Faculty of Science, Technology, Engineering, and Mathematics

School of Computer Science & Statistics

M.Sc. Computer Science **Semester 1, 2022**

Mathematics of Light and Sound

13th December 2022 **"Take at Home"** **14:00–19:00**

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Instructions to Candidates:

- Answer **three** questions out of five. All questions carry **equal** marks.
- Use **three hours** as a target for how long you should take to write your answers.
- If you have been granted additional time for written examinations, adjust the suggested target accordingly.
- Email me at **fshevlin@tcd.ie** with any specific queries and I will reply if I can.
- All program code should be written in the **Python** language using the **SciPy** library. *Good comments and explanations are essential.* Your answer to each question should be presented in a separate **Jupyter** notebook.
- Your notebooks should be arranged within a single **private** project in your `gitlab.scss.tcd.ie` repository. Add me as a member with **reporter** access.
- Email me a link to your repository. *Your email should include a version of each notebook in PDF or HTML format; or screenshots in the worst case.*
- Note that **collaboration** is not permitted. You must submit a picture of the enclosed declaration signed by you.

Materials permitted for this examination:

- This is an "open book" exam. Feel free to refer to any appropriate sources of information you have available, e.g. lecture notes, textbooks, or internet.

Question 1. Write a program to plot wave propagation showing *diffraction* at an aperture. Use Huygens-Fresnel construction. Wavefronts at selected moments in time need *not* be explicitly labelled.

[60/180 marks]

Question 2. Write a program to plot the motion over time of some particles in a vibrating string. Use an iterative simulation algorithm with a discrete approximation of the wave equation.

[60/180 marks]

Question 3. Write a program to plot a histogram of simulated wave resultant intensities arising from a random phasor sum whose amplitude is known to follow a Rayleigh distribution.

[60/180 marks]

Question 4. Write a program to plot images that show the difference between the probability density of the sum of two wave resultant intensities and the probability density of one wave resultant intensity.

[60/180 marks]

Question 5. Write a program to plot the diffraction pattern of a triangular aperture. It should use Fraunhofer approximation and the Fourier transform.

[60/180 marks]