



ENGR 3502 – Radiation Detection & Measurement Spring 2017

Prerequisite(s)

ENGR 3501 - Fundamentals of Nuclear Engineering

Required or Elective

Required if minoring in Nuclear Engineering

Meeting Location, Days and Times

Q-216 TR 12:30 AM – 1:45 PM

Instructor

Dr. Eduardo B. Farfan, Associate Professor

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Office Phone: 678-915-4971

Office Location: Q 233

Office Hours:

TR 8:30 AM – 9:30 AM

W 11:00 AM – 2:00 PM

Other times by appointment only.

Textbook

Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, Fourth Edition, 2010. ISBN: 978-0-470-13148-0 (hardback).

Course Description

The detection and measurement of radiation is an integral component of the nuclear sciences field. This course covers the sources and properties of nuclear radiation, mechanisms of radiation interactions with matter, detection methods and in particular detection of ionization radiation that are of primary interest in nuclear power generation as well as medical and industrial applications. Various types of radiation detectors, neutron detection techniques and counting statistics are also discussed. The subject of radiation spectroscopy is covered in detail and students perform several gamma spectroscopy experiments.

Learning Objectives

Upon completion of the course, the students should be able to:

- 1- Explain radiation interaction with matter and detection methods
- 2- Describe the design principles of different radiation detectors and how they work
- 3- Discuss neutron interaction and detection methods
- 4- Employ the statistical nature of radiation measurements
- 5- Implement the statistics of radiation counting
- 6- Examine the techniques and applications of radiation spectroscopy

Topics Covered

- 1- Sources and properties of nuclear radiation
- 2- Mechanisms of radiation interactions with matter
- 3- Detection methods
- 4- Detection of ionizing radiation
- 5- Various types of radiation detectors
- 6- Radiation spectroscopy
- 7- Gamma-ray spectroscopy experiments
- 8- Neutron detection techniques and counting statistics

Grading

Attendance	5%
Homework	15%
Lab exercises	5%
Project	25%
Midterm	25%
Final	25%
Total	100%

Grade Conversion: A: (90-100), B: (80-89), C: (70-79), D: (60-69), F: (0-59)

Late work: **No late homework assignments will be accepted.** Students must date and sign the assignment cover sheet provided by the instructor.

Exams and Project: All students are expected to be present at the time exams and project presentations are given. Students not present at the time when an exam or presentation is given will receive a "0" for that exam or presentation. No make-up exams will be given, unless the student makes arrangements with the instructor, prior to the exam due date, to receive an excused absence. The students will be informed when an exam will take place (e.g., at least a week before the exam).

Laboratory Assignments: Students will be notified two weeks before a laboratory assignment takes place in Q 309. All students are expected to participate in the laboratory assignments and complete the laboratory reports (if required), which will be due a week after the laboratory assignment is concluded.

Course Outline

Unit	Lecture	Homework/Exams/Project*
1	Radiation Sources	
2	Radiation Interactions	HW 1
3	Counting Statistics and Error Prediction	
4	General Properties of Radiation Detectors	HW 2
5	Ionization Chambers	
6	Proportional Counters	HW 3
7	Geiger-Mueller Counters	
8	Scintillation Detector Principles	HW 4 / Midterm Exam
9	Photomultiplier Tubes and Photodiodes	
10	Radiation Spectroscopy with Scintillators	HW 5
11	Semiconductor Diode Detectors	
12	Germanium Gamma-Ray Detectors	HW 6
13	Other Solid State Detectors	
14	Slow Neutron Detection Methods	HW 7
15	Fast Neutron Detection and Spectroscopy	Project
16	Multichannel Pulse Analysis	HW 8 / Final Exam

*Students will be informed about an upcoming exam at least a week before the exam due date. Students will be given at least a week to complete the homework assignments.

Use of Electronic Equipment in Class

- Calculators will be used periodically in class.
- Use of phones, tables, and pagers is not permitted in class.
- Use of computers will be allowed only with the instructor's permission.

Tips for Effective Learning

- **Work closely with your instructor.** If you have any questions, please contact me immediately. The best way to contact me is via email or phone call, and you will be guaranteed to have a reply within 24 hours.
- **Begin your work early.** If you can start a task early, don't start late. Assuming you spend the same amount of time completing the task, starting later will be much more stressful than starting early. Never wait until the last minute to begin an assignment! You'll have no turnaround time if you need help or something happens.

