NRE 6759
Radiation Shielding
Spring 2021

Classroom: Deliver will be asynchronistic delivery
Instructor: Nolan E. Hertel, 3-84 Boggs
Credit: 3 hours
Time: Prerecorded and uploaded to Canvas
Office Hours: TBA. I will try and find a couple of times for live internet office hour sessions that will be recorded and uploaded for everyone's access.

Textbooks

J. Kenneth Shultis and Richard E. Faw, Radiation Shielding**,** American Nuclear Society, 2000. [Useful info from Shultis webpage and includes errata for book - https://www.mne.k-state.edu/~jks/]

References:

- NCRP Report No. 144, Radiation Protection for Particle Accelerator Facilities, 2003.
- NCRP Report No. 147, Structural Shielding Design for Medical X-Ray Imaging Facilities, 2004.
- P. H. McGinley, Shielding Techniques for Radiation Oncology Facilities, Medical Physics Publishing, 1998.
- William Dunn & J. Kenneth Shultis, Exploring Monte Carlo Methods, , Academic Press/ Elsevier Science, 2012.
- N.M. Schaeffer (ed.), Reactor Shielding for Nuclear Engineers, AEC, 1973, TID-25951.
- R. G. Jaeber (Editor-In-Chief), Engineering Compendium on Radiation Shielding, Springer-Verlag, New York, 1968.
- J. Wood, Computational Methods in Reactor Shielding, Pergamon Press, 1982.
- H. Goldstein, Fundamental Aspects of Reactor Shielding, Addison-Wesley Publishing Company, Inc., 1959.
- E.E. Lewis and W.F. Miller, Jr., Computational Methods of Neutron Transport, Wiley-Interscience, pp. 296-358, 1984.
- L. L. Carter and E.D. Cashwell, Particle Transport Simulation with the Monte Carlo Method, TID-26607, NTIS, 1975.
- A. E. Profio, Radiation Shielding and Dosimetry, Wiley-Interscience, 1979.
- A.B. Chilton, J. K. Shultis and R.W. Faw, Prentice-Hall, Principles of Radiation Shielding, 1984.
- J. E. Turner, H. A. Wright and R.N. Hamm, Review Article: A Monte Carlo Primer for Health Physicists," Health Physics Journal 48, 717-733, 1985.

- D. E. Knuth, The Art of Computer Programming, Vol. 2: Seminumerical Algorithms, Addison-Wesley, 1969, Chapter 3 – Random Numbers.
- A. Biejalew, Fundamentals of the Monte Carlo Method for Neutral and Charged Particle Transport, http://www-personal.engin.umich.edu/~bielajew/MCBook/book.pdf.

Course Outline:

I. Fundamental Concepts
   a. Definition Of A Shield
   b. Characterizations of Radiation Fields and Sources
   c. Review Of Particle Interactions
   d. Common Radiation Sources Encountered in Shield Design
   e. Detector Responses
      i. Generalized Fluence-Dependent Response Functions
      ii. Energy Pathways In Photon Interactions
      iii. General Dosimetry And Dose Concepts
      iv. Fluence-To-Dose Equivalent Conversion Coefficients
II. Monte Carlo Simulation For Shielding Analysis
   a. Review Of Required Statistical Concepts
   b. Generation And Testing Of Pseudorandom Numbers
   c. Probability Distribution Functions
   d. Sampling Distributions
   e. Geometry Specification And Particle Tracking
   f. Scoring And Estimators
   g. Biasing Techniques (Variance Reduction)
   h. Simulating Photon Transport And Scattering
   i. Simulating Neutron Transport And Reactions
   j. Simulating Charged-Particle Sampling
III. Basic Methods for Radiation Dose Calculations
IV. Special Techniques for Photons
   a. Buildup Factors
   b. Extending Point Kernel Techniques To Include Buildup
   c. Point Kernel Codes
   d. Medical Facility Shielding
V. Special Techniques for Neutrons
VI. Transport Solutions
   a. Straight-Ahead Approximation
   b. Discrete Ordinates
   c. Method Of Moments
VII. Albedos And Duct Penetration Methods
VIII. Skyshine And Air Scatter

Evaluation:	Midterm Examination	30%
	Homework	10%
	Final Examination	30%
	Projects	30%

Objectives:
   a. To introduce students to radiation shielding analysis

b. To provide formal coverage of the use of Monte Carlo techniques in nuclear shielding applications.