



**Syllabus: Fall 2024**

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Course Information	GG379: Remote Sensing Location: Hybrid - Exploratory Hall
Instructor	Dr. Konrad Wessels About Konrad Wessels COS ( <a href="https://science.gmu.edu/directory/konrad-wessels">https://science.gmu.edu/directory/konrad-wessels</a> ). Also see Instructor Introduction video in Blackboard Kwessel4@gmu.edu
Office Hours	By appointment request via email. Kwessel4@gmu.edu
Teaching Assistant	Amy Rose-Tejwani, arose20@gmu.eu Email her with any queries. (Blackboard/Teaching Assistant Zoom room, link in main menu)
Course Description	The world is currently experiencing a proliferation in image data from satellites, aircraft and UAV's. These images have to be processed to produce geospatial information to inform natural resource management, urban planning, defense intelligence and business decisions. This course will introduce the foundations of remote sensing, as well as the processing and analyses of imagery for diverse applications using ENVI. The course will introduce key concepts in electromagnetic radiation, passive (multi-spectral) and active (Lidar) sensor systems, and methods for image processing, classification and geospatial information extraction.
Course Objectives	Upon completion of the course, students will be able to: <ol style="list-style-type: none"> <li>1. Understand and explain the key theories of remote sensing and image analysis.</li> <li>2. Use image processing tools to process imagery to geospatial products.</li> <li>3. Gain fundamental insight into the use of remote sensing for multiple, real-world applications.</li> </ol>
Course Methodology	<b>This will be a hybrid course that will provide on-line material, but meet in person weekly for crucial interaction and required participation.</b> The class format will combine reading, lectures, in-class presentations, and hands-on processing of satellite imagery. The class will be interactive and require every student to be engaged in the material and assignments. In addition to the lectures and timely completion of assignments, <b>every student will be expected to be an active participant in class.</b> <b><u>Go to "Start Here: Welcome" in Blackboard for Course instructions.</u></b>
Required textbook(s) and/or materials	Required Textbook: <b>Relevant chapters are available as pdf under " Textbook" at the bottom of the main menu of this course's Blackboard page</b>

	<p>“Remote Sensing and Image Interpretation” by Lillesand, Kiefer and Chipman (7<sup>th</sup> edition, John Wiley &amp; Sons). <a href="https://www.wiley.com/en-us/Remote+Sensing+and+Image+Interpretation%2C+7th+Edition-p-9781118919477">https://www.wiley.com/en-us/Remote+Sensing+and+Image+Interpretation%2C+7th+Edition-p-9781118919477</a>.</p> <p>Additional Textbook: In the lecture presentations I also use figures and Examples from “Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition” by J.R. Jensen. (4<sup>th</sup> edition, Pearson). <a href="https://www.pearson.com/us/higher-education/program/Jensen-Introductory-Digital-Image-Processing-A-Remote-Sensing-Perspective-4th-Edition/PGM30020.html">https://www.pearson.com/us/higher-education/program/Jensen-Introductory-Digital-Image-Processing-A-Remote-Sensing-Perspective-4th-Edition/PGM30020.html</a></p>
Computer Requirements	<p><b>ENVI has the following system requirements:</b></p> <p>Operating systems:  Windows 10 and 11 (Intel/AMD 64-bit)  macOS 11.5 and 12 (M1 and Intel 64-bit)<b>(not recommended – ENVI on iOS is slow as it uses X-Windows. Rather use windows PC / Laptop)</b></p> <p>Linux (Intel/AMD 64-bit, kernel 4.18.0 or higher and glibc 2.28 or higher)  Disk space: Approximately 4 GB for installation  Memory (RAM): Minimum of 8 GB  Number of processing cores: Minimum of 2, recommended 4 or more  Graphics card: Minimum of 1 GB RAM and support for Open GL 2.0 or later  ENVI 5.7 has been tested with ArcGIS Pro version 3.0.</p> <p>An X-Windows manager is required for macOS. ENVI was tested using XQuartz 2.8.5.</p> <p>A Rosetta 2 emulator is required for Mac M1.</p> <p><b>Course-specific Hardware/Software</b></p> <p>You will have to install <b>ENVI</b> on your own computer. <b>Temporary student licenses have been provided for home installation by NV5 Geospatial.</b> <a href="https://www.nv5geospatialsoftware.com/Products/ENVI">https://www.nv5geospatialsoftware.com/Products/ENVI</a></p> <p><b>Home installation instructions will be provided on BlackBoard page /Start Here/Welcome.</b></p>
Cheating Policy	<p>Any form of cheating on an activity, project, or exam will result in zero points earned.</p> <p>“Cheating” includes, but is not limited to, the following: reviewing others’ exam papers, having ANY resources utilized when not allowed, collaborating with another student during an individual assignment or exams. Consulting internet resources during an exam constitutes cheating.</p> <p><b>Using ChatGPT to answer questions in Assignments and exams.</b></p>
Individuals with Disabilities	<p>Students with documented disabilities should contact the <a href="#">Office of Disability Services</a> (703) 993-2474) to learn more about accommodations that may be</p>

