Midwestern State University

Robert D. & Carol Gunn College of Health Sciences & Human Services
Department of Radiologic Sciences
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Course Number: RADS 3033 3 credits Spring 2019
Course Title: Image Acquisition & Processing

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Course Overview:

This course will analyze radiographic image qualities and the effects of exposure variables upon these qualities. The course will also study radiographic imaging technique formulation, image quality assurance, and the synthesis of all variables in image production.

Course Objectives:

Upon completion of this course the students will:

- Define, recognize, and evaluate qualities of the radiographic image
- Analyze the effects of exposure variables upon each image quality
- Formulate techniques to optimize image quality, minimize patient exposure, and preserve equipment
- Apply methods of image quality assurance
- Adapt technical variables to changing conditions

Textbooks:

Johnston, J. N., & Fauber, T. L. (2016). *Essentials of radiographic physics and imaging* (2nd ed.). St. Louis, MO: Elsevier.

Carter, C. E., & Veale, B. L. (2014). *Digital radiography and PACS* (3rd ed.). Maryland Heights, MO: Elsevier Mosby.

Introduction:

Welcome to RADS 3033 – Principles of Radiographic Imaging. Over the next 15 weeks, you will be introduced to the basic principles of radiographic imaging and an in-depth look at the mechanics of digital radiography. This course will feature two, one-hour lecture periods per week, followed by hands-on laboratory experience for two hours once per week. This semester will be extremely fast-paced and knowledge-intensive. You should expect to study at least 20 hours per week if you wish to do well. If you have problems in this class, do not hesitate to seek help. Please do not wait until the last minute, as that will be too late.

Class Meeting Date and Time:

This class meets for lecture on Monday from 10:00 – 10:50 AM in Dillard 101 and Thursday from 11:30 AM – 12:20 PM in Bridwell 108. Lab meets Monday from 1:00 – 2:50 PM, and Wednesdays from 1:00 – 2:50 PM and 3:00 – 4:50 PM.

Attendance Policy:

The student has a responsibility to attend all classes / labs at the designated time of that class or lab. If a student does not, they may be classified as tardy or absent. The following criteria of those classifications are solely those of the instructor of this class. Attendance counts as 10% of your course average.

Tardiness

Any student that arrives to class / lab after the starting time designated in the university catalogue of classes will be considered tardy. If a student arrives tardy, two (2) points will be deducted from his or her attendance grade for each tardy. Three tardies constitutes 1 unexcused absence, resulting in five (5) points being deducted from the student's attendance grade.

Absent from Class

A student will be considered absent from class / lab if the student does not show up after fifteen (15) minutes has expired. If the student has an unexcused absence, five (5) points will be deducted from his or her attendance grade. Three (3) unexcused absences **will** result in failure of the course and possible dismissal from the program. **There will be no exception to this policy.**

A student will be considered as having an excused absence from class / lab if the following criteria have been established:

1. **Death of an immediate family member.** An immediate family member is considered to be a grandparent, parent, sibling, spouse, in-law, aunt, uncle, or child.
2. **Summons to appear in court or jury duty.** A copy of the summons is required.
3. **Call to military service.** A copy of your orders to report is required.

4. **University sponsored event.** Members of athletic teams, college bowl participants, etc. will be excused with proper notification.
5. **Debilitating illness or disability.** Will be addressed on an individual basis.

If a student if affected by an illness that is not debilitating, (i.e. flu, virus infection) which may result in the student missing one or more consecutive class / lab sessions, that student will be marked as unexcused for the amount of days missed **unless a doctor's note is provided.** A doctor's note **must** have a statement to the affect that you were seen in the office, or you are cleared to return to classes. It **does not** have to state what you were seen for. **There will be no exception to this policy.**

Personal Appointments
Students should refrain from making appointments that will take them out of class / lab. Routine doctor or dentist visits are an example of this. If you leave class / lab early because of an appointment, or for any other reason, the occurrence will be treated with the same regard as tardiness. Doctor visits will be approved only with an accompanying release note.

Classroom Behavior:

It is important that you respect the right of every student in the classroom to learn. Talking during lecture, leaving or entering the room repeatedly during lecture, or any other type of disruptive behavior will not be tolerated, and may result in your being asked to leave the classroom. If this should occur, you will not be allowed to return to class that day and it will be treated as an unexcused absence with a 5-point deduction from your final grade. Repeat offenders will be sent directly to the program chair's office. **Cell phones are not to be used in class.** Disruptions due to these devices may result in your dismissal from class and/or the program.

