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## The Driven Pendulum Part 2

## Driving Force: $F_D = 0.5$

When we run the model for $F_D = 0.5$, we are able to see the relationship between the frequency and the angular frequency. The angular frequency is related to the frequency through the following formula:

$$\omega = 2\pi f$$

The angular frequency is the measure of the rate of rotation where $2\pi$ radians is one full revolution. The frequency on the second graph in Figure 1 is $f = 0.10$ hz. Thus, omega equals $\omega$ = 0.66, which is what we set our angular frequency to be.

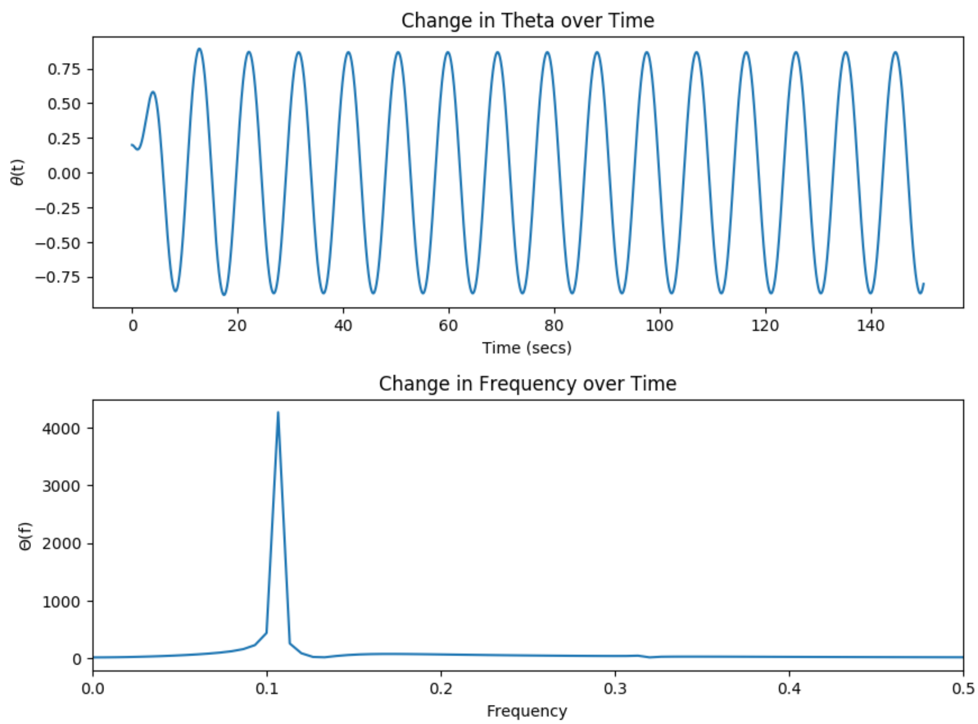


Figure 1: Driving Force: $F_D = 0.5$

## Driving Force: $F_D = 0.95$

The next driving force we will be looking at is when $F_D = 0.95$. This is an example of frequency mixing because the larger peaks frequency is $f_L = 0.10$ hz and the smaller peaks frequency is $f_s = .32$ hz. The smaller peaks frequency is three times that of the larger peaks frequency. This occurs from interference of waves at different frequencies.

