Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Faculty of Engineering, Mathematics and Science
School of Computer Science & Statistics

M.Sc. Computer Science   **Semester 1, 2021**

Mathematics of Light and Sound

13 December 2021   **"Take at Home"**   **14:00–19:00**

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Instructions to Candidates:

- Answer **four** questions out of six. 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 as attachments either screenshots or PDF versions of each notebook.*

- 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.

- Non-programmable calculators—indicate make and model.

Question 1. Write a program to plot wavefront propagation showing refraction at the interface between two media with different characteristics. Use Huygens-Fresnel construction.

[25 marks]

Question 2. Write a program to plot the motion over time of a set discrete particles in a transverse acoustic wave. Use a closed-form solution of the wave equation.

[25 marks]

Question 3. Write a program to plot one-dimensional wave motion over time. It should use an iterative simulation algorithm for a discrete set of points. Choose appropriate initial and boundary conditions.

[25 marks]

Question 4. Write a program to plot a Normal-like distribution arising from the sum of a large number of random phasor sums.

[25 marks]

Question 5. Write a program to plot images that show the difference between the probability density of the sum of two intensities and the probability density of one intensity.

[25 marks]

Question 6. Write a program to plot the diffraction pattern of a square aperture. It should use Fraunhofer approximation and the Fourier transform.

[25 marks]