This course also requires working in groups. Teamwork is an essential element in the healthcare industry. When in the labs, you must work within the group and **NOT** as an individual.

Course Requirements:

Lecture:

Weekly Quizzes / Midterm / Final Exam
Every Monday you will have a quiz over the previous week's lectures. The quizzes will be given the first 10 minutes of class and then lecture will follow. Weekly quizzes will be worth 10% of your final grade. Your midterm will cover the first 7 weeks of class and will count for 20% of your final grade. Your final will cover the last 7 weeks of class and count for 20% of your final grade.

EAQ
You will also be required to complete assigned EAQ Adaptive Quizzes. These mastery quizzes will be worth 10% of your total grade. If you reach intermediate mastery you will earn a 100, if you reach novice mastery you will earn a 50, and if you don't reach any mastery level you will get a zero.

Research Poster
You will form groups within the class to create a research poster for the Undergraduate Research Colloquium on campus in late April. Everyone is required to produce a poster and it is for a grade. Posters chosen for submission to the colloquium will receive extra credit on the final course grade. Details about the poster are provided later in the syllabus and will be elaborated in class.

Laboratory:

The laboratory portion of this course is designed to offer you the opportunity to test and practice the theories and facts discussed in lecture. There will not always be pre-designed experiments or procedures. Instead, the design of this lab is one of discovery. While you must follow all personal and equipment safety procedures, you will use information from lectures along with provided equipment to "discover" if a particular set of rules, guidelines, or theories prove true. You will also be doing scenarios and film critique sessions. The laboratory portion of this course will count as 30% of your course average comprised of the technique chart, poster, and final.

Occasionally, laboratory sessions for this course will be shared with Advanced Radiographic Procedures. You will still attend lab at your scheduled times, only the material covered will coincide with that course instead of imaging.

At the beginning of the semester, you will be put into groups within your lab period. You will work together to create a technique chart for your assigned room throughout the semester. You will be permitted some time during lab to work on this, but you may also have to work outside of class to complete it. The instructor will provide you with examples and more detailed instructions in class. **This project will be due the last week of class on your scheduled lab day.**

There is a lab "final" in this course this semester. It is the Mystery Box assignment and will require the student to take images and explain them to the instructor in a set amount of time. More information about the final will be given closer to time. The lab final will be held the last week of classes (the week before lecture finals).

Grading:

Attendance	10%
EAQ	10%
Weekly Quizzes	10%
Midterm	20%
Final	20%
Poster	10%
Lab (Technique Chart & Final)	20%

Scale:

100 - 90 = A
89 - 80 = B
79 - 75 = C
74 - 69 = D
68 - below = F

NOTE: You must make a C average or above to have this course count toward continuation in the Radiologic Technology Program. Please be aware, Professor Wagner does NOT round grades.

Poster Submission to EURECA Research Colloquium

Students will form groups and be required to develop a professional poster over an instructor-approved topic. The topic should be something current in the field of radiology and will need to be researched either through literature review or hands-on experimentation.
(The ASRT and Aunt Minnie are great references for current topics in the field.)

The guidelines for the poster are:

1. Displays should be emailed to the instructor using the provided format. (I will email the group leader the supplied template from EURECA).
2. The following must be included on the display:
   (You may name these sections differently if you choose.)
   a. Introduction
   b. Discussion (or each section of the body)
   c. Conclusion
   d. References
3. The name of the school/program must NOT be identified on the poster.
4. The poster must be the original design and creation of the students.

5. Your background must be white and no more than two (2) font colors may be used for printing purposes. Font choices must be legible. Refrain from using cute or silly images or designs. This is a professional research poster.
6. Students selected must present their poster at the EURECA Spring Undergraduate Research Colloquium (date TBA). All members must be present.

An example poster can be found at the end of this syllabus. *Please keep in mind the font used when creating the poster will appear very small because it will be blown up and printed much larger.*

Special Needs:

In accordance with Section 504 of the Federal Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, Midwestern State University endeavors to make reasonable adjustments in its policies, practices, services, and facilities to ensure equal opportunity for qualified persons with disabilities to participate in all educational programs and activities.

