Fall 2002 13.00 Problem Set 7 — Answers

1.(a.) In <u>The Perfect Storm</u> (page 141), Sebastian Junger writes that at 10 pm on October 28th (before the storm peaked), the sustained average wind speed was 40 knots. Assuming an adequate fetch and duration such that a fully developed sea state was achieved, what values would you predict from the Peirson-Moskowitz spectrum for the average wave height and the significant wave height?

3.2, 9.05

(b.) Estimate values for the frequency, wavelength, phase velocity, and group velocity of the most energetic waves.

most energtic waves: $\lambda_{max} = 354$ meters.

phase velocity: $c_p = sqrt(\frac{g\lambda}{2\pi}) = 23.5$ m/sec.

frequency: $f = \frac{c}{\lambda} = .066$ Hz.

group velocity: $c_g = 0.5c_p = 11.75$ m/sec.

(c.) Later in the storm, the book speculates that the *Andrea Gail* might have experienced significant wave heights of 30 meters. Assuming the seas were fully developed and could be described by the Peirson-Moskowitz spectrum, what wind speed would have been necessary to create these waves?

$U = sqrt(30/.0213) = 37.52$.

(d.) Junger reports that data buoy #44147 recorded significant wave heights over 50 feet. What wind speeds do you estimate for this location? What would be the wavelength, phase velocity, group velocity, energy density, and flux rate of the most energetic waves?

Significant wave height of 15.24 meters implies a wind speed of 26.7 meters/second. This implies (from the formulae on page 114):

most energtic waves: $\lambda_{max} = 596$ meters.

phase velocity: $c_p = sqrt(\frac{g\lambda}{2\pi}) = 30.5$ m/sec.

frequency: $f = \frac{c}{\lambda} = .052$ Hz.

group velocity: $c_g = 0.5 c_p = 15.25$ m/sec.

energy density: TE$= \frac{1}{2}\rho g\overline{\zeta^2}$. To get $\overline{\zeta^2}$, use Eqn. 11.58, $\overline{\zeta^2} = .0000285 * U^4 = 144$.TE $= 1.45$MJ/m^2.

flux rate: $\overline{\mathrm{F}} = \mathrm{TE} * c_g = 22.1$MW/m.

(e.) Do the numerical values you calculate match your expectations for the ferocity of the storm as described in the book? Discuss/explain any discrepancies.

This is a subjective answer.

2.

```
%% 13.00 hw7
%% Script to make all the plots
%% (After that, I used ginput() to select points on the graphs, as shown
%% in class, then I computed c_g and c_p manually
clear all;
close all

load half_hz.dat
waves = half_hz;
figure(1)
plot(waves(:,1), waves(:,2), 'r');
hold on
plot(waves(:,1), waves(:,3), 'g');
plot(waves(:,1), waves(:,4), 'k');
grid on
zoom on
title('13.00 wave probe data for 0.5 Hertz');
print -depsc f1.ps


load one_hz.dat
waves = one_hz;
figure(2)
plot(waves(:,1), waves(:,2), 'r');
hold on
plot(waves(:,1), waves(:,3), 'g');
plot(waves(:,1), waves(:,4), 'k');
grid on
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```
zoom on
title('13.00 wave probe data for 1.0 Hertz');
print -depsc f2.ps


load one_and_a_half_hz.dat
waves = one_and_a_half_hz;
figure(3)
plot(waves(:,1), waves(:,2), 'r');
hold on
plot(waves(:,1), waves(:,3), 'g');
plot(waves(:,1), waves(:,4), 'k');
grid on
zoom on
title('13.00 wave probe data for 1.5 Hertz');
print -depsc f3.ps

load two_hz.dat
waves = two_hz;
figure(4)
plot(waves(:,1), waves(:,2), 'r');
hold on
plot(waves(:,1), waves(:,3), 'g');
plot(waves(:,1), waves(:,4), 'k');
grid on
zoom on
title('13.00 wave probe data for 2.0 Hertz');
print -depsc f4.ps
```