Student Info

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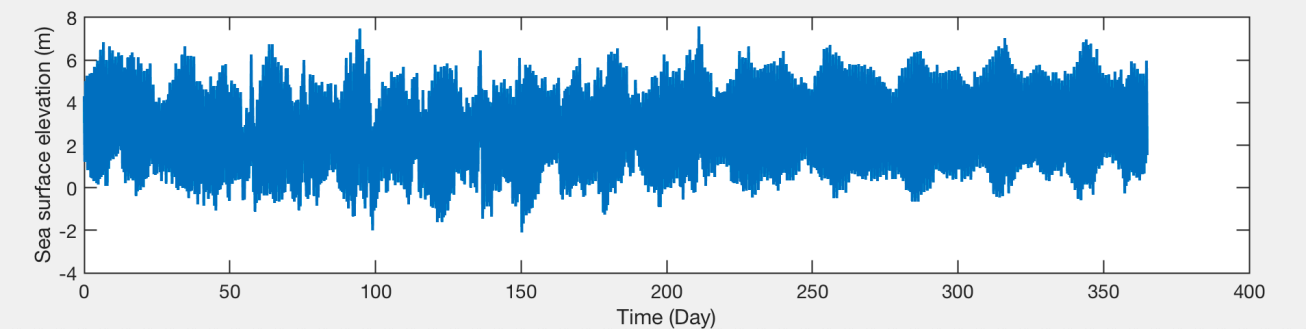
HW 7

A.



Script:

```
% initiate variables

clearvars;
load('QMDA_HW_07.mat');



% A.

figure(1);
plot(ti,hi, 'LineWidth',2);
xlabel('Time (Day)');
ylabel('Sea surface elevation (m)');
set(gca,'LineWidth',1,'FontSize',14);
```

B.

Yes the data is sampled at a constant interval, $\Delta t = 0.00416667$ in the unit of day.

The output of my script:

> The mean of the time interval 0.00416667, and the max and min of the dti are 0.00416667, 0.00416667

Since mean = max = min, the values in this array are the same.

Script:

```
% B.

% To calculte the delta_t of sampling, we calculate the
differenciate of ti

dtilist = diff(ti);

% to check if the time intervals are equal
dti = mean(dtilist);
fprintf('The mean of the time interval %g, and the max and
min of the dti are %g, %g\n',dti, max(dtilist),min(dtilist));
```

C.

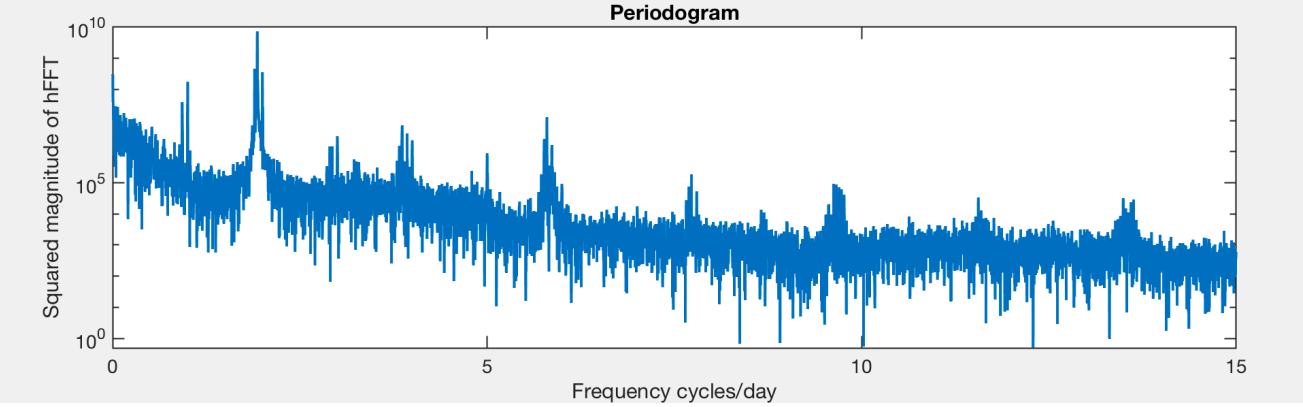
```
% C.

% compute fourier coefficients
hft = fft(hi);

% compute vector of N +ve and -ve frequencies
N = length(ti);
Nf = N/2+1;
fNyq=1/(2*dti);  % Nyquist frequency
fpos=linspace(0,fNyq,Nf)';
fneg=flipud(-fpos(2:N/2));
f=[fpos; fneg];
```

D.

