

# Earth Image Processing (GG5-680)

## (A Distance Learning Course)

### Introduction:

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- **Instructor:** Dr. Arie Croitoru
- **Teaching Assistant:** TBA
- **Where:** online.
- **When:** each learning module begins on Wednesday and ends on the following Tuesday, Assignment due dates are specified separately on each assignment.
- **Course website:** Blackboard
- **Credits:** 3.0
- **Prerequisites:** GGS 416 or GGS 579 or permission of instructor
- **Instructor's Office Hours:**
  - Face-to-face: Tuesdays at 3:30-4:30pm, or by appointment. My office is located in Exploratory Hall 2205, Fairfax campus
  - Online: Mondays at 4:30 – 5:30pm via Blackboard
- **Instructor's Office Hours:**
- **Preferred contact method:** email via Blackboard (I will typically respond within 24-36 hours Monday to Friday, messages sent during the weekend will be addressed on the following Monday).

### Being a Distance Learning Student:

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Being a distance-learning student is different from being a face-to-face student. Learning online requires **self-discipline, time management, and organization** since the learning tasks are not set for a specific class hours – instead the material is formed as a set of learning modules, which students may complete at their own pace. While each one of us may have a different learning style, there are several key themes that you should consider and incorporate as you develop your approach to taking a distance-learning course. In particular:

- Review this syllabus as well as the course website and make sure you have a good understanding of the course expectations.
- Ensure access to the required hardware and software before the semester begins (see the Technical Requirements section below). Not having the necessary hardware and software tools will impact your ability to participate in the course.
- Build a schedule for your learning activities and follow it. Note that while this distance learning course do not include extensive face-to-face time, you are required to spend time reading materials, completing assignments, and taking exams.
- Take the time to review any assigned course materials (videos, written instructions, book chapters, etc.), and keep notes and comments on what you reviewed. Try to identify key themes and strive to develop a thorough understanding of them.
- Complete assignments on time and submit all assignments. While this is true for both face-to-face and online courses, in a distance learning course it is sometimes more difficult to notice that you are missing work. Keeping in touch with the course instructor and your peers can help with this.

- Keep track of all important dates of the course (assignment due dates, exam dates, etc.), as well as the completion time of each learning module.

A key factor in your success as a distance-learning student is being proactive and self-aware. Like any other learning experience, distance learning requires you to **be responsible for your own learning experience**. As most of the learning is done individually, it is often easy to overlook important details or even miss key ideas in the material. This is why it is essential that you keep in touch with the class and with the instructor, and seek feedback on your progress and work. Throughout the course you will have several ways accomplish this:

- **The Discussion Board:** the course discussion board on blackboard contains several discussion themes. Post any questions or feedback in the board.
- **Online Virtual Class Meeting:** during the semester we will hold virtual class meetings via blackboard. This is a great opportunity to ask any questions you might have.
- **Office Hours:** I hold weekly office hours, as indicated above. You are welcome to drop in during these office hours. If these times are not convenient for you, please contact me to schedule a spate appointment.

The benefit you will gain from any of these options, however, depends on how **proactive** you are with respect to seeking interaction, feedback, or help. Your success in the course, especially if this is your first distance learning experience, depends on how proactive you are in identifying any issues you have and seeking feedback.

In addition, the course instructor will send students **announcements and updates** via the blackboard announcements tool. Often you will receive these messages as emails to your Mason email account. **Please do not ignore these messages** – it is your responsibility to check your Mason email account and the course website several times during the week.

Another important resource that could contribute significantly to your success is the **class community**. If you have questions about a course topic, it's likely that some students in your class could help, and sometimes simply discussing the topic with a fellow student will help you understand it better. This is why it is important that you establish from early on some connections with other students, participate in discussions in one of the class forums, and form study groups.

When communicating with your peers (and your instructor) it is important to **be respectful** of one another. Please be aware that innocent remarks can be easily misconstrued, and that sarcasm and humor can be easily taken out of context. When communicating, please try to be positive and offer **constructive feedback**.