The Office of Disability Support Services (DSS) provides information and assistance, arranges accommodations, and serves as a liaison for students, instructors, and staff. The DSS has assistance devices such as books on tape, recorders, and adaptive software which can be loaned to qualified individuals. A student/employee who seeks accommodations on the basis of disability must register with the Office of Disability Support Services in the Clark Student Center Room 168 or call 940-397-4140 for more information. Documentation of disability from a competent professional is required.

Individuals with grievances related to discrimination or lack of accommodation on the basis of a disability are encouraged to resolve the problem directly with the area involved. If the matter remains unresolved, advice and/or assistance will be provided by the Office of Disability Services for resolution. The grievance procedure may be found in the Student Handbook and Activities Calendar.

The ADA Coordinator may be contacted at (940) 397.4140, or 3410 Taft Blvd., Clark Student Center Room 168.

Conduct/Honesty/Honor System:

RADS 3033 adheres to the MSU Code of Conduct. In particular, academic dishonesty, however small, creates a breach in academic integrity. A student's participation in this course comes with the expectation that his/her work will be completed in full observance of the MSU Code of Student Conduct. A student should consult the Student Handbook for answers to any questions about the code.

Students are encouraged to take full advantage of many resources available including Internet sites, handouts, other textbooks & journals, faculty, and peers. This interactive collegial learning environment is conducive to life-long learning.

Specific components of RADS 3033 are designed to represent the efforts of each student individually and are NOT to be shared. Submitting someone else's work as your own or improperly cited work constitutes plagiarism. Please see the Midwestern State University Catalog for further discussion of plagiarism. Plagiarism will constitute in an F for the course and the student will be referred to administration for further action. When students submit their efforts for grading, they are attesting they abided by this rule. ***Quizzes and exams are not to be copied in any form or shared in any form. Students caught engaging in such activity will receive an F for the course and be referred to University administration for dismissal.***

Cheating includes, but is not limited to: (1) use of any unauthorized assistance in taking quizzes, tests, or examinations; (2) dependence upon the aid of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or completing other assignments; or (3) the acquisition of tests or other academic materials belonging to the university faculty or staff without permission.

Plagiarism includes, but is not limited to: the use of, by paraphrase or direct quotation without correct citation in the text and on the reference list, the published or unpublished works of another person. Students may not submit papers and assignments that they have previously submitted for this or other courses. The use of materials generated by agencies engaged in "selling" term papers is also plagiarism. Students are encouraged to review the tutorials and suggested websites for more information about plagiarism.

By enrolling in this course, the student expressly grants MSU a limited right in all intellectual property created by the student for the purpose of this course. The limited right shall include but shall not be limited to the right to reproduce the students work product in order to verify originality and authenticity, and for educational purposes.

Administrative Process:

Unresolved issues related to this course should be first addressed between the student and the course instructor. If there is no resolution, students must follow this sequence:

1. Interim Department Chair: Debra Wynne (940) 397.4608
2. College Dean: Dr. Jeff Killion (940) 397.4594
3. Dean of Students: Matthew Park (940) 397.7500

Tentative Course Schedule

Dates	Lecture Material
Week 1 **1/14 & 1/17**	**Welcome & Course Expectations/Overview** **Image Production:** *Johnston Chapter 8*
Week 2 **1/21 & 1/24** ***NO LABS***	**Image Characteristics & Quality** *Johnston Chapter 9/Carter Chapter 2* ***Monday's lecture will be posted online in D2L since the university is closed – view before Thursday's lecture***
Week 3 **1/28 & 1/31**	**Exposure Technique** *Johnston Chapter 10*
Week 4 **2/4 & 2/7** ***OPEN LAB***	**Exposure Technique Selection** *Johnston Chapter 13* ***This week's lectures will be online in D2L because Jessyca will be at ACERT***
Week 5 **2/11 & 2/14**	**Image Processing & Manipulation** *Carter Chapter 3*
Week 6 **2/18 & 2/21**	**Image Receptors** *Carter Chapters 4-6*
Week 7 **2/25 & 2/28**	**Scatter Control** *Johnston Chapter 11*
Week 8 **3/4 & 3/7**	**Midterm Review (Monday) & Midterm (Thursday)**
Week 9 **3/11 & 3/18**	**Computer Principles** *Carter Chapter 7*
Week 10 **3/18 & 3/21**	**Spring Break – No Classes or Labs**
Week 11 **3/25 & 3/28**	**Networking & Communication Basics** *Carter Chapter 8*
Week 12 **4/1 & 4/4**	**Medical Informatics & PACS** *Carter Chapters 9 & 11*
Week 13 **4/8 & 4/11**	**PACS Archiving & Peripherals** *Carter Chapter 10*
Week 14 **4/15 & 4/18** ***OPEN LAB***	**QA/QC/CQI in PACS** *Carter Chapter 12* ***Easter Break – No Class on Thursday***
Week 15 **4/22 & 4/25**	**QA Testing in Digital Imaging** *Carter Chapter 13*
Week 16 **4/29 & 5/2**	**Final Review Week** **Mystery Box Final in Lab**
Week 17 **5/6**	**Final Exam** **Monday, May 6 @ 3:30 PM in Dillard 129**

