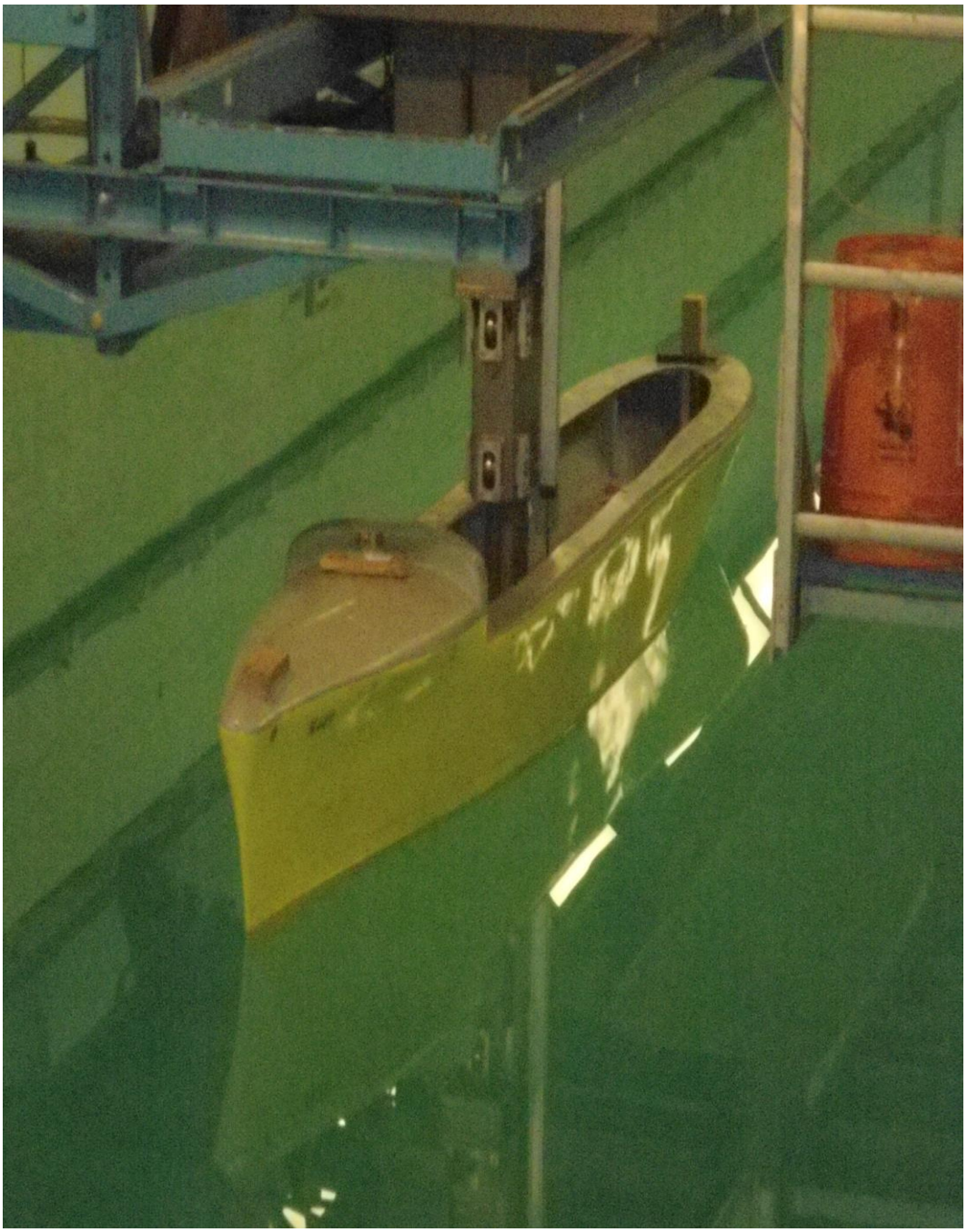
# EXPERIMENTAL METHODS

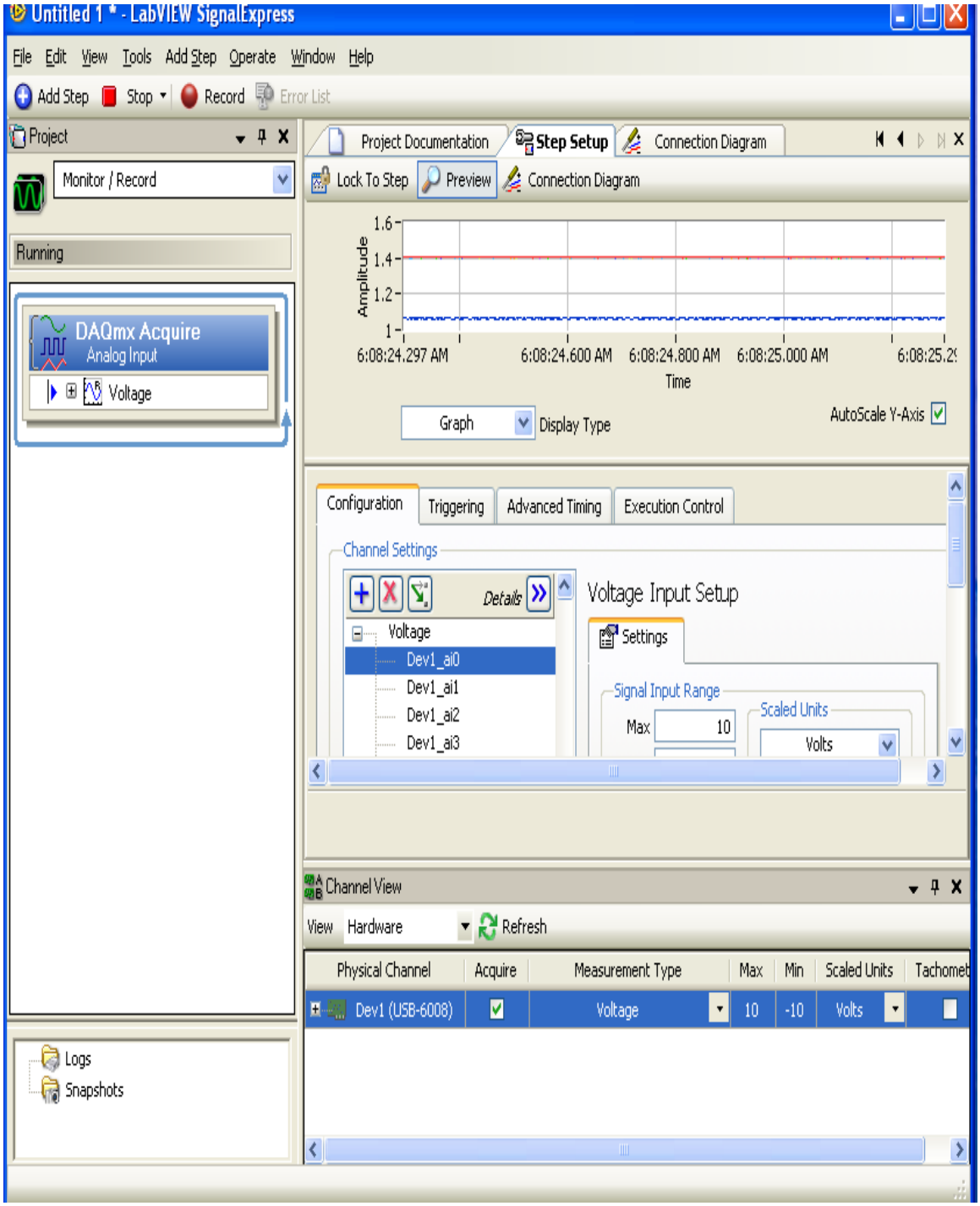
## SIGNAL PROCESSING LAB

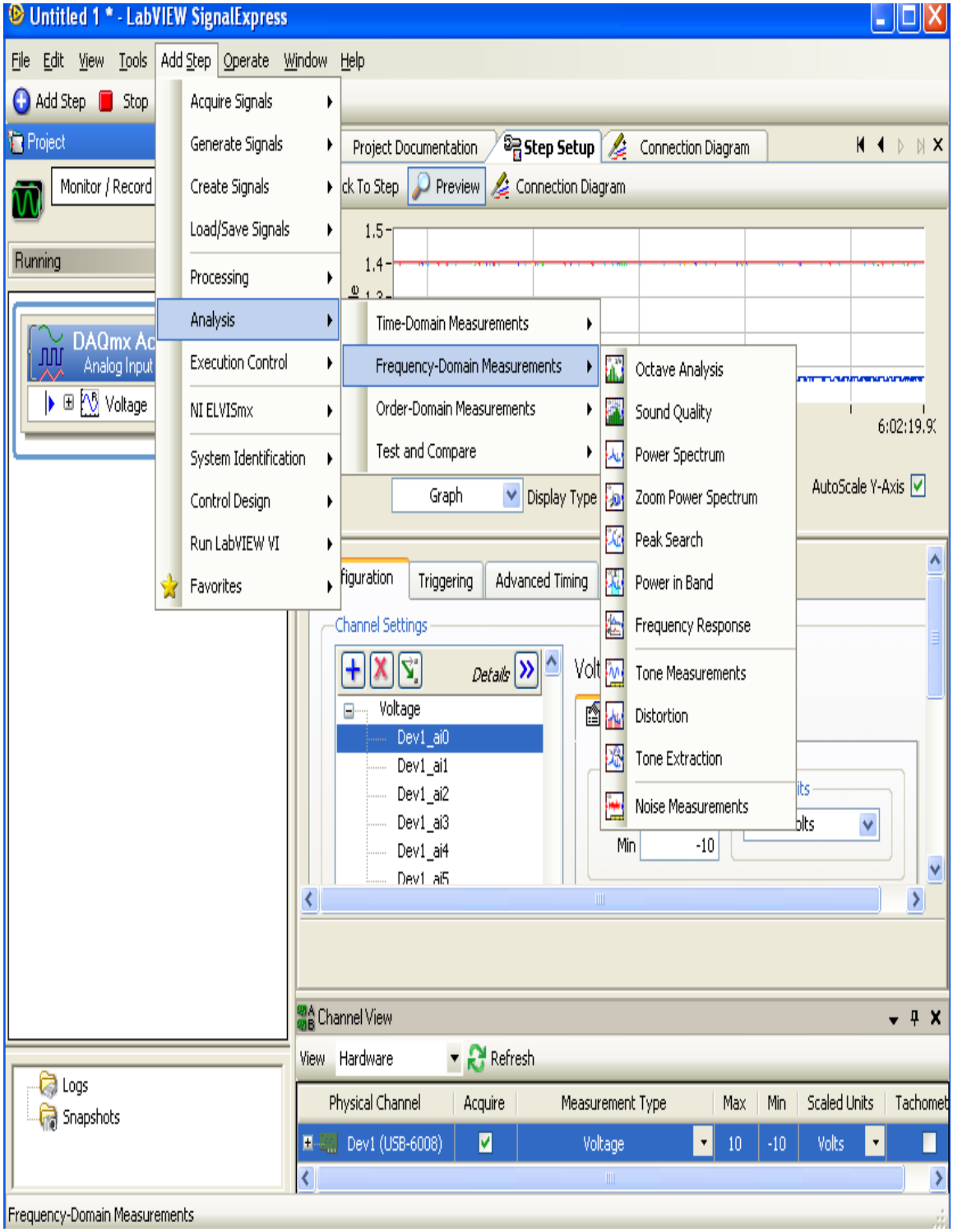
PURPOSE: The main purpose of this lab is to give you some experience doing spectral analysis of data using Fourier Transforms. Another purpose to give you some experience using LabView Signal Express.

SETUP: A boat free to pitch and heave has been installed in the wave tank. A boat pitch angle sensor and a capacitance wave probe have been wired to a NI DAQ. The DAQ reads data using LabView Signal Express. The wave board controller can make the board generate pure sinusoidal waves and random waves with a specific distribution of wave energy.

OBSERVATIONS: Measure the boat pitch response in both pure sinusoidal waves and random waves. Process the response and wave data using the Fast Fourier Transform code signals.m and the Standard Fourier Transform code waves.m. Apply a band pass filter to the data and repeat the data processing.




