

Syllabus: Special Topics: Mathematics for Visual Computing, Fall 2026

Course Information

Course Number: VIZA 689/601
Course Title: Special Topics: Mathematics for Visual Computing
Lecture Time: TBA
Lecture Location: TBA
Credit Hours: 3

Instructor Details

Instructor: *Suryansh Kumar*
Office: -
Phone: -
E-Mail: *suryanshkumar@tamu.edu*
Office Hours: *By Appointment*

Course Description

Selected topics in an identified field of visual studies. May be repeated for up to 9 credit hours. **Prerequisite:** Approval of instructor and undergraduate program coordinator.

Additional Course Description

Introduces the foundational mathematical tools that underlie modern visualization, graphics, and computational media. Designed to develop the mathematical intuition and computational skills necessary to analyze, model, and transform visual data across a range of applications in computer vision, computer graphics, and computational media. Students develop mathematical literacy and practical skills through theory applied in hands-on exercises and programming projects involving linear algebra, signal processing, rigid body transformations, modeling, and neural representation in visual computing.

Summary

The course emphasizes intuitive, geometry-first understanding of linear algebra, transformations, camera models, complex numbers, quaternions, and Fourier Transforms. Students will explore the mathematical representations central to visual computing pipelines. The content is rigorous yet accessible, focusing on practical, visually motivated applications rather than abstract formalism. Keeping up with modern trends in computing, the course also teaches the fundamentals of neural network-based modeling via the lens of linear algebra.

Students should possess basic familiarity with coordinate geometry and computational workflows. No prior background in advanced mathematics or engineering is required. Nevertheless, students should be comfortable with trigonometry, calculus, visual reasoning, and working with digital images or simple code. The course is designed to build upon these foundations and make more advanced mathematical ideas accessible through visual intuition and application-driven examples.

Course Requirements

A serviceable laptop computer with the following minimum system configuration:

["Download the Student Laptop Requirement Document Report"](#)

MATLAB software: Use TAMU Academic License for Installation

Course Prerequisites

MATH 152 and VIST 272 or permission of the instructor

Course Learning Outcomes

Upon completing the course, successful students will:

- Apply core linear algebra concepts such as vectors, matrices, transformations, eigen analysis, SVD, etc., to visual computing problems.
- Use complex numbers and quaternions to model 2D and 3D rotations and understand their applications to geometric computer graphics and computer vision problems.
- Apply Fourier transforms (a signal-processing approach) to visual computing problems.
- Interpret neural networks as functional approximators for visual signals.
- Program advanced mathematical concepts to develop visual computing applications.

Textbook and/or Resource Materials

Recommended reference texts:

1. Introduction to Linear Algebra, Sixth Edition (2023), Gilbert Strang, MIT Press ([Link](#))
2. Mathematics for computer graphics (Fifth Edition), John Vince, Springer-Verlag ([Link](#))
3. Quaternions for computer graphics, John Vince, Springer-Verlag ([Link](#))
4. Introduction to Implicit Surfaces by Jules Bloomenthal et al. (Morgan Kaufmann) ([Link](#))
5. Fundamentals of Computer Graphics (4th Edition) Steve Marschner & Peter Shirley ([Link](#))

Web-based Resources:

- [Matlab tutorial](#): A good resource to get started with Matlab software.
- [Python.org](#): A resource for all things Python
- [W3 Schools Python Tutorial](#): A great set of tutorials with simple examples
- [Matplotlib](#): For 3D plotting in python
- [Scipy](#) and [Numpy](#): For numerical computing in python

Grading Policy

There will be no written exams in the class. Note that although there is no final exam, the final exam time will likely be used for final project presentations. It would be best if you planned to be available at that time. Grading will depend on assignments and projects

- **Assignments (60%)**
 - i) Generally, you will have two weeks from when it is assigned to when it is due.
 - ii) This will be generally related to the concepts or topics discussed in the class.
 - iii) There will be five assignments in total.
- **Final project (35%)**
 - i) Students are encouraged to form a group of 2-3 students and propose their project. Forming a group for the course project is highly recommended. Completing a final project on an individual level will require obtaining permission that it is not causing work

Course Syllabus

overload—refer to the statement on mental health and wellness. The groups shall demonstrate the work, along with a final presentation.

- ii) In case any group is unable to come up with a suitable project, then the course convenor or tutor will propose the project for them.