## Technology Requirements:

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**The technology requirements for this online course are listed below:**

### Hardware

In order to participate in the course you **must** have access to:

- A Windows or Macintosh (Intel based) computer with at least 2 GB of RAM.
- A reliable broadband Internet connection
- Computer speakers or headphones to listen to recorded content.
- A computer microphone
- A web camera is highly recommended but not required.

A USB computer headset that includes a microphone is highly recommended for live audio sessions using course tools like Blackboard Collaborate.

## Software

- A supported web browser (See [Blackboard Support](#) for supported web browsers)
- Blackboard Courses (Log into <http://mymason.gmu.edu>, select the Courses Tab)
- Blackboard Collaborate (Select Tools from the Blackboard Course Menu, then select "Blackboard Collaborate")
- Adobe Acrobat Reader ([free download](#))
- PDF Creator - An open source PDF printer ([free download](#))
- Flash Player ([free download](#))
- Windows Media Player ([free download](#))
- Microsoft Office ([purchase](#), also available in the GGS computer lab which is located in Exploratory Hall), Open Office, or a cloud-based office application suite (e.g. Google Docs, Office 365, etc.)

## Matlab

Throughout this course we will use the Matlab scientific computing environment as the primary computing platform. You will also use Matlab to prepare your assignments. In addition to Matlab you will also need access to a word processor and a PDF document generator (more information will be provided in class).

Matlab is installed in the GGS computer lab located in Exploratory Hall, as well as other general computing labs in the Johnson Center and Innovation Hall. These facilities are maintained on a regular basis. If you wish to work on your own computer you can purchase a student license through the Mason [Patriot computers](#) store or through [Mathworks.com](#). Please note that we are unable to support any technical issues related to the installation or maintenance of Matlab on your personal computer. Please note that we will work with Version 2013a (later versions of Matlab may also be used). If you use your own Matlab license, please make sure it is Version 2013a or later.

While other programming environments exist (e.g. Python, IDL, Java, C/C++, etc.), we will not be able to support other programming environments that you may be familiar with. The course materials are designed specifically for Matlab. If you wish to use a programming environment other than Matlab please contact the instructor to receive permission to do so.

**Note:** If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications and that system or corporate firewalls do not block access to any sites or media types.

# Course Objectives:

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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) to enable the extraction of spatial and spatiotemporal information from imagery. In particular, the objectives of this course are to:

1. Provide an understanding of the fundamentals and theory of DIP and their relation to RS.
2. Introduce key analytical techniques and tools that are used in these areas.
3. Develop the ability to apply these tools for various processing tasks.
4. Identify and gain insight into some of the emerging trends in DIP as applied to earth image processing.

## Learning Outcomes:

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By the end of the course each student will be able to:

1. Have a broad knowledge-base on fundamentals, theory and techniques of Digital Image Processing and Remote Sensing in the context of earth image processing and Geo-Intelligence and other geospatial applications.
2. Articulate and effectively communicate concepts and ideas related to Digital Image Processing and Remote Sensing 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.
3. Have the ability to appropriately apply the tools, algorithms and concepts covered in the course for various hypothetical and real-world data processing tasks.
4. 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.
5. Perform a critical review of the potential, effectiveness, and reliability of Digital Image Processing and Remote Sensing processing processes and outcomes.

## Required Textbooks:

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The following book is a required textbook for this course: "Digital Image Processing, 3rd Edition" by R. C. Gonzalez and R. E. Wood, Prentice-Hall 2009 (ISBN 978-0-13-168728-8). **This book is also available as an eBook** (please refer to the [Mason Bookstore](#), the [publisher's website](#), or online textbook retailers for further details). Additional readings (selected readings from research journals, technical reports, and other sources) will be provided via the course website. Students wishing to review additional materials may find supplementary readings in the following textbook: "Introduction to Digital Image Processing, 3rd Edition" by John R. Jensen, Pearson Press 2005 (ISBN 0-13-145361-0). Students interested in additional resources are encouraged to contact the instructor for additional recommended materials.

