# HW01

**Partial Differential Equations and Complex Variables (EE 2021 Summer)**

Due date : 9/24 (Thur.) bring it to the class!

**I.** Following **the next 2-page instruction**, play Fourier app (https://phet.colorado.edu/en/simulation/legacy/fourier) and **answer all questions mentioned inside**.

II. Reading Erwin 10th edition: **11.1**, **11.2** and **11.3**

III. Problems in the Problem Set 11.1 (page 482): **1, 2, 3, 4, 6, 14**
where in **6, 14** plot using matlab and print out the graph and your matlab code.

Introduction to Fourier Analysis

Learning Goal: To gain a qualitative intuitive understanding of Fourier Analysis

Open the simulation "Fourier: Making Waves" from the Math Tools section of the PhET simulations website.

Try playing with the controls on the "Amplitudes" graph. (Checking the "autoscale" box next to the "Sum" graph may make it easier to see what's going on.) How does changing the "Amplitudes" graph change the "Harmonics" and "Sum" graph? Explain how these three graphs are related.

Hit the "Reset" button so that there is only one sine wave shown.

What is the definition of wavelength? Use the horizontal zoom controls next to the "Harmonics" graph so that more than one period is displayed on the graph. Check the "Wavelength Tool" box and use the tool that appears to measure from peak to peak, from trough to trough, and then from some arbitrary point in the wave to the same arbitrary point on cycle farther. Is this consistent with your definition of wavelength?

Adjust the amplitudes to show more than one sine wave, and use the pull-down menu for the wavelength tool to compare the wavelengths of different sine waves.

In general, does amplitude depend on wavelength? Does changing the amplitude of a wave change its wavelength?

Try switching from a function of space to a function of time. What changes? What doesn't change? Explain why you can't use the Period Tool in "space" mode or the Wavelength Tool in "time" mode.

How are the periods of different harmonics related? Is this consistent with a definition of "harmonics" that you have heard in the context of sound and music?

What happens when you switch from showing "sines" to "cosines"?

Try out the different options in the "Select Function" pull-down menu. For each function, try increasing and decreasing the number of harmonics. What effect does this have and why? What would happen if you had many more than 11 harmonics? Test your prediction by checking the box labeled, "Show function with infinite number of harmonics."

Explain in words why each harmonic should have the approximate amplitude that it does in order to make up a triangle wave. For example, why are all the even harmonics zero? Why is the third harmonic negative or positive? Are the amplitudes different for sines and cosines? Why?

What happens if you try to make a sawtooth wave in “cosines” mode?  Why?

Which harmonics would you need to include to produce the following “Sum” graph?