

	Document Code	RG-	Written by	Name	Dr. Sajid Ghuffar
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				Date	

## INSTITUTE OF SPACE TECHNOLOGY

### COURSE SYLLABUS

**Program:** RS & GISc\_\_\_\_\_

**Department:** Space Science (SS)

**Course Code:** RG-

**Course Name:** Photogrammetry

**Credits:** CR 3-0

**Instructors:** Dr. Sajid Ghuffar (PhD. in Photogrammetry, Vienna University of Technology, Austria)

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#### **COURSE DESCRIPTION:**

This is a graduate level course on Photogrammetry, which deals with measurement of 3D/geometric information from photographs/Images. This course provides introduction to imaging geometry and then covers topics related to orientation of multiple images together with extraction of 3D information. Special focus will be given to generating Digital Surface Models (topographic modeling) from multiple images. These images may be acquired from airborne or space borne imaging sensors. The main topics for generating surface models are: aero-triangulation: bundle adjustment and image matching.

An introduction to computer vision techniques for automatic extraction and detection of corresponding points in images will be presented. Towards the end of the course, a brief overview on laser scanning and 3D cameras will be presented.

There will be exercises (in Matlab) pertaining to topics of image orientation and image matching.

Please note that it is only a preliminary course outline. In the first lecture there will be an overview presentation on the course, which will give a better idea on the topics of this course.

#### **Prerequisites:**

Basic knowledge of Linear Algebra (Matrices, Vectors, Transformations) and Statistics (variances, distributions) is required. Previous knowledge in least squares estimation/adjustment will be very beneficial.

Matlab will be used for exercises. Therefore, basic knowledge of Matlab and programming will be highly beneficial.

**Reading/Reference Materials:**

Recommended Textbooks:

- Edward Mikhail, Introduction to Modern Photogrammetry
- Karl Kraus, Photogrammetry: Geometry from Images and Laser Scans
- Karl Kraus, Photogrammetry Vol. 2

Supporting & Reference Books and Readings:

- Thomas Luhmann, Close Range Photogrammetry: Principles, Techniques and Applications
- Chris McGlone, Manual of Photogrammetry, Sixth Edition
- Lecture Notes
- Research Papers
- <http://www.cs.cmu.edu/~jcm/book/>
- <http://www.ifp.uni-stuttgart.de/EuroSDR/ImageMatching/index.en.html>

**COURSE PLAN:**

<b>Week</b>	<b>Topic</b>	<b>Resource Persons</b>
<b>1</b>	- Introduction to Photogrammetry and Laser Scanning	Dr. Sajid Ghuffar
<b>2</b>	- Transformations - Rotation Matrices	
<b>3</b>	- Image Orientation - Interior Orientation - Exterior Orientation - Control Points - Georeferencing	
<b>4</b>	- Imaging Geometry - Collinearity Equations - Camera Calibration	
<b>5</b>	- Automatic Point measurements - Distinctive features - Scale invariant features - SIFT	
<b>6</b>	- Stereo Imaging 1 - Relative Orientation - Co-planarity Constraint	

	- Epipolar Geometry	
7	- Stereo Imaging 2 - Essential Matrix - Fundamental Matrix	
8	- Least Squares Adjustment 1 - Measurements - Accuracies - Equation system - Outliers	
9	- Least Squares Adjustment 2 - Measurements - Accuracies - Equation system - Outliers	
10	- Aero-triangulation 1 - Bundle Adjustment	
11	- Aero-triangulation 2 - Bundle Adjustment	
12	- Image Matching - Stereo Matching - Stereo cost functions - Semi global matching	
13	- Point Clouds from Image Matching - Digital Terrain and Surface Models - Orthophoto	
14	- 3D Sensors - Time of Flight Cameras - Microsoft Kinect	
15	Laser scanning 2 - Point densities - Radar Equation - Full waveform laser scanning - Multiple Time Around - Strip Adjustment - Laser Scanning Bathymetry	
16	To be announced	
	<b>Final Examination</b>	
<b>Extra</b>	-	

## TEACHING METHODOLOGY

*The course will be taught using lectures, in-class discussions and homework assignments.*

## ASSESSMENT:

*The general grading distribution is as follows (subject to change):*

Assignments	30%
Mid-term Exam	30%
Final Exam	40%
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Total	100%

## General Course Policies:

- The Course Grading percentage distribution is loosely defined and may be changed by the end of the course. Students will be notified if such changes take place.
- The classroom environment shall preferably be active and open discussions are very much favored, but please try to stick to the topic under discussion.
- In assignments, any/all references must be PROPERLY quoted and cited and this must be STRICTLY followed. Marks will be deducted if this strict rule is not attended to.
- All graded work must be the original effort of the student. Plagiarism (either copying from another student or writing text without proper referencing) will NOT be tolerated. Severe grading loss may result, so please be careful. A quick search on Google will show you what plagiarism is and how to avoid it. It is your responsibility to avoid plagiarism.
- Do NOT take assignment deadlines lightly. If you have a problem, come to the instructor before the deadline, not after it. Deadlines will not be relaxed unless in case of an emergency. Marks will be deducted, as deemed suitable, for late submissions.