



## SNOW AVALANCHES AND RELATED MOUNTAIN NATURAL HAZARDS

Enrollment year	2020/2021
Academic year	2021/2022
Regulations	DM270
Academic discipline	ICAR/02 (MARITIME HYDRAULIC CONSTRUCTION AND HYDROLOGY)
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	CIVIL ENGINEERING
Curriculum	Idraulico
Year of study	2°
Period	2nd semester (07/03/2022 - 17/06/2022)
ECTS	6
Lesson hours	45 lesson hours
Language	English
Activity type	WRITTEN TEST
Teacher	PASIAN MARCO (titolare) - 3 ECTS BARBOLINI MASSIMILIANO - 3 ECTS
Prerequisites	Basic knowledge of statistic, mathematics, and physics for engineers. Passion for mountain and related natural hazard
Learning outcomes	<p>Mountains occupy about 20% of the land, and approximately 10% of the Earth's population live in mountains. Great differences in altitude and significant energy potential due to gravity, along with the important role of water in both liquid and solid phases, means that natural hazards of gravitational type are common phenomena in mountains and significantly affect lives and good of people living there. The goal of the course is to introduce the student to the phenomenology and specific features of the considered processes (namely snow avalanches, rock fall and rock avalanches, debris avalanches) as well as to key concept of general validity related to hazard estimate and risk mitigation. At the end of the course the student should: (a) be able to classify the</p>

processes, either on the base of phenomenological features or size; (b) properly handle general concept of risk estimate and mitigation; (c) have basic insight on modelling of considered processes; (d) be able to perform a preliminary design of structural work to reduce hazard and vulnerability; (e) be able to properly and effectively apply a set of empirical relationship and expert criteria for engineering practice.

#### Course contents

##### 1. Snow cover formation and stability

Introduction and motivations; Snow cover formation; Metamorphisms; Snowpack stratigraphy; Snow cover stability; Release mechanisms; Snowpack profiling; Stability tests; Avalanche classification; Identification of avalanche paths;

##### 2. Snow Avalanches

Statistical avalanche modelling; Avalanche return period: definition and estimate based on historical data; Avalanche encounter probability; Avalanche dynamics models: definition of the design event; Estimate of avalanche velocity and run-out distance using centre of mass models; Estimate of avalanche forces against obstacles; Example of avalanche calculation based on real world cases; Outline of risk mitigation strategies; Outline of structural avalanche defence works; Design criteria for active avalanche defence structures; Design criteria for passive avalanche defence structures; Example of design of avalanche active/passive protective works based on real world cases

##### 3. Rockfall and Rock avalanches

Rock avalanche and rock falls: definitions; UNI 11211 Italian design code for rock fall protective measures; Design criteria for rock fall barrier and anchoring systems; Design criteria for rock fall embankments; Active vs passive rock fall defence works: real world examples

##### 4. Debris flow and debris avalanches

Susceptibility of a mountain basin to debris flow formation; Empirical relationship for debris flow: calculation of magnitude, peak flow rate, velocity, run-out distance; Design criteria for passive structure against debris flow: flexible vs rigid barrier; Passive debris flow defence works: real world examples.

#### Teaching methods

Lectures (hours/year in lecture theatre): 36  
Practical class (hours/year in lecture theatre): 15  
Practicals / Workshops (hours/year in lecture theatre): 0

#### Reccomended or required readings

The avalanche Handbook, D. McClung & P. Schaerer, Ed. The Mountaineers  
The Technical Avalanche Protection Handbook, Wiley Eds (Ernst & Sohn)  
UNI 11211-4 – Rockfall protective measures, Part 4 – Definitive and executive design  
Dieter Rickenmann, Empirical Relationships for Debris Flows, Natural

	Hazards 19: 47–77, 1999
Assessment methods	Written exam
Further information	
Sustainable development goals - Agenda 2030	Goal 13: Take urgent action to combat climate change and its impacts <a href="#">\$lbl legenda sviluppo sostenibile</a>