	available to them. <b>Documentation for accommodations has to be provided to the instructor at the start of the semester.</b>																																		
Course Grading & Evaluation	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Assignments</td> <td>45%</td> </tr> <tr> <td>Midterm exam</td> <td>20%</td> </tr> <tr> <td>Quizzes and participation</td> <td>15%</td> </tr> <tr> <td>Final exam</td> <td>20%</td> </tr> <tr> <td><b>Total:</b></td> <td><b>100%</b></td> </tr> </table> <p>Grades will be assigned as follows:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Weighted average range</th> <th>Letter grade</th> </tr> </thead> <tbody> <tr> <td>&gt;98.0</td> <td>A+</td> </tr> <tr> <td>97.9 – 93.0</td> <td>A</td> </tr> <tr> <td>92.9 – 90.0</td> <td>A</td> </tr> <tr> <td>89.9 – 87.0</td> <td>A-</td> </tr> <tr> <td>86.9 – 83.0</td> <td>B+</td> </tr> <tr> <td>82.9 – 80.0</td> <td>B+</td> </tr> <tr> <td>79.9 – 77.0</td> <td>B</td> </tr> <tr> <td>76.9 – 73.0</td> <td>B-</td> </tr> <tr> <td>72.9 – 70.0</td> <td>C</td> </tr> <tr> <td>69.9 – 60.0</td> <td>D</td> </tr> <tr> <td>&lt; 59.9</td> <td>F</td> </tr> </tbody> </table>	Assignments	45%	Midterm exam	20%	Quizzes and participation	15%	Final exam	20%	<b>Total:</b>	<b>100%</b>	Weighted average range	Letter grade	>98.0	A+	97.9 – 93.0	A	92.9 – 90.0	A	89.9 – 87.0	A-	86.9 – 83.0	B+	82.9 – 80.0	B+	79.9 – 77.0	B	76.9 – 73.0	B-	72.9 – 70.0	C	69.9 – 60.0	D	< 59.9	F
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Discussion board	We will use Discussion board mainly for trouble shooting during Assignments.																																		
Assignments – 45%	Each week’s assignment has to be uploaded to Blackboard by the due date and time. Assignments are due by Sunday, 11:59 PM, ET unless otherwise stated. Refer to the course schedule and weekly overviews for details. See further information on Assignments below. <b>DO NOT FALL BEHIND ON ASSIGNMENTS. Late assignments will incur a 5-10 point penalty.</b>																																		
Exams – 40%	Mid-term Exam 20% Final Exam 20% <b>Exams are open-book, open-note, but are challenging.</b>																																		

**Assignments:**

- Expect to work **2-3 hours per week** on assignments for this course.
- Submission of assignment report should be done only **through the Blackboard course website**. Reports should be neat and clearly indicate question number and answer. Insert cropped screen shots of processed satellite imagery at appropriate zoom level to respond to the question.
- Submit **pdf files** of assignment to Blackboard, not Word documents.
- Unless otherwise stated, all assignments are due by the end of the week in which they are assigned.
- For the purposes of this course, a week is defined as **beginning at 12:01 am each Monday EST, and ending at 11:59 pm on the following Sunday EST.**

- Each Assignment will have a **demo video** which explains all the steps you need to follow in ENVI - be sure to watch the video. ENVI's website also has outstanding instructions and additional information for each function in the software. If you have a specific question, email the LA/TA for help. If the question and answer is potentially useful to other students, the TA will post it on Discussion Board.