Applications of X-Ray Backscatter

Imaging Student, Imaging Student, Imaging Student

INTRODUCTION

Backscatter radiation is a form of radiation that detects x-rays that have been reflected off the subject, and scattered toward the film, to create an outlined image of the subject on a viewing monitor. Backscatter x-ray screening systems were manufactured as a preventative security measure to detect potential threats to society (Schauer, 2011). Backscatter x-ray scanners allow operators and authorities to scan individuals, by virtually seeing beneath articles of clothing to discover any hidden objects (Klitou, 2008). Backscatter x-rays are less harmful than standard x-rays, because backscatter x-rays produce low energy x-rays that only interact with the surface of the skin and scatter away, instead of penetrating through the body (Schauer, 2011). Even though x-ray scanners emit very miniscule quantities of ionizing radiation, dangerous encounters have been prevented numerous times because of the ability to search transportation vehicles and individuals.

Discussion

How it Works

Backscatter x-ray scanners can discover objects that traditional x-ray machines and metal detectors cannot identify easily. Metal weapons that are assembled with high Z materials (high atomic number), absorb x-rays, explosives , and low Z materials (low atomic number), scatter x-rays (Klitou, 2008). The quantity of backscatter radiation decreases as the atomic number increases. Fortunately, human tissue is composed primarily of oxygen, which has a very low atomic number (Klitou, 2008). When an object or individual is positioned inside the scanning portal, the x-ray source and detectors are on the same side as the object, and a narrow beam of low energy x-rays are emitted. X-ray energies are absorbed, releasing new photons, and backscatter z-rays are only reflected off the surface of the object. After the rapid screening, the backscatter is electrically transmitted and displayed on a monitor, if the image appears bright white that's where the most scatter hit, signifying explosive materials or drugs. Metal objects, such as weapons, reveal a lack of scatter, and form a Z-shaped pattern on the image (Klitou, 2008).

Airport Security

The use of background scatter radiation in airport security has increased since its first inception in the early millennium. The desire to more effectively monitor security risks before they compromise passenger safety has driven the mass introduction of devices which use, among other methods, background scatter x-rays in order to analyze subjects to determine if they are smuggling unseen items beneath their garments.

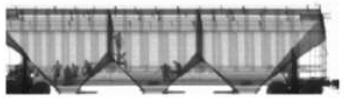

Fig. 3.4.1. [illegible] Railway wagon with illegal aliens. The form of the wagon's loading spaces indicates design for coal or grain transport. Border Honduras- Mexico.

Note: Vogel, H. (2007). Search for persons. *European Journal Of Radiology, 63*(2), 220-226. doi:10.1016/j.ejrad.2007.03.038

Though concerns about airport backscatter have included radiation exposure, the levels of exposure present are miniscule even when compared to medical imaging. The generally accepted dose which is a standard set by regulatory committees including UNSCEAR, BEIR, and ICRP recognizes a 5% increase for every one Sievert a person is exposed to. This would result in an estimated risk increase of about one in ten million for a trip which involved two screenings (Brenner, Hindié, & Orton, 2012).

The NCRP recommends that the annual dose for members of the public should be no more than 1mSv per year, not including exposure to background levels. This is far in excess of the amount which is experienced during one scan. Due to the effects of ionizing radiation the FDA asked the NCRP to decide upon a dose limit for backscatter machines which was set at 0.1μSv, which means that an individual can experience as many as 2500 scans per year without exceeding the dose limits (Schauer, 2011). In fact, the dose amounts which are needed for backscatter lie far below the levels with which we know there to be an effect from exposure. According to Brenner (2011), "The lowest doses for which we have definitive evidence for an increased risk are in the range from 5-125 mSv, far larger than the doses concerned here" (p. 7). Even with these figures, many researches are not sufficiently convinced that the scanners are perfectly safe.

