

PHYS-E0565 - Monte Carlo method in particle transport simulations

The Monte Carlo method is used for radiation and particle transport problems in various fields of science and engineering. The course provides a hands-on introduction to particle transport simulations, with an emphasis on neutron transport problems in fission reactor physics.

Course staff:

Lecturer: **Jaakko Leppänen**, Research Professor (VTT) / Adjunct Professor (Aalto)¹

The course consists of five programming exercises:

- 1 Introduction to Monte Carlo method
- 2 Constructive Solid Geometry model (CSG)
- 3 Particle interaction physics
- 4 Particle tracking
- 5 Additional exercise on special topic

Each topic is covered on a lecture before the assignment. Additional reading: (available on-line)

I. Lux and L. Koblinger, "*Monte Carlo particle transport methods: neutron and photon calculations*". CRC Press, 1991.

"*The OpenMC Monte Carlo Code.*" <https://openmc.readthedocs.io/en/stable/>

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Programming exercises:

- ▶ Programming languages: Fortran/C/C++ (recommended), Python (slow, not recommended) or similar, use of high-level math functions not allowed
- ▶ Each exercise consists of mandatory and bonus tasks. Passing the course requires completing all mandatory tasks, grade is based on points awarded from completing the bonus tasks
- ▶ The exercises are not independent – each task makes use of subroutines developed in previous exercises (the final goal is to build a simplified Monte Carlo particle transport code)
- ▶ Each exercise should be completed within 2 weeks, the algorithms and results are summarized in a short report that describes the problem and its solution (make use of flow diagrams, etc.) or alternatively a short presentation (max 10 min).
- ▶ Each report must also include a list of completed bonus exercises and an estimate of working hours spent on the exercise
- ▶ Reports and source code by email to: Jaakko.Leppanen@aalto.fi

Previous years' statistics:

- ▶ Total working hours: 80–177 (2016), 60–150 (2017), 90–160 (2018), 99–400 (2019)
- ▶ Grades: 5p – 2, 10p – 3, 15p – 4, 20p – 5

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Lectures in Zoom on Tuesdays 12:15–14:00. Preliminary schedule:

- 15.9 Introduction to Monte Carlo method
- 22.9 Q&A
- 29.9 Constructive Solid Geometry model (CSG)
- 6.10 Q&A
- 13.10 Particle interaction physics
- 27.10 Q&A
- 3.11 Particle tracking
- 10.11 Q&A
- 17.11 Additional exercise on special topic
- 24.11 Q&A
- 1.12 Presentation of final work

Two weeks to complete each exercise. Every other lecture time is reserved for questions and general discussion (from 12:15 until as long as it takes, if you wish participate, please be on time).