CmpE 49G –Fundamentals of Particle-based Simulations

Objectives & Description: This course aims to introduce concepts related to mathematical modeling methods and simulation tools for a wide range of natural phenomena that are related to interactions of particles/entities. Different approaches that will be presented here can be applied to wide range of topics such as diffusion, particle physics, population evolution.... The assignments of this course will be made as practical as possible in order to allow you to create short programs from scratch that will solve simple problems.

Instructor: Assist. Prof. H. Birkan YILMAZ (**Room**: 38, birkan.yilmaz@boun.edu.tr)

Class Hours/Rooms: WWW 345 / Online (Zoom)

Reference Books & Documents:
"The Nature of Code," **Daniel Shiffman**
"Computational Many-Particle Physics," **H. Fehske, R. Schneider, A. Weisse**
"PENELOPE-2014: A Code System for Monte Carlo Simulations of Electron and Photon Transport,"
https://www.oecd-nea.org/science/docs/2015/nsc-doc2015-3.pdf

Tentative Outline:

Week 1: Introduction to General Concepts & Elementary Probability Theory
Week 2: Random Number Generation & Introduction to Monte Carlo Simulation Method
Week 3: Random Walk & Perlin Noise Walker
Week 4*: Vectors and Vector Fields
Week 5: Case Study I: Particle-based Diffusion Simulation
Week 6: Modeling Enzyme Reactions: Decomposing and Diffusing Particles
Week 7: Midterm Exam
Week 8: Voxel-based Simulations & Cellular Automata Model
Week 9: Lattice Boltzmann Modeling of Fluid Flow
Week 10: Interaction Modeling in High Energy Physics - I
Week 11*: Interaction Modeling in High Energy Physics - II
Week 12: Case Study II: Monte Carlo Simulations in High Energy Physics
Week 13: Final Project Presentations

Grading:
- 15% Two Quizzes (Quizzes will take place on the 4th and 11th weeks) + Two **Pop** Quizzes
- 35% Projects (at least two projects will be given)
- 20% Midterm
- 30% Final