**Course Objective:** This course will introduce the students to the principles and applications of Interferometric Synthetic Aperture Radar (InSAR). It includes the sensor technology, platforms and data portals to retrieve data. An overview of Differential InSAR (DInSAR) principle processing techniques and applications will be also provided. The course will provide short hands-on experience with open-source processing packages and techniques with ad-hoc InSAR and SInSAR applications in the areas of geosciences (geology, seismology, volcanology, hydrology, environmental sciences, etc.)

The objectives of this course are: i) to provide background knowledge and understanding of principles of InSAR; iii) to acquire skills on basic InSAR and DInSAR image processing and analysis as well as basic knowledge on main limitations and error sources of these techniques; iv) to enable critical, spatial and temporal thinking on InSAR for real-world applications.

**Learning Outcomes:**

The students on the completion of this course would be able to:

1. Evaluate critically the principles of INSAR and DInSAR systems
2. Search and download relevant SAR data required for a certain InSAR and DInSAR -based project/purpose.
3. Perform basic signal processing techniques for InSAR and DInSAR imaging using publicly available software packages and SAR data.
4. Visually interpret in a qualitative way InSAR and DInSAR output images and interferograms.
5. Gain insight into the strengths and limitations InSAR and DInSAR systems and applications.

**Prerequisite:** AT76.03 Remote Sensing

**Course Outline:**

I. **Synthetic Aperture Radar (SAR) principles and Image Acquisition**
   1. Key features of satellite radar systems
   2. Amplitude and phase information
   3. Range resolution, signal compression and formation of a range line
   4. Acquisition geometry and synthetic aperture
5. SAR images
6. Geometric distortions and satellite orbit
7. Scattering mechanisms

II. SAR Interferometry
1. Measuring phase variations
2. Modelling the interferometric phase
3. SAR interferograms
4. Phase decorrelation and coherence maps
5. Atmospheric effects
6. Phase Unwrapping

III. Multi-interferogram techniques
1. Historical background
2. Time series approach
3. Estimation of 2-dimensional displacement fields
4. Precision assessment and validation

IV. SAR, InSAR and DInSAR applications in geosciences.

Tutorial(s):
1. SAR Basic Tutorial with Sentinel-1 Toolbox and Radarsat-2 data.
2. InSAR Tutorial with Sentinel-1 Toolbox and Radarsat-2 data: digital elevation model production.
3. DInSAR Tutorial with Sentinel-1 Toolbox and Sentinel-1 data: earthquake displacement mapping.

Learning Resources:

Textbooks: No designated textbook, lecture notes, handouts and other ancillary learning resources will be provided.

Reference Books:

Alessandro Ferretti
Satellite InSAR data: reservoir monitoring from space. EAGE Publications bv, 2014.

Bert M. Kampes

Ramon F. Hanssen

Journals and Magazines:

Remote Sensing, MDPI
International Journal of Photogrammetry and Remote Sensing (ISPRS), Elsevier
Photogrammetric Engineering and Remote Sensing, ASPRS
Remote Sensing of Environment, Elsevier

Others: None

Teaching and Learning Methods:

1. **Lectures**: Students will receive lecture notes and the weekly lecture schedule at the beginning of the course. They will be requested to read the lecture notes before coming to the class.

2. **Laboratory sessions**: 4 laboratory exercises will expose students to different tools in SAR imaging. Laboratory instruction will provide a basic guideline for student to learn and familiarize with Radar Interferometry software and data. Students are requested to understand the algorithm of each operation so that they able to operate with other software. Students can be requested to complete home assignments submit a report in due time.

3. **Discussion Sessions**: Every class will have discussion sessions to engage all the students.

4. **Mini project**: Students will carry out mini-project to show their ability to apply Remote Sensing data analysis in practice and problem solving. Data is provided and proposals are evaluated. They are also evaluated extensively on concept and expertise on different RS software.

Time Distribution and Study Load:

Lecture: 15 Hrs
Tutorials: 15 Hrs
Assignments: 15 Hrs
Self-studies: 40 Hrs

Evaluation Scheme:

Assignment: 50%
Final-semester examination (close book): 50%
In the examination, an “A” would be awarded if a student shows excellent and insightful understanding of key concepts and processing techniques of SAR and InSAR technology and master originally and sophisticatedly the knowledge learned in the class to obtain and analyze information on the earth for various applications; a “B+” would be awarded if a student shows very good understanding of key concepts and processing techniques of SAR and InSAR technology and master and elaborate the knowledge learned in the class to obtain and analyze information on the earth for various applications; a “B” would be awarded if a student shows a good understanding of all given topics and able to implement basic InSAR techniques; a “C+” would be given if a student meets below average expectation but may demonstrate some understanding on both knowledge and mastery of InSAR concepts and techniques; a “C” would be given if a student meets fairly below average expectations and is deficient on both knowledge and mastery of InSAR concepts and techniques; a “D” would be awarded if a student does not meet basic expectations and is highly deficient on both knowledge and mastery of InSAR concepts and techniques; a “F” would be awarded if the student shows unsatisfactory and very limited comprehension of InSAR concepts and processing techniques.

**Instructor(s):** Dr. Salvatore G.P. VIRDIS