

# Ultrafast Optics, Spring 2022,

## Homework 1

**Due on March 25<sup>th</sup> 2022, in class or electronic file sent to TA's email by 23:00 March 25<sup>th</sup>, 2022**

Problem 1:

Prove following Fourier Transform theorems,

- Scaling theorem
- Time-delay theorem
- Frequency-offset theorem
- Convolution theorem

Problem 2:

Prove following Fourier Transform operations:

- $F.T. \left\{ \frac{\partial f(t)}{\partial t} \right\} \rightarrow -j\omega F(\omega)$
- $F.T. \left\{ e^{-\pi t^2} \right\} \rightarrow e^{-\pi \nu^2}$

Problem 3:

A pulsed laser generates pulses with  $10^5 \text{W}$  of peak power. Spatially the laser output is a Gaussian beam. If the beam is focused in air to a diameter of 10  $\mu\text{m}$  round area (at  $e^{-2}$  points of the intensity), give the peak intensity and the corresponding peak electric field amplitude.

Remark: Use the Fourier Transform defined in class.