The plot of the periodogram vs. positive frequencies up to about 15 cycles/day:



Script:

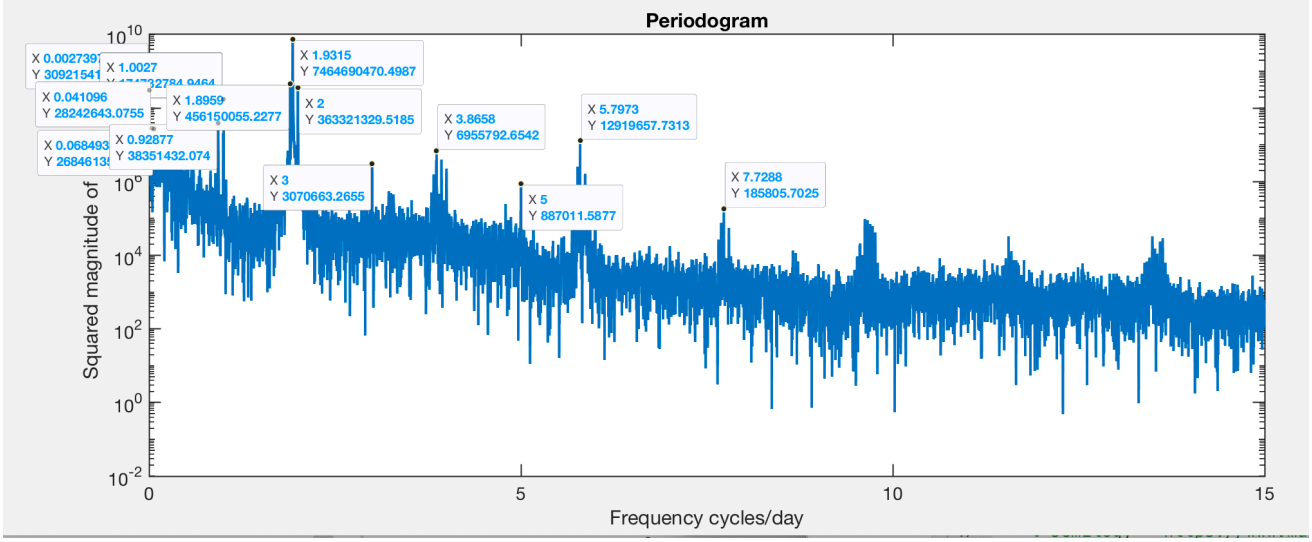
```
% D.
% compute periodogram
pg = abs(hft).^2;
```

```
N1 = 2;
N15 = round(15/(2*dti));
% plot the periodogram
figure(2);
% semilogy -
https://www.mathworks.com/help/matlab/ref/semilogy.html
semilogy(f(N1:N15),pg(N1:N15),'LineWidth',2);

title('Periodogram');
xlabel('Frequency cycles/day');
ylabel('Squared magnitude of hFFT');
set(gca,'LineWidth',1,'FontSize',14);
```

E.

Here the peaks are labeled:



Frequencies (cycles/day)	Periods (days)
0.0027397	365.0
0.041096	24.33
0.068493	14.60
0.92877	1.077 $\approx$ 25.85 hours
1.0027	0.9973 $\approx$ 23.85 hours
1.8959	0.5275 $\approx$ 12.66 hours
1.9316	0.5177 $\approx$ 12.42 hours
2	0.5 $\approx$ 12 hours
3	0.3333 $\approx$ 8 hours
3.8658	0.2587 $\approx$ 6.209 hours
5	0.2 $\approx$ 4.8 hours
5.7973	0.1725 $\approx$ 4.14 hours
7.7288	0.1277 $\approx$ 3.064 hours

F.

(A). Is there a peak in the spectrum that is more prominent than others? At what frequency and period?

Yes! The most prominent peak locates at frequency $= 1.9316$ cycles/day, which period is 0.5177 day, ≈ 12.42 hours.

(B). Can you explain the numeric value of the frequency and period of the most prominent peak?

The value is a little bit more than 0.5 day, which suggests that the high and the low reach the same place every 12 hour and 25 minutes. There will be two highes and lows in one day, but they do not happen at the same time every day. There is a little laggacy, mostly due to the self-rotation of Earth and Moon. According to Tides and Water Levels, this occurs because the moon revolves around the Earth in the same direction that the Earth rotates around its axis.

(C). Can you explain the numeric value of the frequency and period of the other peaks in the periodogram?

Frequencies (cycles/day)	**Periods (days)**	**Species**	**DarwinSymbol**
0.0027397	365.0	Solar annual	S_a
0.041096	24.33	Lunar monthly	M_m
0.068493	14.60	Lunisolar synodic fortnightly	M_{sf}
0.92877	1.077 ≈ 25.85 hours	**Lunar diurnal**	K_1
1.0027	0.9973 ≈ 23.85 hours	Lunar diurnal (lunar-solar declinational)	O_1
1.8959	0.5275 ≈ 12.66	Larger lunar elliptic semidiurnal	N_2

	hours		
1.9316	0.5177 ≈ 12.42 hours	**Principal lunar semidiurnal**	M_2
2	0.5 ≈ 12 hours	**Principal solar semidiurnal**	S_2
3	0.3333 ≈ 8 hours	Shallow water terdiurnal	MK_3
3.8658	0.2587 ≈ 6.209 hours	Shallow water overtides of principal lunar	M_4
5	0.2 ≈ 4.8 hours	no match...	
5.7973	0.1725 ≈ 4.14 hours	Shallow water overtides of principal lunar	M_6
7.7288	0.1277 ≈ 3.064 hours	Shallow water eighth diurnal	M_8

Thanks a lot for Theory of tides - wikipedia.

The periods are closely related to the solar and lunar months and days.