Laurea Magistrale
Atmospheric Science and Technology (LMAST)

SUBJECT TITLE	**Physical Oceanography**
TEACHER NAME(S)	Antonio Ricchi
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Teacher meeting	Wednesday, h. 15-16
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DISCIPLINE (SSD)	GEO-12 – Oceanography and Atmospheric Physics
Semester (1-4)	4
Credits (CFU/ECTS)	6
Lecture hours (h)	60 (40 lectures + 20 exercise/laboratory)
Prerequisite and learning activity	Background in physics and mathematics
Teaching language and method	English & Lectures, exercises and homeworks
Assessment method	Oral examination, assignment, report

OBJECTIVES

Main goals are:
- to describe the physical and chemical properties, sea water and processes that occur in the ocean
- to derive the primitive equations that describe the geophysical fluid dynamics;
- to provide the basics of waves theory and description;
- to describe how the oceanographic instrument works;
- to illustrate the main applications of numerical models and data processing.

OUTCOMES (Dublin descriptors: knowledge, understanding, explain, skill, ability)

After the successful completion of this module, the student should be able to:
- Know the principles of oceanographic processes and characteristics.
- Know the equations of fluid motion for a rotating fluid and waves
- Define the most important space and time scales for the different types of flow and type of waves.
- Describe the driving and controlling mechanisms of the local and large-scale circulation in the ocean
- Describe the feedback between ocean and atmosphere and effect in meteorological and climatic system.
- Know how the oceanographic instruments and ocean numerical model works.

PROGRAM CONTENT

Introduction to physical oceanography. Physical and Chemical properties of seawater and typical distributions of water properties. External and internal factors that drive physical processes in the ocean.
Geophysical fluid dynamics. Ocean general circulation. Equations of motion. Equation of motion with viscosity. Parameterizations of turbulence in the ocean. Advection, diffusion and mixing in ocean. Shallow water equations. Response of ocean to wind forcing. Geostrophic current. Wind driven circulation. Upwelling and downwelling processes. Deep and intermediate water convection.
General Circulation. Large Scale ocean circulations. Thermohaline circulation. Overturning circulation. Equatorial circulation and ENSO. Atlantic Ocean deep circulation. Southern Ocean circulation. Ocean-Atmosphere interaction in meteorological and climatological events.
Waves in ocean. Linear and non-linear theory of surface waves. Waves offshore. Waves nearshore and interaction with the bottom. Tides and tidal currents. Tsunamis. Rogue/Freak waves.
Coastal dynamics. Wave in shallow waters, coastal and bottom effect and waves transformations. Storm surge and its component. Littoral currents and coastal fronts.
Oceanographic measurements. Measuring and monitoring the ocean environmental and data analysis.
Laboratory. Circulation and waves numerical model. Exercises to simulate upwelling events with ocean model. Analysis of model results using MATLAB (and/or Python) code.

REFERENCES AND MATERIAL

- Texts and slides provided by the teachers and available on the course web site.
- J. Pedlosky. Geophysical Fluid Dynamics, 2nd Edition, Springer, 1992.
- Batchelor, G. K. : "An Introduction to Fluid Dynamics". Cambridge University Press, 1967.
- Cushman-Roisin, B., Introduction to Geophysical Fluid Dynamics, Academic Press
- Steward, R. H. : "Introduction to Physical Oceanography". Text available online, 2005.
- GL Pickard e WJ Emery "Descriptive Physical oceanography: an introduction".