Phys106, II-Semester 2019/20, Tutorial 5, Fri 7.2.

Work in teams of three. Do "Stages" in the order below. When all teams finished a stage, make sure all students at your table understand the solution and agree on one by using the board (in Studio-Air), or paper sheets (in L1).

This tutorial has a large online component. If you can bring a laptop, that would be helpful.

Stage 1 (i) Re-read the lecture notes regarding **beating** of two waves, that is section 2.3.1).

(ii) Now explore beating using this web applet . You can also hear the result for the example of acoustic waves. What does the beating effect sound like? What happens to the beating frequency if the two combined waves have a larger (smaller) frequency difference?

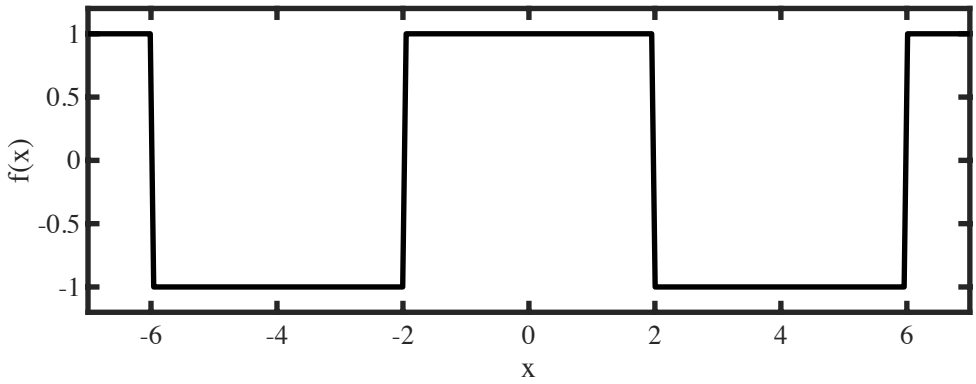
(iii) Revise the concept of group-velocity Eq. (53) and share with your table. You can now explore two moving combined waves with this web applet . How does it look if $v_g < v$, $v_g = v$, $v_g > v$, where v is the phase velocity? More control over the two constituent waves, like in the lecture, can be found in this app .

Stage 2 (i) Re-read the lecture notes regarding the **Fourier series** method to decompose any periodic function into cosines or sines, that is Eq. (43), (44), (46), (47). Make sure you all understand the gist of what this equation means (not yet why it works, see stage 4). Ask a TA otherwise.

(ii) Now explore this similarly to the pictures in the lecture using the online app on http://www.falstad.com/fourier/ . Select sequentially the triangle, sawtooth square function. Move the "Number of Terms" slider fully to the left, then add slowly term by term. The white dots appearing are the g_n (cosines), h_n (sines) coefficients from the lecture. What happens for larger n?. How can you tell if there are only cos or only sin? What happens if you switch $f(x)$ itself to be a cos or sin?

(iii) Also check out https://www.geogebra.org/m/EYhBXfmK for some additional choice of functions.

Stage 3 Now redo yourself what you have seen in the apps as a team on the whiteboard (Air), sheet of paper (L1). Draw the square-wave function $f(x)$ shown below. You want to expand this as $f(x) = \sum_{n=0}^{\infty} g_n \cos(\lambda_n x)$ (Eq. 43), however we just "guess" the g_n and λ_n, instead of using (Eq. 44).



(i) Carefully draw the cosine wave that has most resemblance with $f(x)$.

(ii) Now draw the next cosine wave with a shorter wavelength that can improve the sum in Eq. (43) when added to the one in (ii).

(iii) Keep doing this until too difficult to draw. Also discuss in your team which waves would be unsuitable to add.