General Information: This assignment contains written and/or programming tasks. Combine all the answers to the written tasks in a single PDF document, named `{lastname}-written.pdf`. You can also scan or take pictures of (readable) handwritten papers. JPEG/PNG image files are accepted in this case and they should be named `{exercisenumber}-{lastname}-written.{jpeg/png}`. Make sure that we can follow the manual calculations. Do not combine too many small steps into one. The programming tasks have to be solved in *Julia* and the source code files have to be submitted using the following naming scheme: `{exercisenumber}-{lastname}.jl`.

Exercise Information: In this exercise you will get familiar with the programming language Julia and the *package* Plots. Following resources could be helpful:
https://benlauwens.github.io/ThinkJulia.jl/latest/book.html
https://docs.julialang.org/en/v1/
https://docs.juliaplots.org/stable/
https://docs.juliaplots.org/latest/generated/gr/

Note that for every exercise in this sheet, there is a template *Julia* file provided.

(1) (3.5 points) In linear algebra, we differentiate between scalars, vectors, and matrices. There exists a range of operations between instances of these types. For this task you will implement a subset of those operations:

a) Scalar/Scalar multiplication

b) Scalar/Vector multiplication

c) Vector/Matrix multiplication

d) Matrix/Matrix multiplication

e) The dot product of two vectors

f) Matrix/Matrix addition

g) The transpose of a matrix

Use the provided template *Julia* file in OLAT and implement each functionality in the respective function definition. Your implementation should optimally pass all test cases! Do **not** use:

1. Any extra *Julia packages* for this task (especially not `LinearAlgebra`).
2. The multiplication (`*`) and transpose (`'`) operators.

You are free to use these for future exercises.

(2) (3.5) When playing the guitar, a musical tone is produced by the vibration of a spring – the periodic impacts against air produce sound waves. We can express a *perfect* tone mathematically by a sinusoidal function describing the pressure fluctuation at a given time t:

$$y(t) = A\sin(2\pi f t),$$

where A is the amplitude (volume) and f is the frequency of the oscillation in Hertz (Hz). In music theory a note is assigned to a certain frequency e.g. an **A** referenced to the **concert pitch** has 440 Hz.

a) Plot the above function for the notes **E (329.63 Hz), G# (415.30 Hz) und B (493.88 Hz)** with amplitude 1 over a period of 12ms (using GR's plot function). Be sure to use small time steps for the axis so that the oscillations are visible.

b) When two or more waves propagate simultaneously in the same space, superposition of the aucustic signals occurs. The superposition principle states that the total effect of simultaneously occurring individual effects is given by the sum of the individual effects (applies to linear wave equations). For a triad consisting of three tones, we can thus form its function as the sum of the individual tone functions y_0, y_1, and y_2:

$$y(t) = y_0(t) + y_1(t) + y_2(t)$$

Form the function of the triad based on the notes **E, G#, and B** and plot it. The graph should be emphasized by a thicker line.

c) Add information to your plot, i.e. an appropriate title, legend, and axis labels. The final result should resemble the following: