HOMEWORK CE576 STATISCTICAL METHODS IN COASTAL ENGINEERING

ASSIGNMENT NO. 1 -- PART (1)

Write a computer program which will compute:

$$\eta(t) = \sum_{i=1}^{N} \eta_i(t) \qquad (N=30)$$

$$\eta_i(t) = a_i \cos(2\pi f_i t + \epsilon_i) \qquad (0 \le t \le 600\ s, \quad \Delta t = \cancel{1s}\ 0.5)$$

$$f_i = 1.1 f_{i-1} \qquad (f_0 = 0.04\ Hz)$$

$$a_i^2 = 0.1 f_i \left\{0.257 A^2 B (B f_i)^{-5} \exp\left[-1.03 (B f_i)^{-4}\right]\right\}$$

$A = 3.5$, $B = 7.0$

ϵ_i is chosen randomly in the range **[0 , 2π]**

Save the output [the total surface elevation values, $\eta(t)$] in a disk file for later use.

(1) Draw a plot of the surface elevations: $\eta_6(t)$, $\eta_8(t)$, $\eta_{10}(t)$, $\eta_{13}(t)$, $\eta_{16}(t)$, $\eta_{20}(t)$ and $\eta_{26}(t)$ for a time period of 300s.

(2) Draw a plot of the total surface elevations: $\eta(t)$ for a time period of 300s.

ASSIGNMENT NO. 1 -- PART (2)

Write a computer program which will analyze wave records using both:

(1) Zero-upcrossing method, and
(2) Zero-downcrossing method.

Your program should compute all possible statistical parameters for the given wave record (especially: H_{max} , T_{max} , $H_{1/10}$, $T_{1/10}$, $H_{1/3}$, $T_{1/3}$, $\overline{H}$ and $\overline{T}$). H_{rms}

Run your program with the data you saved in the first assignment. Draw the histogram of the wave heights using a suitable wave height increment for grouping wave heights (e.g. ΔH = 0.5 m).

HOMEWORK 2

PART I: COMPUTER WORK:

Perform FFT analysis to the wave record you produced in Assignment No. 1 - Part 1. Then carry out the following:

1. Plot the produced spectrum smoothed by averaging:
   i) for 8 neighbouring points, and
   ii) for 16 neighbouring points.
2. Compute and plot the confidence interval for 90% confidence level at the spectral peak (i.e. at the maximum spectral energy) for the two cases above.
3. Compute the significant wave height, the mean wave period and the peak wave period. Compare with the results obtained from zero-crossing method.
4. Compute three different spectral bandwidth parameters for the resulting spectrum.
5. Compute and plot (on the plots produced in part 1 above) the Peirson-Moskowitz (PM) spectrum in terms of significant wave height and period found from statistical analysis (Assignment No. 1 - Part 2).
6. Comment on the results.

PART II: PROBLEMS:

1. A storm with significant wave height ($H_{1/3}$) of 4 m and mean wave period (T_{mean}) of 8 s attacks a breakwater with a crest elevation (h_c) of 4 m. Estimate the percentage of waves that overtop the breakwater during this storm. Assume the following:

a) The given wave height and period are at the structure location (i.e. no need to make any wave transformation).

b) The individual wave heights and periods are uncorrelated, and the wave heights and the squares of wave periods are Rayleigh distributed.

c) The run-up (R_u) over a given structure can be computed as:

$$\frac{R_u}{H} = \xi = \frac{\tan\alpha}{\sqrt{H/L_o}} \quad ; \qquad \tan\alpha = 1/3 \quad \textit{for this breakwater.}$$

Note that overtopping occurs when $R_u > h_c$.

2. A wave record of one hour duration was measured at a location during a certain storm. Spectral analysis was carried out and the following expression was found to fit the resulting spectral estimates (measured spectrum):

$$E(\omega) = 0.8175\ \omega^{-5} \exp(-\ 0.1211\ \omega^{-4}) \quad ; \quad \textit{where:} \quad \omega = 2\pi f$$

(a) Rewrite the spectrum in terms of frequency, f; i.e. find E(f).
(b) Compute the peak wave period (period of spectral peak) and mean wave period.
(c) Compute the significant wave height.
(d) What is the maximum individual wave height expected to occur in this record?
(e) Try to rewrite the spectrum in terms of wave period, T; i.e. find E(T).

(Part f below will be covered towards the end of Chapter 3. You have to do it later!)

(f) Compute the minimum storm duration and the minimum fetch length required in order to obtain this wave record.

EXERCISE 1

Exercise #1

ⓐ Prove that for a wave record with N waves, the relation

$$H_{max} = \sqrt{\frac{\ln N}{2}} \quad H_{1/3}$$

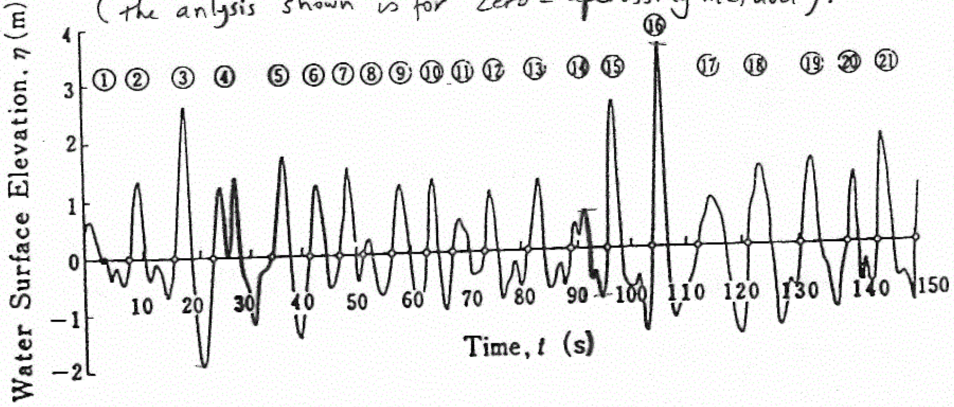
is correct.

ⓑ Derive the probability density function of wave amplitude, $p(a)$, where $a = H/2$.

ⓒ Use the zero-down crossing method to analyze the following wave record and to compute:

H_{max}, T_{max}, $H_{1/10}$, $T_{1/10}$, $H_{1/3}$, $T_{1/3}$, $\bar{H}$, $\bar{T}$, H_{rms}

(the anlysis shown is for zero-upcrossing method).



Zero upcrossing analysis:

Wave number	Wave height H(m)	Wave period T(s)	Order number m
①	0.54	4.2	21
②	2.05	8.0	12
③	4.52	6.9	2
④	2.58	11.9	8
⑤	3.20	7.3	4
⑥	1.87	5.4	17
⑦	1.90	4.4	16
⑧	1.00	5.2	20
⑨	2.05	6.3	13
⑩	2.37	4.3	10
⑪	1.03	6.1	19
⑫	1.95	8.0	15
⑬	1.97	7.6	14
⑭	1.62	7.0	18
⑮	4.08	8.2	3
⑯	4.89	8.0	1
⑰	2.43	9.0	9
⑱	2.83	9.2	7
⑲	2.94	7.9	6
⑳	2.23	5.3	11
㉑	2.98	6.9	5