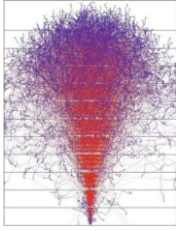


## Syllabus



### ***NSEG 5134 - Monte Carlo Methods for Particle Transport (Fall 2015)***

**Description:** This is a general course on the Monte Carlo Methods which uses fundamental particle transport concepts to demonstrate various methodologies and examine associated issues. The topics covered include: random processes; random number generation techniques and testing; fundamental formulation of Monte Carlo (FFMC); various sampling procedures; fundamentals of probability and statistics as needed for MC simulations; non-analog or variance reduction techniques; various tallying procedures; representation of physical models based on combinatorial geometry; solving integral formulations via MC; importance sampling and the use of importance function; use of MC for eigenvalue problems; MC methods in parallel and vector environments; and use of MC for simulation of various real-life applications.

**Instructor:** Prof. Alireza Haghighat, [haghighat@vt.edu](mailto:haghighat@vt.edu), (571) 858-3333

**Time:** Monday & Wednesday, 12:30-1:45 pm

**Locations:** NVC 219, Falls Church; BUR 123A, Blacksburg

**Registration, Course ID:** NVC CRN: 87441; Blacksburg CRN: 85394

### **Outline**

<b>Topic</b>	<b>Allocation Time (%)</b>
Random Processes, Fundamental Formulation of Monte Carlo (FFMC)	6%
Sampling Procedure	8%
Random Number Generation & Analog Monte Carlo	12%
Fundamentals of Statistics	13%
Non-Analog Monte Carlo Methods, "Variance Reduction Techniques for Basic Physical Processes"	13%
Tallying/Scoring & Geometry	12%
Integrals and Associated Variance Reduction Techniques	15%
Monte Carlo Methods for Criticality or Eigenvalue Problems	12%
Vector and Parallel Processing of Monte Carlo Methods	5%
Analysis/Discussion of Recent Applications of the Monte Carlo Methods and Monte Carlo Machine	4%
Total	100%

**Grading:** One mid-term exam (20%) and Homework and course project (see following page for examples) (80%)

### **Textbook**

A. Haghighat, *Monte Carlo Methods for Particle Transport*, CRC Press Taylor & Francis Group, 2014; <http://www.crcpress.com/product/isbn/9781466592537>

**Optional books:**

- M.H. Kalos and P. A. Whitlock, *Monte Carlo Methods (Vol. I: Basics)*, M John Wiley & Sons, 1986
- R.L. Morin, *Monte Carlo Simulation in Radiological Sciences*, CRC Press, 1988.
- E.E. Lewis and W.F. Miller, *Neutron Transport Method (Chapter 7)*, American Nuclear Society Publication, 1984.

**Other References:**

- L.L. Carter and E.D. Cashwell, *Particle Transport Simulation in Monte Carlo Method*, TID-26607, NTIS, 1975
- E.D. Cashwell and C. J. Everett, *A Practical Manual on Monte Carlo Method for Random Walk Problems*, Pergammon Press, 1969
- J. Spanier and E.M. Gelbard, *Monte Carlo Particle Transport Methods: Neutron and Photon Calculations*, CRC Press, 1991.

**Example Projects from previous years (selected)**

- Monte Carlo Simulation of Aerosol Particle Detection and Analysis via Laser-Induced Breakdown Spectroscopy
- Approximating Soot-Laser Interactions via Monte Carlo Methods
- Monte Carlo Simulation of a Computed Tomography Scan
- Radiant Heat Transfer View Factors Between Adjacent Like Spheres
- Performance of Recycled Weapon Grade Plutonium for Use in Commercial PWRs
- MCNP Evaluation of Carbide Nuclear Fuel
- Calculation of the “Flory-exponent” for Linear Polymers using Monte Carlo Methods
- Atomic migration study in intermetallic compounds using Monte Carlo simulation
- Modeling of a set of horizontal venetian blinds using Monte Carlo methods
- Modeling of a medical CT scan
- Computer simulation of radiative heat transfer in enclosures using the Monte Carlo method
- Study of the influence of thickness of Tungsten insert to the open shutter background of the CSG unit
- Analysis of CSG-IV (Compton Scatter Gauge) Behavior using MCNP
- Calculation of the Radiative Heat Fluxes in two Vertical Plates by Monte Carlo Method
- An Analysis of Radiative Heat Transfer in a Rectangular Enclosure using Monte Carlo Method
- Spatial prediction in Data Mining Using Monte Carlo
- Feature Selection Based On Random Walk Process and re-sampling
- Direct Simulation Monte Carlo Method for Fluid Flows
- Application of Monte Carlo Methods on Precipitation Data of Virginia
- Non-Homogeneous vs. Homogenous Multi-region Shield
- Monte Carlo Simulation of a Gas-Solid Fluidized Bed
- Calculate Density of State in Ising Model by Markov Process Sampling
- Application of a Variance Reduction Technique to the Simulation of the miniLENS Gamma Shield
- Markov chain Monte Carlo in Traffic Sensor Data Simulation
- Density of State in Ising Model
- Truly Random Distribution on Pebble Bed Reactor