

MEDICAL IMAGING SYS BSEN414 SEC 001 Fall 2022

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Medical imaging Systems

CLASS IN THE MIDST OF COVID-19

Please just be respectful to those around you. If you're feeling like you might be coming down with something, just wear a mask. If you're definitely sick, stay home. That is all, easy peasy.

Class Time/Place:

TR 11:00 AM – 12:15 PM

Rm. 112 L.W. Chase Hall

Textbooks:

Medical Imaging – Signals and Systems, 2nd ed.

Prince, J. Links (Prentice-Hall)

Note: This text provides great, supplementary information for the course and provides a different framework for describing the content discussed in class. There will be homework problems assigned from the book. However, if you can get the homework questions from a classmate, the book is not a requirement to pass the course, but is a useful tool in deeper understanding of the material.

Instructor:

Dr. Forrest Kievit

262 Morrison Center

Office hours: TBA + drop in or by appointment, fkievit2@unl.edu

Course Description:

This course will cover the underlying physics, basic instrumentation, and signal analysis of several biomedical and biological imaging modalities. MRI. X-ray (radiography). CT (computed tomography).

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systems will be taught. (Although some MATLAB projects will be assigned, this is not a digital image processing course).

Course Objectives:

Having successfully completed this course, students should be able to:

- Comprehend the application of physics and mathematics to the design of medical imaging systems (ABET 1, 2)
- Apply standard imaging quality parameters to the analysis of medical images (ABET 1, 2, 6, 7)
- Identify the contributions of engineers to a state-of-the-art medical imaging facility (ABET 2, 7)

ABET Criterion 3 outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to acquire and apply new knowledge as needed, using appropriate learning

Professionalism:

Students will be graded on professionalism during class time and in interacting with the instructor and TAs and includes attendance, punctuality, participation, activities during class time, etc. This does not mean you cannot have fun and joke around during class as you will find I do, but this fun should be appropriate and respectful. Attendance is always expected and may be taken at any time, unless a prior arrangement for an excused absence has been made with the instructor. If you have an upcoming excused absence planned, please notify the instructor prior to the absence. Make-up exams and homework will not be given.

Class Procedures:

- Scheduled classes begin at 11:00 AM.
- Computer exercises (using MATLAB) will be assigned.
- Announcements may be given by email or by Canvas – **you are responsible for checking Canvas**



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Grading:

Homework (approximately biweekly)*	20%
Experiential Learning Activities	20%
Tests (2)	30%
Final	20%
Intangibles (attendance, punctuality, participation, activities during class time, etc.)	10%

*For students taking 814, the term project will take the place of graded homework assignments.

Points (x)	Final Grade
$x \sim > 90$, rarely makes minor mistakes in HW and exams	A range (A-, A, A+)
$80 \sim < x \sim < 90$, rarely makes major mistakes in HW and exams	B range (B-, B, B+)
$70 \sim < x \sim < 80$, often makes major mistakes in HW and exams	C range (C-, C, C+)
$60 \sim < x \sim < 70$, major mistakes are dominant in HW and exams	D range (D-, D, D+)
$x \sim < 60$, showed minimal effort	F

Academic Honesty:

Academic honesty is essential to the existence and integrity of an academic institution. The



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addresses academic dishonesty. Students who commit acts of academic dishonesty are subject to disciplinary action and are granted due process and the right to appeal any decision. The BSE Department process for grade and academic dishonesty appeals can be found at <http://bse.unl.edu/academicadvising-index> (<http://bse.unl.edu/academicadvising-index>). Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns.”

Services for Students:

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can discuss options privately. To establish reasonable accommodations, I may request that you register with Services for Students with Disabilities (SSD). If you are eligible for services and register with their office, make arrangements with me as soon as possible to discuss your accommodations so they can be implemented in a timely manner. SSD contact information: 232 Canfield Admin. Bldg.; 402-472-3787; acontreras3@unl.edu (<mailto:acontreras3@unl.edu>).

UNL offers a variety of options to students to aid them in dealing with stress and adversity. Counseling and Psychological & Services (CAPS) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450. Big Red Resilience & Well-Being provides one-on-one well-being coaching to any student who wants to enhance their well-being. Trained well-being coaches help students create and be grateful for positive experiences, practice resilience and self-compassion, and find support as they need it. BRRWB can be reached by calling 402-472-8770.

