

COURSE OF STUDY *Physics (LM-17)*
ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT *Satellite Radar Remote Sensing*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September - December 2023
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	<ul style="list-style-type: none"> 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	<i>No specific prerequisites required</i>

Teaching strategie	<i>Lectures supported by slides, and training on satellite image processing software (e.g., SNAP, QGIS)</i>
Expected learning outcomes in terms of	
Knowledge and understanding on:	<ul style="list-style-type: none"> Theoretical and analytical knowledge in the field of Remote Sensing (RS) / Earth Observation (EO) by means of satellite SAR systems Interdisciplinary view
Applying knowledge and understanding on:	<ul style="list-style-type: none"> Knowledge of software tools for managing and processing satellite SAR images and geo-spatial data

	<ul style="list-style-type: none"> o Expertise in using software tools for managing and satellite SAR images and geo-spatial data
Soft skills	<ul style="list-style-type: none"> • <i>Making informed judgments and choices</i> <ul style="list-style-type: none"> o Capability to identify mathematical and statistical tools and methods for the extraction of information from satellite SAR data • <i>Communicating knowledge and understanding</i> <ul style="list-style-type: none"> o Effective communication of the results of the final research project • <i>Capacities to continue learning</i> <ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> • <i>Fundamentals of Remote Sensing (RS)</i> <ul style="list-style-type: none"> o <i>Definition of a RS system, examples of RS applications</i> o <i>Basics of Radiometry: electromagnetic (e.m.) spectrum, radiometric quantities, radiation interaction with the Earth's atmosphere and surface, atmospheric windows for RS</i> o <i>Spectral response of different targets</i> o <i>Sensors and platforms</i> o <i>Spaceborne RS systems: types of orbits for RS, swath, orbit cycle and revisit period, classification of sensors</i> o <i>Overview of spaceborne passive and active sensors, raster image, RGB composition</i> • <i>Synthetic Aperture Radar (SAR)</i> <ul style="list-style-type: none"> o <i>Imaging Radar: principle of detection and ranging, viewing geometry and glossary. Conventional radar (SL/RAR): image formation, spatial resolutions</i> o <i>Radar Equation, Normalised Radar Cross Section (NRCS)</i> o <i>SAR imaging and processing: chirped pulse, synthetic antenna array, spatial resolutions, image formation, spectral and radiometric resolutions, polarizations, imaging modes</i> o <i>Overview of satellite SAR missions and Space agencies</i> o <i>SAR amplitude, speckle noise, geometric and radiometric distortions, scattering mechanisms, SAR phase</i> • <i>Basics of SAR Interferometry (InSAR)</i> <ul style="list-style-type: none"> o <i>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</i> o <i>InSAR coherence and decorrelation terms</i> o <i>Short notes of Differential SAR Interferometry (DInSAR): sensitivity, issues, and applications</i> • <i>Basics of SAR Geocoding</i> <ul style="list-style-type: none"> o <i>Concept of Geoid, reference ellipsoids, Coordinate Reference Systems and Datums, ellipsoidal and orthometric heights, map projections, UTM coordinate system</i> o <i>SAR Forward and Inverse Geocoding, and applications</i> • <i>SAR-derived applications for environmental studies and information extraction</i> <ul style="list-style-type: none"> o <i>Sea Surface Wind field retrieval</i> o <i>Water bodies extraction</i> o <i>Shoreline Extraction</i>
Texts and readings	<ul style="list-style-type: none"> o <i>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.</i>

	<ul style="list-style-type: none"> o Links to "open access" remote sensing journals (e.g., http://www.mdpi.com/journal/remotesensing)
Notes, additional materials	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> ● Knowledge and understanding <ul style="list-style-type: none"> o Ascertaining the acquisition of notions concerning the topics covered during the course and of the correct scientific terminology ● Applying knowledge and understanding <ul style="list-style-type: none"> o Ascertaining the acquisition of skills to process the knowledge acquired for carrying out the research project ● Autonomy of judgment <ul style="list-style-type: none"> o Assessment of the capability to solve theoretical and implementation problems for the research project ● Communicating knowledge and understanding <ul style="list-style-type: none"> o Assessment of the capacity to effectively convey the results obtained during the implementation of the research project ● Communicating skills <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> o Assessment of the ability to access up-to-date bibliographic sources and online resources
Final exam and grading criteria	The final mark will be expressed in thirtieths
Further information	
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