- **Participation Grade (5%)**

- i) Participation involves lecture attendance, participation of in-class activities, turning in work on time, and generating/providing a demo video clip at the end of the course.
- ii) Failure to participate in the final project presentation and submit the final video clip at the end of the course will result in a participation grade of 0.

- Failure to submit work drafts and final presentations will cause a loss of grade in this course.

- Scale for overall course grade:

90-100 = A; 80-89.9 = B; 70-79.9 = C; 60-69.9 = D; 0-59.9 = F

Late Work Policy

Assignments are due at the beginning of the class time on the due date, unless otherwise specified. If an excusable absence is anticipated or occurs, you should contact the instructor as soon as you know you will be absent. In general, you should finish and turn in assignments before the absence, although turning in shortly after the due date may be allowed with the permission of the instructor. Late work due to university excused absences will be handled in accordance with Student Rule 7.

Late assignments will result in a reduction of assignment grade, generally 5% penalty for each day late thereof. Assignments with a time constraint (e.g., paper presentations, final project presentation) will not be accepted late at all (the time constraint will be stated when assigned).

Course Schedule

The specific course topics may be adjusted from what is below, but the information below is given as a starting point and expectation for the approximate order and amount of time spent on each. Schedule subject to change depending on class interaction.

Week	Dates	Topics	Assignments
1	-	Intro to Linear Algebra for Visual Computing-I • Vectors and Linear Combinations • Length and Dot Products • Matrices	
2	-	Intro to Linear Algebra for Visual Computing-I • Solving Linear Equations • The Idea of Elimination • LU Decomposition	Assignment 1
3	-	Vector Spaces and Subspaces • Introduction to spaces of vectors • Introduction to rank • Notion of Independence, Basis, and Dimension • Dimensions of the Four Subspaces	
4	-	Orthogonality and Rigid Body Motion	Assignment 2



		• Orthogonality of subspaces • Orthonormality and Rotation Matrix • Rigid Body Motion	
5	-	Determinants and Inverses • Properties • Permutations and Cofactors • Inverses and Volumes	
6	-	Eigen Values and Eigen Vectors • Introduction to Eigen Value and Eigen Vectors • Symmetric Matrix and Positive Definite Matrix • Singular Value Decomposition	Assignment 3
7	-	Least Squares and Pseudo Inverses • Modeling visual data as matrices • Underdetermined, Overdetermined system • Least Squares, Normal Equations	
8	-	Visual Computing Application-I • Matrix and Linear Transformation • Principal Component Analysis • Projection Matrices and its applications	Assignment 4
9	-	Visual Computing Application-II • Image Transformation • Homography Matrix • Modeling Perspective Camera	
10	-	Visual Computing Application-III • Camera Calibration • Direct Linear Transform (DLT) Approach • Zhang's Approach	Project Proposal
11	-	Understanding Rotation in 2D and 3D-I • Complex Numbers, Basic Operations • Complex Numbers: Geometric Interpretation • Euler form and Rotation Matrix Representation	
12	-	Understanding Rotation in 2D and 3D-II • Axis-Angle representation • Quaternions • Application to camera modeling	Assignment 5
13		Visual Computing Application-IV • Linear Algebra for Functions • Fourier Series, Fourier Transform • Applications to Imaging	
14	-	Multi-layer Perceptron (MLP) • MLP from the lens of Linear Algebra • Affine Transformation + Non-linear activation • Application to visual computing problems	
15	-	• Course Revision • Final project presentation and demo	Final Project

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

Texas A&M at College Station

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at [Aggie honor weblink](#).

Notice of Nondiscrimination

Texas A&M University is committed to providing safe and non-discriminatory learning, living, and work environments for all members of the University community. The University provides equal opportunity to all employees, students, applicants for employment or admission, and the public regardless of race, color, sex (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, or veteran status. Texas A&M University will promptly, thoroughly, and fairly investigate and resolve all complaints of discrimination, harassment (including sexual harassment), complicity and

Course Syllabus

related retaliation based on a protected class in accordance with System Regulation 08.01.01, University Rule 08.01.01.M1, Standard Administrative Procedure (SAP) 08.01.01.M1.01, and applicable federal and state laws. In accordance with Title IX and its implementing regulations, Texas A&M does not discriminate on the basis of sex in any educational program or activity, including admissions and employment. The following person has been designated to handle inquiries and complaints regarding the non-discrimination policies: Jennifer M. Smith, TAMU Associate VP & Title IX Coordinator at YMCA Ste 108, College Station, TX 77843, 979-458-8407, or email civilrights@tamu.edu. For other reporting options, visit [office for civil rights complaint assessment system weblink](#) to locate the address and phone number of the office that serves your area, or call 1-800-421-3481.

