**GGS 680 – Earth Image Processing**
**Fall 2025 – Tuesday – 4:30 to 7:10**
**Classroom –** Exploratory Hall **2103**

**Instructors**: Mike Wolf, PhD; Adjunct Professor
**Email:** mwolf7@gmu.edu (best way to reach me)
**Office:** Exploratory Hall 2205
**Office Hours:** By appointment; virtual or office

**Course Materials (not required):**

- "Digital Image Processing, 4th Edition" by R. C. Gonzalez and R. E. Wood, Prentice-Hall, 2018 (ISBN 978-0-13-168728-8).
- "Remote Sensing Digital Image Analysis – An Introduction" by John Richards, Springer-Verlag, 2015 (ISBN 978-3-642-30062-2). (PDF available for download)
- "Image Operators: Image Processing in Python 1st Edition" by Jason M. Kinser, CRC Press, 2019 (ISBN-13: 978-1498796187). (PDF available for download)

**Course Description:**
Imagery has become a primary data source in geospatial applications. From satellite remote sensing to aerial and terrestrial imaging systems and networks, vast amounts of imagery are being collected and utilized in various application areas. The wide variety of imagery data sources are now challenging our ability to manage such data, process it, and derive useful high-level information from it. Motivated by this, the primary objective of the course is to provide a systematic introduction to Digital Image Processing (DIP) techniques and related topics in Remote Sensing (RS) and Computer Vision to enable the extraction of spatial and spatiotemporal information from imagery. In particular, the objectives of this course are to:

- Review basic ideas and theories of image processing and their relation to earth observations
- Introduce analytical techniques and tools that are used in image analysis
- Develop the ability to apply these tools in various application areas
- Identify and gain insight into some of the emerging trends in DIP

**Course Objectives:**
This is an upper-level graduate course and so it is expected that one has advanced research abilities along with refined writing and programming skills. By attending class lectures, performing background topic research and independent study, students will be able to:

- Have a broad knowledge-based on fundamentals, theory, and techniques of Digital Image Processing in the context of earth image processing and Geo-Intelligence and other geospatial applications
- Articulate and effectively communicate concepts and ideas related to Digital Image Processing to both image processing experts, non-experts, and other professionals in a work environment. This objective is particularly important in today's interdisciplinary work environment

- Develop the ability to appropriately apply the tools, algorithms and concepts covered in the course for various hypothetical and real-world data processing tasks
- Given a problem or task, be able to effectively analyze it, identify key elements and potential difficulties, and define a strategy for successfully addressing it
- Perform a critical review of the potential, effectiveness, and reliability of Digital Image Processing and Remote Sensing processing processes and outcomes
- Most importantly, learn how to learn from each other in a collaborative environment

**Planned Schedule:**

| Date | Topic | Homework |
|---|---|---|
| 8/26/2025 | Introduction & Lexicon | Problems at the end of the Jupyter Notebook |
| 9/2/2025 | Python & Linear Algebra & Digital Images | Problems at the end of the Jupyter Notebook |
| 9/9/2025 | Color & Geometric Transformations | Problems at the end of the Jupyter Notebook |
| 9/16/2025 | Image Morphing & PCA | Problems at the end of the Jupyter Notebook |
| 9/23/2025 | Scope Presentation & Discussions | Problems at the end of the Jupyter Notebook<br>Project Scope Definition Due & Presentation |
| 9/30/2025 | Eigen Images & Image Frequencies | Problems at the end of the Jupyter Notebook |
| 10/7/2025 | Frequency Filtering & Correlations | Problems at the end of the Jupyter Notebook |
| 10/14/2025 | Interim Report Presentation & Discussions | Problems at the end of the Jupyter Notebook<br>Interim Report Due & Presentation |
| 10/21/2025 | Edge Detection & Hough Transforms | Research Project |
| 10/28/2025 | Noise & Texture Recognition & Histogram Equalization | Research Project |
| 11/11/2025 | TorchGEO | Research Project |
| 11/18/2025 | Image Processing & Quantum Computing | Research Project |
| 11/25/2025 | Project Presentations | Research Project Presentations |
| 12/2/2025 | Project Presentations | Research Project Due and Presentations |

**Grading Policy:**

***Homework Assignments* (50%):**
All homework is due at the beginning of class in a jupyter notebook. Homework that is turned in late is subject receiving a maximum grade no higher than the lowest mark received by assignments turned in on time.

