Stokastiske og ikke-lineære havbølger
- MEK4350 -

Suggested exercises for the part of stochastic linear waves

(document of three pages)

Two exercises are proposed. The first exercise (e.g. Analysis of wave elevation time series) will be done as a practical work during the last lecture of the Gaussian waves part. The second exercise (e.g. Analysis of spatio-temporal wave elevation wave elevation fields) should be done by each student and delivered in a PDF document before the course ends.

1 Analysis of wave elevation time series

Download the following files:

- `BayOfBiscay.mat`: buoy record of a swell wave field measured by an anchored buoy in the Bay of Biscay in deep waters.
- `NewYearWave.mat`: pointer laser record of a wind-sea wave field measured in the Draupner platform (North Sea).

For each record file, proceed with the following:

1. Plot the wave elevation time series.
2. Compute the significant wave height H_s form the standard deviation of the data.
3. Calculate Δf and the Nyquist limit in frequecy.
4. Estimate the wave spectrum $S(f)$ (for $f \geq 0$) from the wave elevation time series.
5. Plot the wave spectral estimation $S(f)$
6. Compute the spectral moments: m_{-1}, m_0, m_1, m_2.

7. Estimate H_s from the power spectrum $S(f)$.

8. Estimate the mean periods T_{m01} andT_{m02}.

9. Discuss for each record if the wave spectrum $S(f)$ describes the statistical behavior of all the individual waves in the record.

2 Analysis of spatio-temporal wave elevation wave elevation fields

Download the following files corresponding to wave elevation field depending on the spatial and temporal coordinates $\eta(x, y, t)$.

- `Record3D_1.mat`.
- `Record3D_2.mat`.
- `Record3D_3.mat`.

Each data file is written in `MATLAB` format containing the following variables:

- `dt`: sampling time Δt in seconds.
- `dx`: sampling spatial resolution in the x-axis Δx in meters.
- `dy`: sampling spatial resolution in the y-axis Δy in meters.
- `nt`: array dimension on the temporal coordinate.
- `nx`: array dimension on the x-spatial coordinate.
- `ny`: array dimension on the y-spatial coordinate.
- `waves3d`: wave elevation field $\eta(x, y, t)$ in meters.

From these data answer to the following questions:

1. Compute the sampling spectral variables $(\Delta k_x, \Delta k_y, \Delta\omega)$, and their respective Nyquist limits in the International System of Units.

2. Estimate the three-dimensional spectrum $F^{(3)}(\mathbf{k}, \omega)$.

3. Plot the spectrum $F^{(3)}(k_x, k_y, \omega)$ for different frequency planes ω = constant, where constant ≥ 0.5 rad s^{-1}.

4. Plot the spectrum in the transect $F^{(3)}(0, k_y, \omega)$.
5. Plot the spectrum in the transect $F^{(3)}(k_x, 0, \omega)$.
6. Is it possible to identify the dispersion relation from the plots above?
7. Compute and plot the unambiguous wave number spectrum $F_+^{(2)}(\mathbf{k})$.
8. Compute H_s for each record by using the following tecnhniques:
    - from the standard deviation of the wave elevation filed.
    - from the three-dimensional spectrum $F^{(3)}(\mathbf{k}, \omega)$.
    - from the two-dimensional spectrum $F_+^{(2)}(\mathbf{k})$.
9. Looking at the results, which record corresponds to wind sea case, swell and a bimodal sea state?