

IMPORTANT: This syllabus form should be submitted to OAA (gsbs_academic_affairs@uth.tmc.edu) a week before the start of each semester.

NOTE to STUDENTS: If you need any accommodations related to attending/enrolling in this course, please contact one of the Graduate School's 504 Coordinator, Natalie Sirisaengtaksin, PhD. We ask that you notify GSBS in advance (preferably at least 3 days before the start of the semester) so we can make appropriate arrangements.

Term and Year: Fall 2026 Course Number and Course Title: GS02 1052: Imaging Science Credit Hours: 2 Prerequisites: Calculus, Linear Algebra Meeting Location: MDACC Building/Room#: DI-FCT14.5059 WebEx/Zoom Link: N/A	Program Required Course: Yes Approval Code: No Audit Permitted: Yes Classes Begin: Sept. 1, 2026 Classes End: December 18, 2026 Final Exam Week: Dec. 14-18, 2026				
Class Meeting Schedule <table border="1"> <tr> <th>Day</th> <th>Time</th> </tr> <tr> <td>Tuesday; Friday</td> <td>11am – 12pm</td> </tr> </table>		Day	Time	Tuesday; Friday	11am – 12pm
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Course Director Name and Degree: David Fuentes, PhD Title: Associate Professor Department: Imaging Physics Institution: MDACC Email Address: dtfuentes@mdanderson.org Contact Number: 713 745 3377 Course Co-Director/s: (if any) Name and Degree: Dragan Mirkovic, PhD Title: Associate Professor Department: Radiation Physics Institution: MDACC Email Address: dmirkovi@mdanderson.org	Instructors 1. David Fuentes, PhD Institution: MDACC Email Address: dtfuentes@mdanderson.org 2. Dragan Mirkovic, PhD Institution: MDACC Email Address: dmirkovi@mdanderson.org				

Contact Number: 713-563-2643

NOTE: Office hours are available by request. Please email me to arrange a time to meet.

Course Description: This course provides a concise and coherent review of some commonly-encountered topics in applied mathematics, with a particular emphasis on their applications and relevance to imaging science. The course covers and is equally divided into two major sections: (i) image analysis methods and (ii) Fourier and wavelet transforms. Our image analysis approach provides a formalism for image registration, image reconstruction, image segmentation, and machine learning.

Textbook/Supplemental Reading Materials (if any)

Jorge Nocedal and Stephen J. Wright. Numerical optimization, 2nd edition, Springer Verlag, 1999.
Ronald Bracewell, The Fourier transform and its applications, 3rd edition, McGraw Hill, 2000.
Michael Greenberg, Foundations of Applied Mathematics, Prentice Hall, 1978
E. Kreyszig, Introductory functional analysis with applications, volume 21. Wiley, 1989

Course Objective/s:

Upon successful completion of this course, students will possess a working knowledge of image analysis methods and transforms commonly encountered in research.

Specific Learning Objectives:

- Develop a mathematical formalism for approaching some commonly encountered problems in medical physics.
- Interpret multiple distance measures for identifying accurate solutions .
- Apply the mechanics of a neural network for image segmentation.
- Understand common computational techniques for solving optimization problems inherent to image registration and image reconstruction.
- Understand the mathematical formulation, properties, and limitations of Fourier transforms (continuous and discrete) and wavelet transforms and how they relate to some medical physics problems.

Student Responsibilities and Expectations:

Students enrolled in this course will be expected to perform the following activities each week.

1. Prepare homework assignments based on course lectures/ readings.
2. Participate in and contribute to course discussions during lecture, and review sessions
3. Prepare for and take a final examination based on the lecture and some reading material

While you may work and discuss all course materials and assignments in groups, all writing assignments must be your own. Cheating or engaging in unethical behavior during examinations (quizzes and final) will be grounds for dismissal from the course without credit and further GSBS disciplinary action.

Grading System: Letter Grade (A-F)	
Student Assessment and Grading Criteria :	
Percentage	Description
Homework (40 %)	
Midterm Exams (30 %)	
Final Exam (30 %)	

CLASS SCHEDULE – Fall 2026

1	Fuentes	1. Preliminaries - Algorithm Complexity, BLAS
2	Fuentes	2. Vector and metric spaces
3	Fuentes	3. Mutual Information
4	Fuentes	4. Entropy
5	Fuentes	5. Linear Independence, Equivalence of Norms
6	Fuentes	6. Linear Operators, Convolution
7	Fuentes	7. Image Segmentation
8	Fuentes	8. Analysis of Neural Network Structure
9	Fuentes	9. Rank and Nullity, Bounded Operator, Stability of Linear Systems
10	Fuentes	10. Inner Product, Orthogonality, Eigen-formulation
11	Fuentes	11. Optimization Characterization of Solution
12	Fuentes	12. Line search, Newton-CG Trust-Region Methods
13	Fuentes	13. Least Square, QR Decomposition
14	Fuentes	14. L1 minimization
15	Fuentes	15. exam on optimization
16	Mirkovic	1. Where Nature does or calls for FT, definition of FT, notations, symmetry and FT, interpretation of FT

17	Mirkovic	2. Some useful functions and calculating their FT
18	Mirkovic	3. Convolution, correlations, the central limit theorem
19	Mirkovic	4. LTI systems, more on convolution, FT as a linear system, what's special about $\exp(-i2\pi xy)$?
20	Mirkovic	5. Convolution theorem and other Fourier theorems
21	Mirkovic	6. The δ -function, distributions/generalized functions, re-defining FT
22	Mirkovic	7. Discrete Fourier Transform, cyclic convolution
23	Mirkovic	8. The Fast Fourier Transform algorithm
24	Mirkovic	9. The Sampling Theorem, ghost function, and Nyquist frequency
25	Mirkovic	10. Drawbacks of FT, wavelets, and continuous wavelet transforms, wavelet transform as a cross-correlation and constant-Q filtering
26	Mirkovic	11. Discrete wavelet transforms and orthogonal wavelet decomposition, multi-resolution analysis
27	Mirkovic	12. more on MRA, scaling function, digital filtering
28	Mirkovic	13. Haar wavelets, filters, filter banks, multistage filter banks, and perfect reconstruction
29	Mirkovic	14. Medical physics applications of Fourier and wavelet transforms
30	Mirkovic	15. Exam on transforms
