480      -1.575284
2   -1.553343      2.412888      -1.575322
3   -1.535890      2.395092      -1.575360
4   -1.518437      2.378117      -1.575398
5   -1.500983      2.362655      -1.575434
6   -1.483530      2.347259      -1.575477
7   -1.466077      2.329947      -1.575514
8   -1.448623      2.313841      -1.575555
```

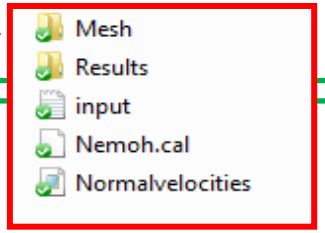
Troubleshooting

- *The calculation doesn't start or I can't mesh the body.*

  ⟹ Make sure the executable versions of the code are located in the correct folders. See below the location of the executables in Mesh and Nemoh



Working folder



Folder created by the user (when using aximesh.m or mesh.m for instance)

Mesh has to contain Mesh.exe and « Nemoh has to contain Solver.exe, Preprocessor.exe, postprocessor.exe

Nemoh.cal and input.txt have to be in the working folder before the calculation. Normalvelocities is created by preprocessor.exe

- *At some frequencies, the values of the excitation force and radiation coefficients are unusual, the curves are not regular (and sometimes could give a negative radiation damping !)*

  ⟹ With a BEM, « irregular frequencies » could appear. Those frequencies correspond to singularities in the system of equations solved. In the actual version, NEMOH doesn't include additional equations for removing these singularities.

- *How could I launch the calculations for only 1 Degree of Freedom ?*

  ⟹ The actual Matlab routines launch the calculation for the 6 Degrees of Freedom. For only one, one should run Nemoh in command lines.

- *What part of my body should I mesh ? If there is a pretension due to the moorings, how could I take it into account ?*

  ⟹ Only the submerged part at the ***equilibrum*** position has to be meshed. If there is an added draft due to a mooring pretension, one should mesh the new equilibrum position.

  ⟹ This is one of the major limitation of a BEM.