To help you manage your schedule and time to complete the assignments in this course, please follow the recommended timeline below. If you have a question or concern or encounter a problem about an assignment, please contact me immediately so we can discuss and work out a resolution. **Dates below in Course Calendar indicate the Monday of each week.**

### Course Calendar

Weeks (Monday)	Lessons	Assignments
<b>Week 1</b> 26 Aug	<b>Lesson 1:</b> Introduction. Overview of Remote Sensing applications, Remote Sensing process, Electromagnetic Waves and Spectrum, Spectral signature, Energy Sources and Radiation	<ul style="list-style-type: none"> <li>• Watch all videos</li> <li>• Start Reading textbook Chapter 1: <b>Concepts and foundations of Remote Sensing</b></li> <li>• Review lecture notes</li> <li>• Set up ENVI license</li> <li>• Do ENVI tutorials</li> </ul>
<b>Week 2</b> 9 Sept	<b>Lesson 2:</b> Energy Sources and Radiation, Energy Interactions, Atmospheric Scattering and Absorption, Interaction with earth surface (vegetation and water)	<ul style="list-style-type: none"> <li>• Watch videos</li> <li>• Read textbook Chapter 1: <b>Concepts and foundations of Remote Sensing</b> (Page 1-30, 45-59)</li> <li>• Do Practical Exercise ENVI: Getting started</li> <li>• Start Assignment 1 in ENVI: Interpretation of WorldView image of GMU campus</li> </ul>
<b>Week 3</b> 16 Sept	<b>Lesson 3:</b> Geometric influence on spectral response, Digital image acquisition, Four digital image resolutions: Radiometric resolution	<ul style="list-style-type: none"> <li>• Watch videos</li> <li>• Read Textbook 25-35</li> <li>• Complete Assignment 1 in ENVI.</li> <li>• Study for Quiz 1 on Lessons 2&amp;3.</li> </ul>
<b>Week 4</b> 23 Sept	<b>Lesson 4:</b> Spatial resolution, Types of multispectral sensors, Spectral resolution, Satellite orbits, Temporal resolution	<ul style="list-style-type: none"> <li>• <b>Take Quiz 1 (on Lesson 2&amp;3)</b></li> <li>• Watch lecture videos</li> <li>• Watch External videos (they are awesome!!)</li> <li>• Class exercise / Discussion: Fill in Google Sheets on 4 resolutions of selected satellite sensors</li> <li>• Textbook: 72-75, 290-293, 218-229, 219-224, 140-143, 286-290, 309-318, 359-367, 290-321</li> <li>• Download Data for Assignment 2</li> <li>• Complete Assignment 2: WorldView image interpretation of Washington DC.</li> </ul>
<b>Week 5</b> 30 Sept	<b>Lesson 5:</b> Processing digital numbers to surface reflectance	<ul style="list-style-type: none"> <li>• Watch lecture videos</li> <li>• Watch External videos</li> <li>• Read textbook: p 491-495</li> <li>• Study for Quiz 2 (on Lesson 5)</li> </ul>
<b>Week 6</b> 7 Oct	<b>Lesson 6:</b>	<ul style="list-style-type: none"> <li>• <b>Take Quiz 2 (on Lesson 5)</b></li> <li>• Watch lecture videos</li> </ul>