***Research Project* (30%)**
The research project will count for 30% of the student's grade. The research project will be due on the last day of class along with the associated presentation. All students must attend the presentation lecture in order to receive a passing grade for this course.

***Class Participation* (20%):**
Students are expected to attend the class periods of the courses for which they register. In-class participation is important not only to the individual student, but also to the class as a whole. Instructor may use absence, tardiness, or early departure as de facto evidence of non-participation.

***Expectations for Participation:***

- Students prepare for and actively engage in class discussion (e.g., demonstrate active listening, not distracted by electronics or peers)
- Students thoughtfully engage in in-class assignments and activities
- Students participate in class discussion by:
    - raising informed discussion points
    - connecting discussion to reading material, news, and relevant experiences
    - asking questions
    - listening to other perspectives
    - sharing the floor with others

**Grading**

| Grade | Points |
|---|---|
| A | >=90 |
| B | >=80 to <=90 |
| C | >=70 to <=80 |
| F | <70 |

**GMU Email Accounts & Blackboard:**
You must use and regularly check your GMU email account and Blackboard to receive information for this class. Please do not send emails from non-GMU accounts, they will be ignored. I will normally respond within 24 hours.

**Honor Code:**
You are expected to follow the George Mason University rules of student conduct as noted in the catalog.

**Office of Disability Services:**
If you require academic accommodation due to a permanent or temporary disability, please contact the Office of Disability Services (ODS) at (703)993-2474, http://ods.gmu.edu. GGS will then contact me to arrange appropriate accommodation.

**Classroom Expectations and other Miscellaneous:**
Students are expected to be on time for class.

1. In the event of any class cancellation (unlikely for a virtual class), including changes in the pandemic situation, inclement weather (e.g. snow), the class will resume where we left off, adjustments, if necessary, will be made later

2. Please turn cell phone sounds off and do not text or talk on your cell phone during class
3. Please be respectful of your peers and your instructor and do not engage in activities that are unrelated to the class. Such disruptions show a lack of professionalism and may affect your participation grade
4. Lecture materials will be posted on Blackboard within 24 hours after the lecture

**Recording and/or sharing class materials**

- Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy. Students requesting the use of assistive technology as an accommodation should direct such requests to the Office of Disability
- Sharing of instructor-created or other materials created or provided as part of the course (including recordings), and in particular materials relevant to assignments or exams, to public online "study" sites is considered a violation of Mason's Honor Code. For more information, see the Office of Academic Integrity's summary of information about online study sites

**Special Notice**

This syllabus is subject to change based on the needs and desires of the students taking the class. An updated syllabus will be posted if changed and the changes clearly described to the students.

**Use of Generative-AI**

Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. Three fundamental principles to follow at all times are that: (1) all work submitted be your own, as defined by the assignment; (2) when you use the work, the words, or the ideas of others, including fellow students or online sites, you give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment or exam, ask for clarification. No grade is important enough to justify academic misconduct. Use of Generative-AI tools should be used following the fundamental principles of the Honor Code. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative-AI tools.

All work submitted in this course must be your own original work; use of AI writing tools, such as ChatGPT, are prohibited in this course and will be considered a violation of academic integrity. All academic integrity violations will be reported to the office of Academic Integrity.

**Common GMU Policies**

All students must abide by the policies contain at https://stearnscenter.gmu.edu/wp-content/uploads/25-Common-GMU-Syllabus-Policies.pdf