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**Istituto Nazionale di  
Geofisica e Vulcanologia**

Catania, 12 luglio 2023

Al prof. Mattia Frasca  
Presidente del Corso di laurea magistrale in  
Automation Engineering and Control of Complex Systems  
Università di Catania

**Oggetto:** Proposta di corso di 3 CFU per l'a.a. 2023-2024 della laurea magistrale in Automation Engineering and Control of Complex Systems.

Caro prof. Mattia Frasca,

si propone un corso di circa trenta ore per usufruire di 3 crediti formativi per la laurea magistrale in Automation Engineering and Control of Complex Systems dell'Università di Catania per l'a.a. 2023-2024.

**Proposta in sintesi**

**Coordinatore:** dott. Ciro Del Negro, Istituto Nazionale di Geofisica e Vulcanologia (INGV)

**Durata:** circa 30 ore

**CFU** = 3 crediti formativi

**Title:** Technologies for Forecasting Volcanic Hazards

**Objectives:**

Volcanic activity provides an excellent demonstration of the dynamic nature of the Earth and is among the most popular Science topics. To capitalize on the high visibility of volcanic activity the Etna Volcano Observatory (EVO) of INGV launched the Forecasting Volcanic Hazards Course for the engineering students. The course is intended to help the students gain a better understanding and appreciation of volcanic hazards and perception of risk. Using Mt Etna as a case study will allow the students to apply this knowledge to people living near potentially dangerous volcanoes. It will also remind the students of the processes, eruptive style, and hazards associated with volcanoes, thus providing the background and motivation for taking the next step to understanding the importance and challenges of volcano monitoring.

The course involves an emerging strategy, based on the integration of traditional ground-based volcano monitoring systems with satellite remote sensing techniques and innovative physics-based models, for developing a better understanding of volcanic hazards. The collection of models and methods will include advanced satellite techniques for ash plumes and lava flows identification and characterization, coupled with geophysical flow models to forecast eruptive scenarios and assess

volcanic hazards. A systems engineering approach will be used for accurate, quantitative forecasting of volcanic hazards.

**Preliminary program:**

1. An introduction to volcanic hazard and risk
2. Volcanic eruptions and their products
3. Geochemical monitoring
4. Seismic monitoring
5. Continuous monitoring of volcanoes with borehole strainmeters
6. Global Navigation Satellite System (GNSS)-based technologies for volcano monitoring
7. Introduction to Unmanned Aerial Systems (UAS) as tools for volcano monitoring
8. Volcano hazard monitoring from space
9. Implementation of satellite detection algorithms for volcano thermal anomalies and ash plume;
10. Design and implementation of the pattern recognition algorithm for classifying eruptive products;
11. Development of physics-based models for ash fallout and lava flows;
12. Validation of physics-based models against analytical, semi-analytical and experimental data;
13. Integration of satellite techniques and mathematical models in a forward communication system from satellite data input to realistic scenarios;
14. Validation of the mutual feedback between satellite techniques and physics-based models to produce realistic eruptive scenarios.
15. Analysis of volcanological data using Artificial Intelligence and statistical methods
16. Machine Learning and deep learning for volcanic eruption forecasting
17. The operational room of the Etna Volcano Observatory
18. Integrating hazard, exposure, vulnerability and resilience for risk and emergency management in a volcanic context

Distinti saluti,



Ciro Del Negro  
Dirigente di Ricerca, INGV