Untitled 1 * - LabVIEW SignalExpress
File Edit View Tools Add Step Operate Window Help
Add Step Stop Record Error List
Project
Monitor / Record
Running
DAQmx Acquire
Analog Input
Voltage
Logs
Snapshots
Project Documentation
Step Setup
Connection Diagram
Lock To Step
Preview
Connection Diagram
Amplitude
1.6
1.4
1.2
1
6:08:24.297 AM
6:08:24.600 AM
6:08:24.800 AM
6:08:25.000 AM
Time
Graph
Display Type
AutoScale Y-Axis
Configuration
Triggering
Advanced Timing
Execution Control
Channel Settings
Details
Voltage
Dev1_ai0
Dev1_ai1
Dev1_ai2
Dev1_ai3
Voltage Input Setup
Settings
Signal Input Range
Max
10
Scaled Units
Volts
Channel View
View
Hardware
Refresh
Physical Channel
Acquire
Measurement Type
Max
Min
Scaled Units
Dev1 (USB-6008)
Voltage
10
-10
Volts


Untitled 1 * - LabVIEW SignalExpress
File Edit View Tools Add Step Operate Window Help
Add Step
Stop
Project
Monitor / Record
Running
DAQmx Ac
Analog Input
Voltage
Acquire Signals
Generate Signals
Create Signals
Load/Save Signals
Processing
Analysis
Execution Control
NI ELVISmx
System Identification
Control Design
Run LabVIEW VI
Favorites
Project Documentation
Step Setup
Connection Diagram
Preview
Time-Domain Measurements
Frequency-Domain Measurements
Order-Domain Measurements
Test and Compare
Graph
Display Type
AutoScale Y-Axis
Octave Analysis
Sound Quality
Power Spectrum
Zoom Power Spectrum
Peak Search
Power in Band
Frequency Response
Tone Measurements
Distortion
Tone Extraction
Noise Measurements
Triggering
Advanced Timing
Channel Settings
Details
Voltage
Dev1_ai0
Dev1_ai1
Dev1_ai2
Dev1_ai3
Dev1_ai4
Min
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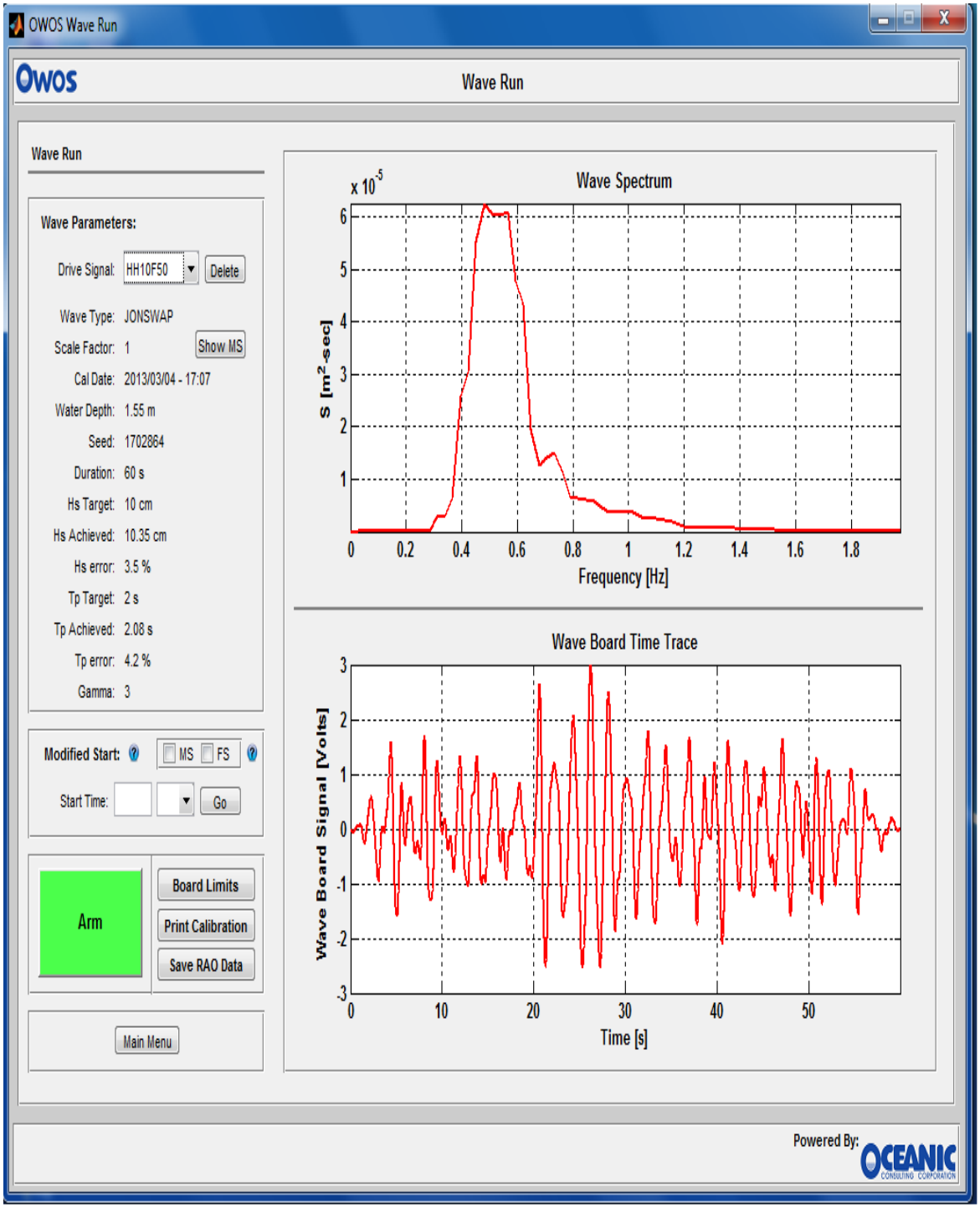
Dev1 (USB-6008)
Voltage
10
-10
Volts
Logs
Snapshots
Frequency-Domain Measurements


OWOS Wave Run
Owos
Wave Run
Wave Run