Emergency Plan

If the University is closed for more than a day or two by some kind of emergency (major weather event, flu epidemic, etc.), please check your SPSU email for information on assignments.

Withdrawal

Students who find that they cannot continue in college for the entire semester after being enrolled, because of illness or any other reason, need to complete an online form. To completely or partially withdraw from classes at KSU, a student must withdraw online at www.kennesaw.edu, under Owl Express, Student Services.

The date the withdrawal is submitted online will be considered the official KSU withdrawal date which will be used in the calculation of any tuition refund or refund to Federal student aid and/or HOPE scholarship programs. It is advisable to print the final page of the withdrawal for your records. Withdrawals submitted online **prior** to midnight on the last day to withdraw without academic penalty will receive a “W” grade. Withdrawals **after** midnight will receive a “WF”. Failure to complete the online withdrawal process will produce no withdrawal from classes. Call the Registrar’s Office at 770-423-6200 during business hours if assistance is needed.

Students may, by means of the same online withdrawal and with the approval of the university Dean, withdraw from individual courses while retaining other courses on their schedules. This option may be exercised up until the W date on the Academic Calendar (on Registrar’s website). Failure to withdraw by the W date will mean that the student has elected to receive the final grade(s) earned in the course(s). The only exception to those withdrawal regulations will be for those instances that involve unusual and fully documented circumstances. In these rare cases, the policies of the university regarding hardship withdrawals will be strictly followed.

If any remaining coursework cannot be completed by the last class day, the instructor of this course will only consider assigning an incomplete grade to a student with an unusual and fully documented circumstance (must be verified by department chair or college dean), who is passing the course within two weeks of the last class day. If the final exam is among the assignments, the student’s grade will remain an “F” until it is taken, after which a grade change form will be submitted to the registrar if necessary, once the other agreed upon conditions are met.

KSU Diversity Vision Statement

It is our vision to create a strong multicultural and diverse educational environment at KSU in order to increase student satisfaction and to promote an understanding and awareness of people from various backgrounds upon graduation. In this way, KSU students will be educated for, and can effectively compete in the global society.

Course Enrollment Status Statement

Students are solely responsible for managing their enrollment status in a class; nonattendance does not constitute a withdrawal.

Student Support Resources – Strategies for Success

- Library, Tech Support, Tutoring, Writing Center, Advising, Bookstore, Resource Guide, Online Courses, other support resources:
<http://learnonline.kennesaw.edu/resources/index.php>
- Accessibility Statements or VPAT for Technologies:
<https://softchalkcloud.com/lesson/serve/jV10GKPfztZwQn/html>
- Academic and Student Services: <http://www.kennesaw.edu/currentstudents.php>

Other Technical Resources

- For D2L Technical Support: <http://uits.kennesaw.edu/>.
- D2L Privacy Statement: <http://www.brightspace.com/legal/privacy/>
- Blackboard Collaborate Support:
https://apps.kennesaw.edu/files/pr_app_uni_cdoc/doc/Blackboard%20Collaborate%20for%20Students.pdf
- The Privacy Policies for External Tools: <http://www.blackboard.com/footer/privacy-center.aspx>
- Help Desk: studenthelpdesk@kennesaw.edu, phone 470-578-6999
- Walk-in Help: Marietta campus - bottom floor H-building just outside the double doors on the East side.
- Personal Laptop/Smart Phone Help: <http://uits.kennesaw.edu/> or walk-in.
- Please remember to use the rules of Netiquette in any online communication environment. <http://www.education.com/reference/article/netiquette-rules-behavior-internet>

Academic Honesty/Integrity/Ethics Statement

The high quality of education at Kennesaw State University is reflected in the credits and degrees its students earn. *All assignments that take place in and out of the classroom must be your own work and original for this course.* The protection of these high standards is crucial since the validity and equity of the University's grades and degrees depend upon it. Any student found to have violated any KSU academic honesty regulation after a hearing before a university hearing panel or before the Vice President for Student Success and Enrollment Services (or his/her designee) shall be suspended for at least one semester, unless the student persuades the deciding body that the circumstances of his or her behavior substantially mitigate the gravity of the violation. These regulations are designed to assist students in (1) developing appropriate attitudes about, and (2) understanding and following the university's standards relating to academic honesty. The regulations protect students by helping them avoid committing infractions that may compromise the completion of their KSU degrees or damage their reputations.