Background of your instructor:

Dr. Forrest Kievit is an Associate Professor of Biological Systems Engineering (40% teaching, 50% research, 10% service) and started at the University of Nebraska in 2016. Dr. Kievit earned his B.S. in Bioengineering (2007) and Ph.D. in Materials Science and Engineering (2011), both at the University of Washington, followed by postdoctoral and research faculty positions in the Neurological Surgery Department. His research involves developing nanoparticle-based delivery vehicles for transport into the brain for more effective brain injury treatments. This stems from his career goal to help translate a nanomedicine into clinical use to improve the survival and quality of life of neurosurgery patients. The vast majority of Dr. Kievit’s research has focused on nanoparticle-mediated delivery of therapeutics into



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Emergency Response Information:

- **Fire Alarm (or other evacuation):** In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- **Tornado Warning:** When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- **Active Shooter**
 - **Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
 - **Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
 - **Take action:** As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- **UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: <http://unlalert.unl.edu> (<http://unlalert.unl.edu>).
- Additional Emergency Procedures can be found here: http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf (http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf)

Course Summary:

Date	Details	Due
Tue Aug 23, 2022	 Introduction, Linear systems review (https://canvas.unl.edu/calendar?event_id=383520&include_contexts=course_135665)	11am to 12:15pm
Thu Aug 25, 2022	 Linear systems review, imaging (https://canvas.unl.edu/calendar?event_id=383511&include_contexts=course_135665)	11am to 12:15pm











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Date	Details	Due
	event_id=383521&include_contexts=course_135665	
Thu Sep 1, 2022	 X-ray radiography. https://canvas.unl.edu/calendar?event_id=383527&include_contexts=course_135665	11am to 12:15pm
	 Bonus Assignment 0 https://canvas.unl.edu/courses/135665/assignments/1314441	due by 5pm
Tue Sep 6, 2022	 X-ray radiography. https://canvas.unl.edu/calendar?event_id=383526&include_contexts=course_135665	11am to 12:15pm
Thu Sep 8, 2022	 no class, Dr. K in Chicago https://canvas.unl.edu/calendar?event_id=383507&include_contexts=course_135665	11am to 12:15pm
Fri Sep 9, 2022	 Homework 1 https://canvas.unl.edu/courses/135665/assignments/1314445	due by 5pm
Tue Sep 13, 2022	 X-ray radiography. https://canvas.unl.edu/calendar?event_id=383510&include_contexts=course_135665	11am to 12:15pm
Thu Sep 15, 2022	 X-ray radiography. https://canvas.unl.edu/calendar?event_id=383515&include_contexts=course_135665	11am to 12:15pm
Tue Sep 20, 2022	 Computed tomography. https://canvas.unl.edu/calendar?event_id=383508&include_contexts=course_135665	11am to 12:15pm
	 Homework 2 https://canvas.unl.edu/courses/135665/assignments/1314446	due by 11:59pm
Thu Sep 22, 2022	 Computed Tomography. https://canvas.unl.edu/calendar?event_id=383525&include_contexts=course_135665	11am to 12:15pm












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Date	Details	Due
Thu Sep 29, 2022	 No CT Lab - CT Lab will be Oct. 4 for everyone https://canvas.unl.edu/calendar?event_id=383528&include_contexts=course_135665	11am to 12:15pm
Tue Oct 4, 2022	 CT Lab https://canvas.unl.edu/calendar?event_id=383529&include_contexts=course_135665	11am to 12:15pm
Thu Oct 6, 2022	 Test review https://canvas.unl.edu/calendar?event_id=383517&include_contexts=course_135665	11am to 12:15pm
	 Homework 3 https://canvas.unl.edu/courses/135665/assignments/1314447	due by 11:59pm
Tue Oct 11, 2022	 Test #1 https://canvas.unl.edu/calendar?event_id=383518&include_contexts=course_135665	11am to 12:15pm
	 Test 1 https://canvas.unl.edu/courses/135665/assignments/1314463	due by 12:15pm
Thu Oct 13, 2022	 Nuclear Medicine https://canvas.unl.edu/calendar?event_id=383516&include_contexts=course_135665	11am to 12:15pm
Tue Oct 18, 2022	 No class, fall break! https://canvas.unl.edu/calendar?event_id=383539&include_contexts=course_135665	12am
Thu Oct 20, 2022	 MRI https://canvas.unl.edu/calendar?event_id=383513&include_contexts=course_135665	11am to 12:15pm
Sun Oct 23, 2022	 CT Lab https://canvas.unl.edu/courses/135665/assignments/1314442	due by 11:59pm
Tue Oct 25, 2022	 MRI	11am to 12:15pm