Wave Parameters:
Drive Signal: HH10F50
Delete
Wave Type: JONSWAP
Scale Factor: 1
Show MS
Cal Date: 2013/03/04 - 17:07
Water Depth: 1.55 m
Seed: 1702864
Duration: 60 s
Hs Target: 10 cm
Hs Achieved: 10.35 cm
Hs error: 3.5 %
Tp Target: 2 s
Tp Achieved: 2.08 s
Tp error: 4.2 %
Gamma: 3
Modified Start:
MS
FS
Start Time:
Go
Arm
Board Limits
Print Calibration
Save RAO Data
Main Menu
Wave Spectrum
x 10^-5
S [m^2-sec]
Frequency [Hz]
Wave Board Time Trace
Wave Board Signal [Volts]
Time [s]
Powered By:
OCEANIC
CONSULTING CORPORATION

```
%
% BOAT PITCH IN RANDOM WAVES
%
% STANDARD FOURIER TRANSFORM
%
%
clear all
name='two.dat';
S=load(name);
nit=2250; mit=60;
delt=0.004; pad=150;
span=delt*nit;
period=0.1;
omega=2*pi/period;
for nat=1:nit
time=nat*delt;
t(nat)=time; window=1.0;
window=sin(pi*time/span);
shake(nat)=S(nat+pad,3)*window;
shake(nat)=sin(omega*time)*window;
end
shake=shake-mean(shake);
abc=0.0;
xyz=0.0;
omega=0.0;
```

```
for mat=1:mit
omega=omega+pi;
hz(mat)=omega/(2*pi);
time=0.0;
for nat=1:nit
time=time+delt;
one=sin(omega*time)*delt;
two=cos(omega*time)*delt;
abc=abc+shake(nat)*one;
xyz=xyz+shake(nat)*two;
end
sum=abc^2+xyz^2;
sum=(abc^2+xyz^2)^0.5;
level(mat)=2*sum/span;
abc=0.0; xyz=0.0;
end
figure(1)
plot(t,shake)
xlabel('time')
ylabel('data')
title('test')
figure(2)
plot(hz,level)
xlabel('hz')
ylabel('data')
title('spectrum')
```

```
%
% BOAT PITCH IN RANDOM WAVES
%
% FAST FOURIER TRANSFORM
%
%
clear all
name='one.dat';
S=load(name);
pad=50; out=250;
cycle=250.0; delt=1/cycle;
nit=1024; mit=2*nit;
bit=nit+1; f(1)=0.0;
for it=1:nit
 iot=it+1;kit=it+pad;
 shake(it)=S(kit,3);
 f(iot)=cycle/2*iot/nit;
end
shake=shake-mean(shake);
z=fft(shake,mit)/nit;
p=2*abs(z(1:bit));
q=p.*conj(p);
plot(f(1:out),q(1:out))
xlabel('hz')
ylabel('g level')
title('spectrum')
```