Border Control

Additional research has also been performed to investigate the use of x-ray backscatter on vehicles such as trucks, airplanes, helicopters, and ships. Scans performed on vehicles and railway wagons are done to search for contraband and stowaways. These searches are performed with either a mobile unit which uses backscatter x-rays, or a stationary unit which uses a combination of backscatter x-rays and fluoroscopy, or transmitted x-rays (Vogel, 2007a). Backscatter x-ray scans expose people and items to a lower dose of radiation while providing images that better show hidden items and people as compared to transmitted x-rays (Hupe & Ankerhold, 2007). To compare, receiving one scan of backscatter radiation emits 0.1 μSv, while a seven hour flight emits 35 μSv (Hupe & Ankerhold, 2007). The amount of radiation received relative to the usefulness of the information gained is miniscule.

Put to use, these low doses of radiation can be the reason that people live, a nation is safer, and that fewer illegal substances enter an area. Large vehicles and railway wagons sometimes house immigrants who are trying to be relocated illegally, or are used as a method of human trafficking (Vogel, 2007a). Often times these people, whether they are willing to make the travel or not, end up dying because of either dehydration or suffocation (Vogel, 2007a). If borders enforce backscatter x-ray scans, lives could be saved.

Table 2
List of personal dose equivalent values, $H_p(10)$, for different types of X-ray exposures

Type of X-ray exposure	$H_p(10)$ (μSv)
Personnel backscatter scanner, dose per scan	0.1
Personnel transmission scanner, dose per scan	6
Flight from Frankfurt to New York (7 h) [5]	35
Natural background radiation exposure per year [5]	2100
Computer tomography (CT)	15000

Table 2 Compares personal dose equivalent values to different types of x-ray exposures.
Note: Hupe, O., & Ankerhold, U. (2007). X-ray security scanners for personnel and vehicle control: Dose quantities and dose values. *European Journal Of Radiology, 63*(2), 237-241. doi:10.1016/j.ejrad.2007.04.029

The hidden travelers may not end up where they wanted to be, but they are alive nonetheless. The spread of contraband is also a big issue that backscatter x-rays can help reduce. Vehicles have numerous areas built into their frame and housing that can serve as compartments for explosives or illegal drugs (Vogel, 2007b). Removal of these items not only keeps them from entering other areas, but removes another pair of hands from the trade.

Conclusion

Radiation exposure is consistently applied through principles of greater help than hurt. Backscatter radiation results in a dose that is miniscule when compared to natural background sources. Though there is no such thing as a safe amount of exposure, backscatter has been proven to be of greater benefit than detriment in its applications. However, in order to sufficiently say whether background radiation is safe, long term studies are needed in order to more deeply understand the effects on such a large population.

REFERENCES

Brenner, D. J. (2011). Are x-ray backscatter scanners safe for airport passenger screening? For most individuals, probably yes, but a billion scans per year raises long-term public health concerns. *Radiology, 259*(1), 6-10. doi: 10.1148/radiol.11102347

Brenner, D. J., Hindié, E., & Orton, C. G. (2012). Point/counterpoint: backscatter x-ray machines at airports are safe. *Medical Physics, 39*(8), 4649-4652. doi:10.1118/1.3694116

Hupe, O., & Ankerhold, U. (2007). X-ray security scanners for personnel and vehicle control: Dose quantities and dose values. *European Journal Of Radiology, 63*(2), 237-241. doi:10.1016/j.ejrad.2007.04.029

Klitou, D. (2008). Backscatter body scanners – A strip search by other means. *Computer Law & Security Review, 24*(4), 316-325. doi:10.1016/j.clsr.2008.05.005

Schauer, D., A. (2011). Does security screening with backscatter X-rays do more good than harm? *Radiology, 259*(1), 12-16.

Vogel, H. (2007). Search for persons. *European Journal Of Radiology, 63*(2), 220-226. doi:10.1016/j.ejrad.2007.03.038

Vogel, H. (2007). Vehicles, containers, railway wagons. *European Journal Of Radiology, 63*(2), 254-262. doi:10.1016/j.ejrad.2007.03.041

Fig. 3.1.4. Multiple parcels (explosives and others), hidden at different sites. Fertilizer in the trunk. Backscatter image. AS&E, with friendly permission.

Vogel, H. (2007). Vehicles, containers, railway wagons. *European Journal Of Radiology, 63*(2), 254-262. doi:10.1016/j.ejrad.2007.03.041