Modeling and Computation of Electric and Magnetic Fields

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Who am I: Arturo Popoli (University of Bologna)

- UniBo web page link
- Virtuale page link

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- **NOT** via MS Teams

Research interest:
- Modeling of Plasma Thrusters for Space Propulsion (w/ University of Toulouse)
- Electrical arc models in complex environments for ITER project
- Plasma-kinetic models for hydrogen production via electric discharges (non-thermal plasmas)

Course program - Part I: electromagnetics

PART I: electromagnetics

- Recap: topology and vector analysis
- Recap: electromagnetics
- Green's identities (I and II)
- Harmonic functions
- Uniqueness theorems for Poisson's equation
- Electromagnetic formulations
    - Electrostatics
    - Magnetostatics
    - Steady-state electrodynamics

...bonus material:

- Green's identity (III)
- Green's functions

Course program - Part II: numerical analysis

PART II: numerical analysis

- Floating point representation
- Numerical derivatives
- Numerical integration
- Numerical interpolation
- Numerical solution of ordinary differential equations
- Finite differences method
- Finite element method

...bonus material:

- Nonlinear problems
- Multiphysics problems

...each PART II topic will involve **lab classes** (MATLAB)

The final test

- **Questions**: two/three open questions on the topics covered during classes
- **Answers:** the student must **write** the answer to the questions, to be subsequently discussed with the instructor
- **Lab reports**
  - The student must submit a **written report** discussing the lab classes/exercises, describing the implementation of the codes and the obtained results
  - Students have to **collaborate** in groups of up to three people to write the report
  - It is not required for all members of a group to attend the same exam session. However, once the first student attends the exam, the report and group composition **can no longer be modified**

Final test dates

- 3 dates for the winter session
- 3 dates for the summer session (including September)
- ...unofficial dates

Course material

- Course material on Virtuale
- PDFs of the lessons uploaded weekly
- Books...
  - S.C. Chapra, R.P. Canale, *Numerical Methods for Engineers*, 8th Edition, McGraw-Hill
  - S.D. Conte, C. De Boor, *Elementary numerical analisys*, McGraw-Hill
  - K. J. Binns, P. J. Lawrenson, C. W. Trowbridge: *The Analytical and Numerical Solution of Electric and Magnetic Fields*. J. Wiley and Sons.

On the lab reports...

- You are encouraged to write the reports in LaTeX
  - Overleaf
  - Local LaTeXdistribution (see Virtuale page)
- ...and use Git/GitHub for you code development!
  - Suggestion: install and use GitHub Desktop