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Date	Details	Due
	 Homework 4 https://canvas.unl.edu/courses/135665/assignments/1314448	due by 11:59pm
Thu Oct 27, 2022	 MRI https://canvas.unl.edu/calendar?event_id=383522&include_contexts=course_135665	11am to 12:15pm
Tue Nov 1, 2022	 MRI Lab https://canvas.unl.edu/calendar?event_id=383523&include_contexts=course_135665	11am to 12:15pm
Thu Nov 3, 2022	 MRI Lab https://canvas.unl.edu/calendar?event_id=383530&include_contexts=course_135665	11am to 12:15pm
Tue Nov 8, 2022	 Review for exam 2 https://canvas.unl.edu/calendar?event_id=383536&include_contexts=course_135665	11am to 12:15pm
	 Homework 5 https://canvas.unl.edu/courses/135665/assignments/1314449	due by 11:59pm
Thu Nov 10, 2022	 Test #2 https://canvas.unl.edu/calendar?event_id=383538&include_contexts=course_135665	11am to 12:15pm
	 Test 2 https://canvas.unl.edu/courses/135665/assignments/1314464	due by 12:15pm
Tue Nov 15, 2022	 No class, Dr. K in Phoenix https://canvas.unl.edu/calendar?event_id=383537&include_contexts=course_135665	11am to 12:15pm
	 MRI Lab https://canvas.unl.edu/courses/135665/assignments/1314459	due by 11:59pm
Thu Nov 17, 2022	 Ultrasound https://canvas.unl.edu/calendar?event_id=383532&include_contexts=course_135665	11am to 12:15pm

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Date	Details	Due
	event_id=383533&include_contexts=course_135665	
Thu Nov 24, 2022	 Gobble gobble https://canvas.unl.edu/calendar?event_id=383524&include_contexts=course_135665	12am
Tue Nov 29, 2022	 Ultrasound Lab https://canvas.unl.edu/calendar?event_id=383535&include_contexts=course_135665	11am to 12:15pm
Thu Dec 1, 2022	 Fluorescence imaging https://canvas.unl.edu/calendar?event_id=383512&include_contexts=course_135665	11am to 12:15pm
Tue Dec 6, 2022	 Review https://canvas.unl.edu/calendar?event_id=383534&include_contexts=course_135665	11am to 12:15pm
Tue Dec 6, 2022	 Ultrasound Lab https://canvas.unl.edu/courses/135665/assignments/1314465	due by 11:59pm
Tue Dec 6, 2022	 Homework 6 https://canvas.unl.edu/courses/135665/assignments/1314450	due by 11:59pm
Thu Dec 8, 2022	 Review and comparison https://canvas.unl.edu/calendar?event_id=383531&include_contexts=course_135665	11am to 12:15pm
Wed Dec 14, 2022	 Final Exam https://canvas.unl.edu/courses/135665/assignments/1314444	due by 10am
Wed Dec 14, 2022	 10 - Point Source Geometry https://canvas.unl.edu/courses/135665/assignments/1314426	
Wed Dec 14, 2022	 11 - Detecting X-rays https://canvas.unl.edu/courses/135665/assignments/1314427	
Wed Dec 14, 2022	 12 - Intro to CT https://canvas.unl.edu/courses/135665/assignments/1314428	















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Date	Details	Due
	 14 - Reconstruction Methods (https://canvas.unl.edu/courses/135665/assignments/1314430)	
	 15 - Intro to backprojection (https://canvas.unl.edu/courses/135665/assignments/1314431)	
	 16 - Backprojection Corrections (https://canvas.unl.edu/courses/135665/assignments/1314432)	
	 17 - Intro to Nuclear Medicine (https://canvas.unl.edu/courses/135665/assignments/1314433)	
	 18 - Detecting Gamma Rays (https://canvas.unl.edu/courses/135665/assignments/1314434)	
	 19 - PET imaging (https://canvas.unl.edu/courses/135665/assignments/1314435)	
	 20 - Intro to MRI (https://canvas.unl.edu/courses/135665/assignments/1314436)	
	 7 - Projection Radiography (https://canvas.unl.edu/courses/135665/assignments/1314437)	
	 8 - Producing X-rays (https://canvas.unl.edu/courses/135665/assignments/1314438)	
	 9 - X-ray/body interactions (https://canvas.unl.edu/courses/135665/assignments/1314439)	
	 Lecture 1 - Intro to course concepts (https://canvas.unl.edu/courses/135665/assignments/1314452)	
	 Lecture 2 - Review of Signals and Systems, 2D signals (https://canvas.unl.edu/courses/135665/assignments/1314453)	









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Date	Details	Due
	. (https://canvas.unl.edu/courses/135665/assignments/1314454)	
	 Lecture 4 - Linear Systems . (https://canvas.unl.edu/courses/135665/assignments/1314455)	
	 Lecture 5 - Fourier Analyses . (https://canvas.unl.edu/courses/135665/assignments/1314457)	
	 Lecture 6 - Discrete Functions . (https://canvas.unl.edu/courses/135665/assignments/1314458)	
	 Professionalism . (https://canvas.unl.edu/courses/135665/assignments/1314460)	
	 Roll Call Attendance . (https://canvas.unl.edu/courses/135665/assignments/1314461)	
	 Term presentation . (https://canvas.unl.edu/courses/135665/assignments/1314462)	



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