Civil Rights, Free Speech, and Title IX Policies

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit discrimination and harassment based on an individual's race, color, sex, (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, veteran status, or any other legally protected characteristic. This includes forms of sex-based violence, such as sexual assault, sexual harassment, sexual exploitation, dating/domestic violence, and stalking.

Students can report discrimination/harassment, access supportive resources, or learn more about their options for resolving complaints on the [University's Civil Rights & Title IX webpage](#).

Students should be aware that all university employees (except medical or mental health providers) are mandatory reporters, which means that if they observe, experience or become aware of an incident that they reasonably believe to be discrimination/harassment alleged to have been committed by or against a person who was a student or employee at the time of the incident, the employee must report the incident to the university.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit the [TAMU disability services link](#).

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services](#) (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below). Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

To request academic accommodations, contact the designated ADA office based on your location:

- Texas A&M University, College of Nursing, College of Dentistry, Irma Lerma Rangel College of Pharmacy College Station, College of Medicine, School of Public Health, Institute of Biosciences and Technology, EnMed Program, Bush School in Washington DC, Mays Business School – CityCentre, TAMU Engineering Academies, Texas A&M University Higher Education Center at McAllen and Texas A&M University at Galveston should contact [Disability Resources](#) at (979) 845-1637 or [TAMU disability services link](#)
- Texas A&M University School of Law should contact the Office of Student Affairs at (817) 212-4111 or law-disability@law.tamu.edu to request accommodations.
- Irma Lerma Rangel College of Pharmacy in Kingsville should contact the Disability Resource Center at Texas A&M University - Kingsville at (361) 593-3024 or drc.center@tamuk.edu to request accommodations.
- Texas A&M University College of Veterinary Medicine & Biomedical Sciences in Canyon should contact the Office of Student Accessibility at West Texas A&M University – Canyon at (806) 651-2335 or osa@wtamu.edu.
- Texas A&M University at Qatar (TAMUQ) should contact the campus psychologist, Dr. Steve Wilson +974-4423-0047 or stephen.wilson@qatar.tamu.edu.

If you are experiencing difficulties with your approved accommodations, contact the office responsible for approving your accommodations or the Texas A&M ADA Coordinator Julie Kuder at ADA.Coordinator@tamu.edu or (979) 458-8407.

Pregnancy Accommodations

Texas A&M provides reasonable accommodations to students due to pregnancy and/or related conditions, such as childbirth, recovery and lactation. Students should contact the University's [Pregnancy Coordinator](#) as soon as they become aware of the need for accommodation. Depending on the circumstances, accommodations could include extended time to complete assignments or exams, changes in course sequence, or modifications to the physical classroom environment. Texas A&M will also allow a voluntary leave of absence, ensure the availability of lactation space, and maintain grievance procedures to provide for the prompt and equitable resolution of complaints of sex discrimination. For information regarding pregnancy accommodations, email TIX.Pregnancy@tamu.edu.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors influencing a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care practices by utilizing the resources and services available through [University Health Services](#) on its [mental health webpage](#). The [TELUS Health Student Support app](#) provides access to professional counseling in multiple languages anytime, anywhere by phone or chat, and the 988 Suicide & Crisis Lifeline offers 24-hour emergency support at 988 or visit the [988 web-address](#).

Texas A&M College Station

Students needing a listening ear can contact University Health Services (979.458.4584) 24-hour emergency help is also available through the 988 Suicide & Crisis Lifeline (988) or at [988 web-address](#).

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items can do so within howdy.tamu.edu using the Directory Information Withholding Form. The complete [FERPA Notice to Students](#) and the student records policy is available on the Office of the Registrar webpage. Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees honors and awards received, participation in officially recognized activities and sports, medical residence location and medical residence specialization.

Campus-Specific Policies

Campuses may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, Campuses can add them in this section. Please remove this section if not needed.

College and Department Policies

Course Syllabus

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section. Please remove this section if not needed.

Use of Artificial Intelligence (AI) Models

The use of AI models to complete the programming assignment and documentation is not recommended for this course.