Student Conduct Pledge/Statement: *As a member of the Kennesaw State University community of scholars, I understand that my actions are not only a reflection on myself, but also a reflection on the University and the larger body of scholars of which it is a part. Acting unethically, no matter how minor the offense, will be detrimental to my academic progress and self-image. It will also adversely affect all students, faculty, staff, the reputation of this University, and the value of the degrees it awards. Whether on campus or online, I understand that it is not only my personal responsibility, but also a duty to the entire KSU community that I act in a manner consistent with the highest level of academic integrity. Therefore, I promise that as a member of the Kennesaw State University community, I will not participate in any form of academic misconduct.*

Types of Academic Misconduct:

1) **Cheating:** Receiving, attempting to receive, knowingly giving or attempting to give unauthorized assistance in the preparation of any work required to be submitted for credit (including examinations, laboratory reports, essays, themes, term papers, etc.) is considered cheating, as is engaging in any behavior that a professor prohibits as academic misconduct in the syllabus or class discussion. Unless specifically authorized, using and/or having access to electronic devices during an examination, quiz, test or other assessment is automatically considered cheating, regardless of the student's reason for using/accessing the device;

2) **Plagiarism:** Including direct quotations from other sources into work required to be submitted for credit without indicating them as such by quotation marks, block quotes or other appropriate formatting. Incorporating the work of someone (e.g. ideas, theories, data, figures, graphs, programs, electronic based information, illustrations, etc.) into a paper or project without due acknowledgement;

3) **Self-Plagiarism:** Submitting any work for credit which was not authored specifically and originally for the assignment in question without the prior permission of the professor receiving that assignment. Most commonly, this means submitting the same, or substantially the same, paper or other assignment for credit in more than one class;

4) **Misrepresentation and/or Falsification:** Knowingly providing false information in completing University forms or applications (including admissions forms, scholarship applications, time sheets, false or counterfeit transcripts, etc.) or in any work submitted for credit. This includes providing fabricated/altered documents to substantiate an excused absence (such as to meet attendance requirements or have the chance to make-up a missed exam). Signing in for another student or having another individual sign in on a student's behalf on an attendance sheet also constitutes a violation of this code section.

5) **Unauthorized Access to University Materials:** Taking, attempting to take, stealing or in any unauthorized manner otherwise procuring, gaining access to, altering or destroying any material pertaining to the conduct of a class (including tests, examinations, grade change forms, grade rolls, roll books, laboratory equipment, University grade records in written or computerized form, etc.).

6) **Malicious/Intentional Misuse of Computer Facilities/Services:** Maliciously or intentionally misusing university-controlled computer facilities and services. This includes violations of state and federal laws (e.g. copyright violations, unauthorized access to systems, alteration/damage/destruction, or attempted alteration/damage/destruction, use for profit, etc.) or a department's rules for computer usage (e.g. account violations, damage, or destruction of the system and/or its performance, unauthorized copying of electronic information, use of threatening or obscene language, etc.).

7) **Malicious Removal, Retention or Destruction of University Resource Materials:** Misplacing, taking, destroying any item or part of an item belonging to or in the protection of the University (or the attempt thereof) with the intention of bringing about an undue disadvantage in the academic pursuits of other Kennesaw State University students.

These examples of academic dishonesty shall not be construed to be comprehensive, and infractions will be dealt with on an individual basis according to university policies and procedures. It is the obligation of each student to assist in the enforcement of academic standards.

See: The KSU Student Code of Conduct at KSU Codes of Conduct-2015.pdf

Enforcement: This policy is strictly enforced. Please note, *I reserve the right to select any paper and/or assignment that are turned in for a grade for plagiarism review. Plagiarism review consists of running your paper/assignment through various search engines and databases at my disposal in order to check for “borrowed” or “bought” information. Students will be required to use TurnItIn.Com to have their papers reviewed for plagiarism.* If you are found in violation of academic dishonesty, then you will be subject to the enforcement policies and procedures, as outlined by the University and the Department.

Disruption of the Classroom

Faculty members are responsible for maintaining discipline in the classroom setting to the extent that all students in that class have an opportunity to participate in the learning process. Free exchange of ideas through appropriate dialogue is a necessary and important part of the learning process. Outside the classroom, other areas of the campus provide support services, which are also important to the total learning process. Sometimes the faculty or staff member may be confronted with a situation where the conduct of a particular student or students is so inappropriate that it impedes the natural and necessary learning process. All incidents of disciplinary violations of the KSU Student Code of Conduct outside of residence hall property shall be reported to the Department of Student Conduct and Academic Integrity (SCAI).