In addition to this book, we will also use the book "Practical Image and Video Processing Using Matlab" by O. Marques, IEEE press / John Wiley & Sons, 2011 (ISBN: 978111093467). This book is available electronically through the [University Library](#) and you **do not** need to purchase it.

Additional reading materials will be made available throughout the course as necessary.

## Course Expectations:

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1. This is a graduate course in the College of Science that involves some use of mathematical and statistical concepts.

2. The course involves the use of computer algorithms as applied in Earth Image Processing. During the course, you will be required to develop and demonstrate your understanding of these concepts, and implement algorithms in a computer environment (e.g. writing computer scripts).
3. Your work should show attention to detail, with the expectation that the experience provide the basis for potential employers to consider your skills.
4. I expect proper preparation for every week. You are expected to make productive use of the time you dedicate for this class. This is essential to the success of this course.
5. You are expected to participate in the scheduled web sessions.

## Assessment:

Your assessment in this course is performance-based, therefore you have the power to control your grade. Successful completion of all the course assignments and exams is highly recommended as it will provide you with the best opportunity of receiving the highest grade. Generally, your assessment in this course includes several interrelated components as described below. Please review this information carefully and make sure you understand them (you are welcome to ask questions or provide feedback through the course discussion board or directly to me via Blackboard)

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### Assignments

The course will include several mandatory written assignments on selected topics from the material covered in class and in the assigned reading. Assignments may include tasks such as algorithm development and implementation, analysis of data processing results, and discussion/analysis of theoretical concepts and test cases. All assignments are mandatory. Typically, one to two weeks will be allocated for every assignment. Submission of assignments should be done only through the Blackboard course website. Unless noted otherwise, we will grade only Assignments that are submitted through the "Assignments" section of the Blackboard system. Please DO NOT email assignments directly to the instructor's @gmu.edu or through their Blackboard email.

**Late Work Policy:** Labs submitted between 1 to 3 calendar days past the due date would result in a late penalty of 5 points per day. As a general rule, labs submitted after more than 3 days will not be accepted and incomplete lab work may not be completed after the due date. Exceptions to this policy may be made on a case-by-case basis at the discretion of the Instructor. Deferral of course work is a privilege and not a right; there is no guarantee that a deferral will be granted. Please make sure you notify the instructor as soon as you know a deferral is required.

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### Exams

The course will include three online exams. The material covered in the exams will be announced in advance. A student who cannot write a course examination or complete a course assignment because of an incapacitating illness, severe domestic affliction or other compelling reasons can apply for extension of time to complete an assignment. Generally, exceptions to the exam dates will not be made.

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### Wiki assignment

During the course you will be responsible for a wiki assignment. The objective of these assignments is to allow you to explore technological and technology-related topics that extend beyond the class materials, and provide you an opportunity to independently study and share your knowledge on a new topic. The topic of each wiki page will vary, and will typically be based on specifically assigned reading materials. In these assignments you will be required to prepare materials, present it as a wiki page, and maintain it.

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## Grading

Each assignment and written exam will be given a numerical grade on a 0-100 scale. Some assignments may include bonus tasks. At the end of the term all the marks will be totaled as a weighted average according to the following weights:

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- Assignments: 45%
  - Wiki assignment: 10%
  - Written exams: 3 x 15% = 45%
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Please note that, in general, assignments will not have the same weight. The weight of each individual assignment will be indicated on the assignment form. Final grades at the end of the course will be assigned using a combination of absolute achievements and relative standing in the class.

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## Schedule:

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Please note that this schedule is **tentative** and it may change depending on the course needs and the instructor's evaluation of the class progress. For up-to-date information on the course schedule please refer to the Weekly Modules on Blackboard for up to date information.

