COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *Satellite Radar Remote Sensing*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September - December 2024
Credits (CFU/ECTS):	3
SSD	FIS/06
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
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Department and address	Department of Physics, Via Amendola 173, 70126 Bari, Italy
Virtual room	Teams class
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Every day, agreeing to an appointment by email at the Department of Physics, 2nd floor, room no. 254

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
75	16	15	44
CFU/ECTS			
3	2	1	

Learning Objectives	• providing a basic knowledge on Remote Sensing (RS) / Earth Observation (EO) by means of passive and active sensors, and a deeper knowledge on electromagnetic imaging through satellite Synthetic Aperture Radar (SAR) systems • providing the necessary tools to choose and to exploit applications for managing and processing SAR images and geo-spatial data • demonstrating the potentials of the application of mathematical and statistical tools for environmental studies and information extraction from satellite SAR data through the presentation of applications
Course prerequisites	*No specific prerequisites required*

Teaching strategie	*Lectures supported by slides, and training on satellite image processing software (e.g., SNAP, QGIS)*
Expected learning outcomes in terms of	
Knowledge and understanding on:	o Theoretical and analytical knowledge in the field of Remote Sensing (RS) / Earth Observation (EO) by means of satellite SAR systems o Interdisciplinary view
Applying knowledge and understanding on:	o Knowledge of software tools for managing and processing satellite SAR images and geo-spatial data

	o Expertise in using software tools for managing and satellite SAR images and geo-spatial data
Soft skills	● *Making informed judgments and choices* o Capability to identify mathematical and statistical tools and methods for the extraction of information from satellite SAR data ● *Communicating knowledge and understanding* o Effective communication of the results of the final research project ● *Capacities to continue learning* o Learning skills necessary to cope with the further acquisition of information and knowledge as the discipline evolves o Problem solving skills for the implementation of the final research project
Syllabus	
Content knowledge	● *Fundamentals of Remote Sensing (RS)* o *Definition of a RS system, examples of RS applications* o *Basics of Radiometry: electromagnetic (e.m.) spectrum, radiometric quantities, radiation interaction with the Earth's atmosphere and surface, atmospheric windows for RS* o *Spectral response of different targets* o *Sensors and platforms* o *Spaceborne RS systems: types of orbits for RS, swath, orbit cycle and revisit period, classification of sensors* o *Overview of spaceborne passive and active sensors, raster image, RGB composition* ● *Synthetic Aperture Radar (SAR)* o *Imaging Radar: principle of detection and ranging, viewing geometry and glossary. Conventional radar (SL/RAR): image formation, spatial resolutions* o *Radar Equation, Normalised Radar Cross Section (NRCS)* o *SAR imaging and processing: chirped pulse, synthetic antenna array, spatial resolutions, image formation, spectral and radiometric resolutions, polarizations, imaging modes* o *Overview of satellite SAR missions and Space agencies* o *SAR amplitude, speckle noise, geometric and radiometric distortions, scattering mechanisms, SAR phase* ● *Basics of SAR Interferometry (InSAR)* o *InSAR geometry, absolute InSAR phase contributions, geometric, topographic and "flat-earth" phase, height of ambiguity, complex interferogram, wrapped InSAR phase, simulated and "real" InSAR phase, Phase Unwrapping* o *InSAR coherence and decorrelation terms* o *Short notes of Differential SAR Interferometry (DInSAR): sensitivity, issues, and applications* ● *Basics of SAR Geocoding* o *Concept of Geoid, reference ellipsoids, Coordinate Reference Systems and Datums, ellipsoidal and orthometric heights, map projections, UTM coordinate system* o *SAR Forward and Inverse Geocoding, and applications* ● *SAR-derived applications for environmental studies and information extraction* o *Sea Surface Wind field retrieval* o *Water bodies extraction* o *Shoreline Extraction*
Texts and readings	o *Books: 1) P.A. Brivio, G.M. Lechi, E. Zilioli, Principles and methods of remote sensing. Grugliasco (TO): CittàStudi Edizioni, 2006. 2) Schowengerdt, Robert A. Remote sensing: models and methods for image processing. Elsevier, 2006. 3) Soumekh, Mehrdad. Synthetic aperture radar signal processing. Vol. 7. New York: Wiley, 1999.*

	o *Links to "open access" remote sensing journals (e.g., http://www.mdpi.com/journal/remotesensing)*
Notes, additional materials	o *Course's Slides* o *Link to SNAP tutorials (https://step.esa.int/main/doc/tutorials/)* o *Link to QGIS tutorials (e.g., http://www.qgistutorials.com/it/)*
Repository	*Materials of the course will be available in the Teams class files*

Assessment	
Assessment methods	*Research project with a final presentation on the activity carried out to show the acquired skills*
Assessment criteria	● *Knowledge and understanding* o Ascertaining the acquisition of notions concerning the topics covered during the course and of the correct scientific terminology ● *Applying knowledge and understanding* o Ascertaining the acquisition of skills to process the knowledge acquired for carrying out the research project ● *Autonomy of judgment* o Assessment of the capability to solve theoretical and implementation problems for the research project ● *Communicating knowledge and understanding* o Assessment of the capacity to effectively convey the results obtained during the implementation of the research project ● *Communicating skills* o Assessment of the appropriateness of language and the autonomous organization of exposure at presenting the results obtained during the implementation of the research project ● *Capacities to continue learning* o Assessment of the ability to access up-to-date bibliographic sources and o online resources
Final exam and grading criteria	*The final mark will be expressed in thirtieths*
Further information	
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