NRE/MP 6759
Radiation Shielding Principles and Computations

Credit: 3 hours

Textbook: J. K. Shultis and R. E. Faw, Radiation Shielding, American Nuclear Society, 2000.
References:

- N.M. Schaeffer (ed.), Reactor Shielding for Nuclear Engineers, AEC, 1973, TID-25951.
- P. H. McGinley, Shielding Techniques for Radiation Oncology Facilities, Medical Physics Publishing, 1998.
- R. G. Jaeger (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.
- NCRP Report No. 144, Radiation Protection for Particle Accelerator Facilities, 2003.
- NCRP Repot No. 147, Structural Shielding Design for Medical X-Ray Imaging Facilities, 2004.
- NCRP Report No. 151, Structural Shielding Design and Evaluation for Megavoltage x-Ray and Gamma-Ray Radiotherapy Facilities, 2005.

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

Objectives:

a. To formally introduce students to a range of radiation shielding analyses as applied in a variety of nuclear facilities.
b. To provide a detailed examination in the use of Monte Carlo techniques in nuclear applications, particularly fixed source shielding problems.
c. To gain insight into the design considerations for shielding.

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