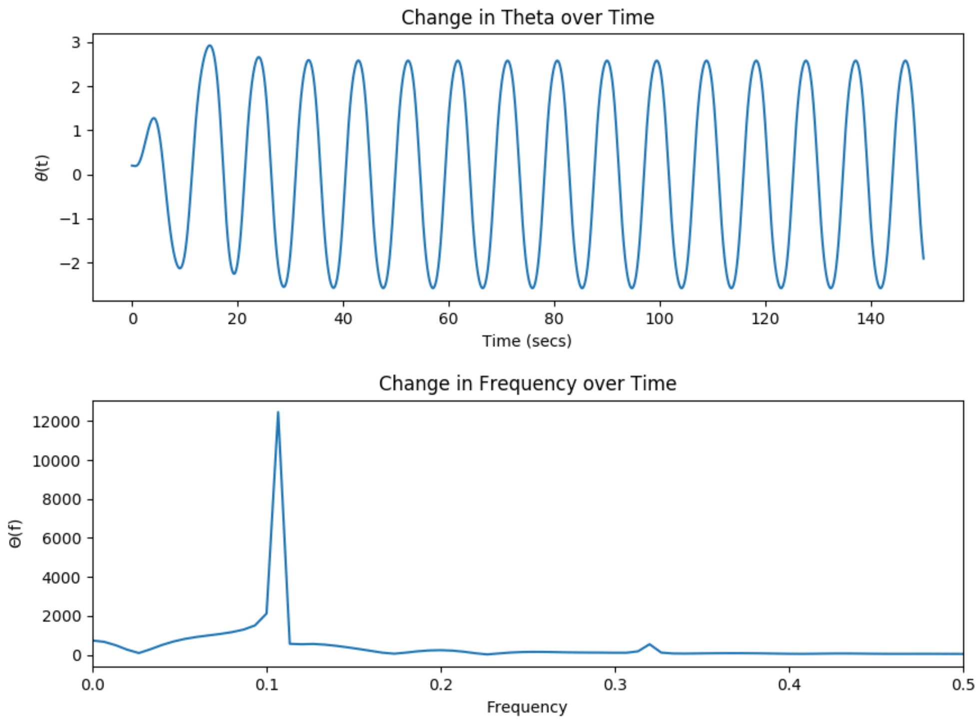


Figure 2: Driving Force: $F_D = 0.95$

## Driving Force: $F_D = 1.2$

The chaotic regime is centered around $F_D = 1.2$. The frequency domain also looks chaotic. The largest peak is still the frequency $f = 0.10$ hz.

## Driving Force: $F_D = 1.44$

When we increase the driving force to be $F_D = 1.44$, we enter the period-doubling regime. The taller frequency components are the fundamental frequency $\Omega$ and multiples (overtones) of that frequency. The smaller peaks are subharmonics of the driving frequency $\Omega$. The small peaks are located at every multiple of 0.10 on the $\Theta(f)$ vs time graph.

## Driving Force: $F_D = 1.6$

We can attempt to identify subharmonics when we increase the driving force to be $F_D = 1.6$. The frequencies occur at every 0.10 and 0.05 on the $\Theta(f)$ vs time graph.