	Geometric correction, Image enhancement, spatial filters	<ul style="list-style-type: none"> <li>• Watch ENVI Demo video on Image enhancement: Contrast stretch</li> <li>• Watch External video</li> <li>• Read text book: 495-499, 500-06, 507-512, 147-148</li> <li>• Complete and submit Assignment 3</li> </ul>
<b>14 Oct</b>	<b>Fall Break</b>	<ul style="list-style-type: none"> <li>• No Class</li> </ul>
<b>Week 7 21 Oct</b>	<b>Lesson 7:</b> Spectral Indices, Vegetation indices time series	<ul style="list-style-type: none"> <li>• View lecture videos</li> <li>• View external videos</li> <li>• Read text book: 517-522</li> <li>• Contribute 2 anticipated Midterm exam questions to Discussion Board</li> <li>• Complete Lesson 7, Assignment 4</li> </ul>
<b>Week 8 28 Oct</b>	<b>Lesson 8:</b> Midterm Exam	<ul style="list-style-type: none"> <li>• Take <b>Midterm exam</b> date TBD - on Bb</li> <li>• There are two parts to this exam. Complete both. Be comprehensive in your answers - explain yourself well.</li> </ul>
<b>Week 9 4 Nov</b>	<b>Lesson 9:</b> Data transforms, Image Classification - Supervised and Unsupervised	<ul style="list-style-type: none"> <li>• View lecture videos</li> <li>• View external videos</li> <li>• Read text book: p529-530, 537-556</li> <li>• Complete Lesson 9, Assignment 5 by Sunday</li> </ul>
<b>Week 10 11 Nov</b>	<b>Lesson 10:</b> Land Cover classification, Accuracy Assessment	<ul style="list-style-type: none"> <li>• Review lecture video</li> <li>• View external videos</li> <li>• Complete and submit lesson 10, Assignment 6 by Sunday 11:59pm</li> <li>• Read textbook: 575-580, 611-618</li> </ul>
<b>Week 11 18 Nov</b>	<b>Lesson 11:</b> Sub-pixel classification, Object-based Classification,	<ul style="list-style-type: none"> <li>• Review lecture video</li> <li>• Read Textbook: 562-567, 568-570, 570-573.</li> <li>• Study for Quiz 3 (Lesson 9-11)</li> </ul>
<b>Week 12 25 Nov</b>	<b>Lesson 12:</b> Change Detection	<ul style="list-style-type: none"> <li>• <b>Take Quiz 3 (on Lesson 9-11).</b></li> <li>• Watch lecture videos</li> <li>• Complete and submit Assignment 7 by Sunday</li> <li>• Read textbook: 582-587</li> </ul>
<b>Week 13 2 Dec</b>	<b>Lesson 13:</b> LiDAR remote sensing	<ul style="list-style-type: none"> <li>• View lecture videos and external video</li> <li>• Read textbook sections: 471-482</li> <li>• View demo video on LiDAR processing</li> <li>• Complete Assignment 8 by Sunday</li> <li>• Review lecture presentation</li> </ul>
<b>Week 14 9 Dec</b>	<b>Lesson 14:</b> Hyperspectral and Thermal remote sensing and applications	<ul style="list-style-type: none"> <li>• View lecture videos and external video</li> <li>• Read textbook sections: 271-281, 598-602, 245 – 269,</li> <li>• Complete all late Assignments</li> <li>• Review lecture presentation</li> <li>• In preparation for Final Exam, post 2 example questions and on discussion board.</li> <li>• Review questions on discussion board</li> </ul>
<b>Week 15 11-18 Dec</b>	<b>Lesson 15:</b> Final exam period	<ul style="list-style-type: none"> <li>• Instructions for Final 379</li> <li>• <b>Final Exam date TBD</b></li> <li>• Go to BlackBoard / Assessments / Final Exam Part1 and 2</li> <li>• Part 1 and Part 1 of the final exam is in 2 separate Assessments / tests. Complete both.</li> <li>• Time available? Part 1 120 min; Part 2 90 min</li> <li>• This is an "open-book" and "open-notes" exam.</li> <li>• You may NOT Google information from other websites.</li> </ul>

		<ul style="list-style-type: none"> <li>You may NOT communicate with other students or anybody during the exam.</li> <li>Do NOT Copy/Paste from notes</li> <li>Email me if you have any problems with the on-line test or questions. <a href="mailto:kwessels4@gmu.edu">kwessels4@gmu.edu</a>.</li> <li><b>Read questions carefully and answer all parts of the questions.</b></li> </ul>

### Assignment due dates:

	Assignment	Due Date	
<b>Week 3</b>	1	22-Sep	
<b>Week 4</b>	Quiz 1	29-Sep	Quiz 1
<b>Week 5</b>	2	6-Oct	
<b>Week 6</b>	3	13-Oct	Quiz 2 this week
<b>Week 7</b>	4	27-Oct	
<b>Week 8</b>	No Assignment		
<b>Week 9</b>	5	10-Nov	
<b>Week 10</b>	6	17-Nov	
<b>Week 11</b>	No Assignment	24-Nov	Quiz 3 this week
<b>Week 12</b>	7	1-Dec	
<b>Week 13</b>	8	8-Dec	
<b>Week 14</b>	No Assignment		
<b>Week 15</b>	Final Exam Period		

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- See detailed instructions on report requirements under “Welcome: Start here” on Bb
- Submit **pdf files** of assignment to Blackboard, not Word documents.
- Unless otherwise stated, all assignments are due by the end of the week in which they are assigned.
- Feedback will be provided on Assignments and if you address the issues and resubmit, you can improve your points
- Write an Assignment report responding to all questions and upload a pdf of report (don't upload a Word doc).
- Reports must contain your name and G-number, clearly demarcated question numbers
- Screen shots of satellite images zoomed in as appropriate level to illustrate specific concepts the question is concerned with. Use multiple screen shots of image and tools to illustrate that you understand.

- Reports must be neat and organized.
- Answer the theoretical questions in sufficient detail in line with the marks assigned to each question.
- Make an effort to explain concepts by referring to textbook or lectures.
- See attached example of a good report for Assignment 1.
- Zoom in to appropriate zoom level to when making a screen capture to illustrate that you
- The pdf files of your report will be graded and comments will be left in inside the pdf explaining how you may improve your answer.
- If you would like to resubmit an improved report (pdf), you have one additional chance to do so.
- Start working on your assignment early, do not wait until the last day.
- For the purposes of this course, a week is defined as **beginning at 12:01 am each Monday EST, and ending at 11:59 pm on the following Sunday EST. Late assignments will incur penalties.**