- If the situation is not imminently dangerous, the faculty or staff member may control the immediate situation by requiring the student(s) to meet specific criteria (not speaking during the remainder of the class period, leaving the classroom or

office area immediately, etc.), or the faculty member may choose to dismiss the class for the remainder of the period to avoid a confrontation.

- In situations where a student's conduct is both disruptive and poses imminent danger to the health and safety of himself/herself or others, immediately contact the KSU Police at [\(470\) 578-6666](tel:470-578-6666). The responding officer at the time of notification shall remove the student from the area immediately.
- Immediately report the incident to the SCAI Dept. and/or the Office of the Dean for Students and for possible handling under the "Interim Suspension" policy, described in Section III below.
- The SCAI officer will investigate the incident and will advise as to the appropriate course of action in each situation.
- See <http://scai.kennesaw.edu/students/general-info/conduct-violation.php> for more information.

Student Records/FERPA

Kennesaw State University adheres to the Family Educational Rights & Privacy Act of 1974 – FERPA. See the following link for more information:

http://www.usg.edu/information_technology_handbook/section9/tech/9.5_privacy_and_security

Student Rights and Responsibilities

Students of Kennesaw State University are entitled to an environment that is conducive to learning and individual growth. To this end, students enrolling at Kennesaw State University assume a responsibility to abide by the policies and regulations expressed in this section. By doing so, students may fulfill their responsibilities and enjoy the exercise of their own rights while also respecting the rights of others. All rights and responsibilities may be found in the University Catalog at catalog.kennesaw.edu.

Sexual Misconduct Policy

Kennesaw State University adheres to KSU's policy prohibiting sexual misconduct both in and out of the classroom. Questions about this policy should be directed to the KSU Equal Employment Opportunity (EEO) and Title IX officer by telephone at (470) 578-2614. You may also visit the University's EEO website

<http://www.kennesaw.edu/eoo/index.html> for more information.

Americans with Disabilities Act (ADA) – Support Services

In compliance with applicable disability law, qualified students with a disability may be entitled to *reasonable accommodation*. Any student with a documented disability (hidden or visible) needing academic adjustments, including classroom or test accommodations is requested to notify the instructor within the first two weeks of the course. Verification from KSU disAbled Student Support Services is required. All discussions and documentation will remain confidential.

Disabled Student Support Services:

James V. Carmichael Student Center Addition – 2nd Floor, Suite 267, 470.578.6443
http://www.kennesaw.edu/stu_dev/dsss/prospect.shtml

Please visit the Student Disabilities Services website at www.kennesaw.edu/stu_dev/sds for more information.

Copyright Law

Kennesaw State University adheres to USG's policy to respect the right of copyright. Holders and comply with copyright laws as set forth in the United States Copyright act. For more information, see the following link to USG's policy: <http://www.usg.edu/copyright/>

Web Accessibility

Kennesaw State University follows the guidelines of the Universal Design for Learning standard of web accessibility. Faculty use Word, PDF, and HTML formats when communicating electronic information to students whenever possible and appropriate in light of the goals of the course. Faculty are trained to use Web Accessibility Evaluation tools, e.g., WAVE (www.wave.webaim.org), and make adjustments as possible and appropriate in light of the goals of the course. For free resources available to students on web accessibility, please visit the Web Accessibility Resources page at the Distance Learning Center: <http://www.kennesaw.edu/dlc/facultyresources/index.php#>

Electronic Recording and Social Media

Electronic recording performed without the consent of the people being recorded chills the free exchange of ideas. Academic freedom, free inquiry, and freedom of expression should not be limited by the fear that one's brainstorming, polemic discourse, speculative inquiry, or any other kind of expressed curiosity made within the space of a university classroom will be made public without one's consent. This fear is unacceptable regardless of whether one is in an online, hybrid, or face-to-face classroom setting. Accordingly, no person shall make public any electronically recorded class discussion without the written permission of the instructor. This policy is not intended to discourage electronic recording in the classroom or the use of social media when such actions are performed with the written consent of the instructor, and others as appropriate. Note: Faculty accommodate all reasonable requests to electronically record a class discussion; these requests must be documented by the DisAbled Student Support Services available at: http://www.kennesaw.edu/stu_dev/dsss/prospect.shtml