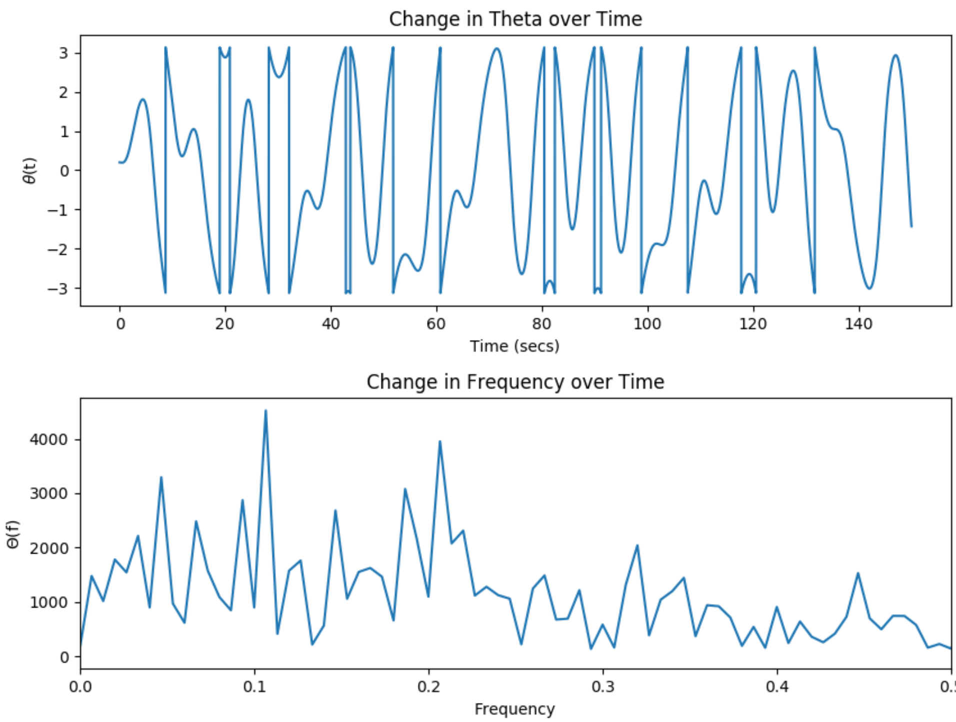


Figure 3: Driving Force: $F_D = 1.2$

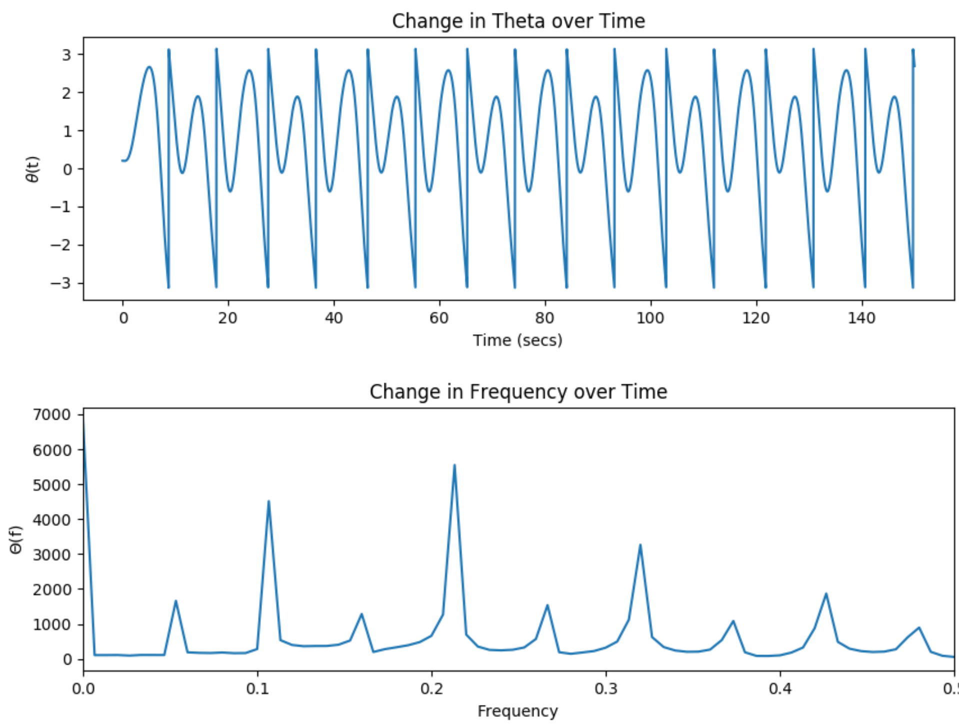


Figure 4: Driving Force: $F_D = 1.44$

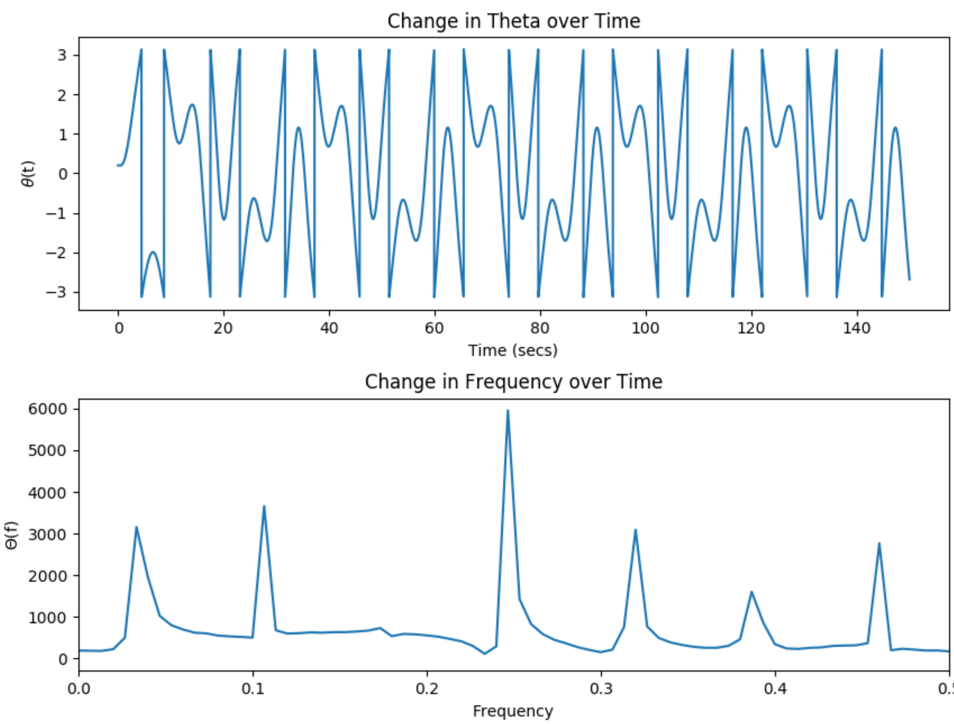


Figure 5: Driving Force: $F_D = 1.6$