Reading Key:

**GW** - R.C. Gonzalez and R.E. Woods "Digital Image Processing 3<sup>rd</sup> Ed."

**OM** - O. Marques "Practical image and video processing using Matlab"

### ***Week 1: Sept. 2 – Sept. 8, 2015***

- **Lesson Theme:** Course Introduction
- **Instructional Activities:** Video - Introduction to the course
- **Reading:** None
- **Teaching tools:** Blackboard
- **Assignments:** None
- **Assessment:** None

### ***Week 2: Sept. 9 - Sept. 15, 2015***

- **Lesson Theme:** Overview and Introduction
- **Instructional Activities:** Videos - Why Image Processing?, Introduction to Matlab (1)
- **Reading:** GW - Ch.1, OM - Chapter 1
- **Teaching tools:** Blackboard
- **Assignments:** None
- **Assessment:** None

### ***Week 3: Sept. 16 - Sept. 22, 2015***

- **Lesson Theme:** The Human Visual System and Introduction to Matlab (1)
- **Instructional Activities:** Videos - The Human Visual System (1), Introduction to Matlab (2)
- **Reading:** GW - Sections 2.1 and 2.2, OM - Sections 3.1 – 3.2.
- **Teaching tools:** Blackboard

- **Assignments:** Lab 1
- **Assessment:** None

### ***Week 4: Sept. 23 - Sept. 29, 2015***

- **Lesson Theme:** The Human Visual System and Introduction to Matlab (2)
- **Instructional Activities:** Videos - The Human Visual System (2), Introduction to Matlab (3)
- **Reading:** OM – Sections 3.3 -3.4, and Sections 4.1 – 4.2.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 2 (Lab 1 due)
- **Assessment:** None

### ***Week 5: Sept. 30 - Oct. 6, 2015***

- **Lesson Theme:** Image formation and pixel relations
- **Instructional Activities:** Video - Image formation, Relations between pixels
- **Reading:** GW - Sections 2.3, 2.4, 2.5, OM – Sections 2.1 – 2.2, Sections 5.1 – 5.4.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 3, (Lab 2 due)
- **Assessment:** None

### ***Week 6: Oct. 7 - Oct. 13, 2015***

- **Lesson Theme:** Image enhancement in the spatial domain
- **Instructional Activities:** Video - Image enhancements
- **Reading:** GW - Sections 3.1, 3.2, OM – Chapter 8.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 4, (Lab 3 due)
- **Assessment:** **Written exam 1**

### ***Week 7: Oct. 14 - Oct. 20, 2015***

- **Lesson Theme:** Histogram processing
- **Instructional Activities:** Video - Histogram processing
- **Reading:** GW - Sections 3.3, OM – Chapter 9.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 5 (Lab 4 due)
- **Assessment:** None

### ***Week 8: Oct. 21 - Oct. 27, 2015***

- **Lesson Theme:** Filtering in the spatial domain (1)
- **Instructional Activities:** Video - Filtering in the spatial domain (1)
- **Reading:** GW- Sections 3.4, 3.5, OM Sections 10.1 – 10.3.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 5 is due
- **Assessment:** None

### ***Week 9: Oct. 28 - Nov. 3, 2015***

- **Lesson Theme:** Filtering in the spatial domain (2)
- **Instructional Activities:** Video - Filtering in the spatial domain (2)
- **Reading:** GW- Section 3.6, Sections 10.4 – 10.5
- **Teaching tools:** Blackboard
- **Assignments:** Lab 6 (Lab 5 due)
- **Assessment:** None

### ***Week 10: Oct. 4 - Nov. 10, 2015***

- **Lesson Theme:** Filtering in the frequency domain (1)
- **Instructional Activities:** Video - Filtering in the frequency domain (1)
- **Reading:** GW - Sections 4.1, 4.2, 4.3, 4.4, 4.5, OM – Sections 11.1 – 11.2
- **Teaching tools:** Blackboard
- **Assignments:** Lab 6 due
- **Assessment:** *Written exam 2*

### ***Week 11: Nov. 11 - Nov. 17, 2015***

- **Lesson Theme:** Filtering in the frequency domain (2)
- **Instructional Activities:** Video - Filtering in the frequency domain (2)
- **Reading:** GW - Sections 4.6, 4.7, 4.8, 4.9, OM – Sections 11.3 – 11.4
- **Teaching tools:** Blackboard
- **Assignments:** None
- **Assessment:** Lab 7

### ***Week 12: Nov. 18 - Nov. 24, 2015***

- **Lesson Theme:** Introduction to image morphology
- **Instructional Activities:** Video - image morphology (1)
- **Reading:** GW - Sections 9.1, 9.2, 9.3, OM – Sections 13.113.1 – 13.4.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 7 is due
- **Assessment:** None

### ***Week 13: Nov. 25 - Dec. 1, 2015***

- **Thanksgiving recess**

### ***Week 14: Dec. 2 - Dec. 8, 2015***

- **Lesson Theme:** Basic image morphology algorithms
- **Instructional Activities:** Video - image morphology algorithms
- **Reading:** GW - Section 9.5, OM – Sections 13.5 – 13.6.
- **Teaching tools:** Blackboard
- **Assignments:** Lab 8
- **Assessment:** None

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## **Week 15: Dec. 9 - Dec. 12, 2015**

- **Lesson Theme:** Summary and conclusion
- **Instructional Activities:** None
- **Reading:** None
- **Teaching tools:** Blackboard
- **Assignments:** Lab 8 due
- **Assessment:** **Written exam 3**

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## Other Important Dates:

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In addition to the course schedule below, please refer to Mason's academic calendar (Fall 2015) for information on important dates and follow Mason's announcements on any calendar changes during the semester.

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## General Expectations:

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### **Academic Integrity**

Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture. [See <http://academicintegrity.gmu.edu/distance>].

### **Honor Code**

Students must adhere to the guidelines of the George Mason University Honor Code [See <http://academicintegrity.gmu.edu/honorcode>].

### **MasonLive/Email (GMU Email)**

Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account. [See <https://thanatos.gmu.edu/masonlive/login>].

### **Patriot Pass**

Once you sign up for your Patriot Pass, your passwords will be synchronized, and you will use your Patriot Pass username and password to log in to the following systems: Blackboard, University Libraries, MasonLive, myMason, Patriot Web, Virtual Computing Lab, and WEMS. [See <https://thanatos.gmu.edu/passwordchange/index.jsp>].

### **Responsible Use of Computing**

Students must follow the university policy for Responsible Use of Computing. [See <http://universitypolicy.gmu.edu/1301gen.html>].

## Students with Disabilities

Students with disabilities who seek accommodations in a course must be registered with the George Mason University Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester [See <http://ods.gmu.edu>]. Please be proactive and let me know how I can help you with any disability issue.

**Students are expected to follow courteous Internet etiquette.**

# Student Services:

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## University Libraries

University Libraries provides resources for distance students. [See <http://library.gmu.edu/distance>].

## Writing Center

The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. [See <http://writingcenter.gmu.edu>]. You can now sign up for an Online Writing Lab (OWL) session just like you sign up for a face-to-face session in the Writing Center, which means YOU set the date and time of the appointment! Learn more about the [Online Writing Lab \(OWL\)](#) (found under Online Tutoring).

## Counseling and Psychological Services

The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance [See <http://caps.gmu.edu>].

## Family Educational Rights and Privacy Act (FERPA)

The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights. [See <http://registrar.gmu.edu/privacy>].

**Disclaimer:** Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported by the instructor.

**Notice:** Recording of any kind (audio, video), reuse or remix of course materials, and further dissemination of the course content is not permitted unless prior written consent of the professor and George Mason University has been given or if recording is part of an approved accommodation plan.