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Universidad del País Vasco
Euskal Herriko Unibertsitatea

BILBOKO
INGENIARITZA ESKOLA

ESCUELA
DE INGENIERÍA DE BILBAO

SUBJECT ACTIVITY PLAN

Theoretical and numerical aspects in fluid dynamics and turbulent flow.
2020/21 school year.

Erasmus Mundus Joint Master Degree REM

Coordinator of the subject

2021/01/19

Carlos Gorria

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1. TEACHING ACTIVITIES OF THE SUBJECT

Link for online classes: https://egela.ehu.eus/mod/collaborate/view.php?id=3845048

Link for online classes: https://egela.ehu.eus/mod/collaborate/view.php?id=3845051

1.1 MASTER CLASSES AND CLASSROOM PRACTICES

2021/02/15, Monday, 9:30-12:00 (2.5 hours). Teacher: Carlos Gorria.

- Reading pages 1-14 of the notes “Fluid Equations under stochastic forces”, without taking care of the mathematical proofs rigorously.
- Became aware of the breath of the central limit theorem and the random walk in the calculus of probabilities. The reading of the notes could be complemented with other resources:

  https://en.wikipedia.org/wiki/Central_limit_theorem

2021/02/17, Wednesday, 12:30-14:00 (1.5 hours). Teacher: Francisco De La Hoz.

- Introduction to programming with Matlab/Octave. We will teach online by means of eGela. Therefore, the students are requested to connect to eGela with their own laptops at the time of the course, i.e., at 12:30 a.m. At least a working version of Octave is compulsory, but a working version of Matlab is strongly advised. In the unlike event of technical problems, the students will be given an introductory assignment to do by themselves.

2021/02/24, Wednesday, 12:30-14:00 (1.5 hours). Teacher: Francisco De La Hoz.

- Introduction to programming with Matlab/Octave. We will teach online by means of eGela. Therefore, the students are requested to connect to eGela with their own laptops at the time of the course, i.e., at 12:30 a.m. At least a working version of Octave is compulsory, but a working version of Matlab is strongly advised. In the unlike event of technical problems, the students will be given an introductory assignment to do by themselves.

2021/03/03, Wednesday, 12:30-14:00 (1.5 hours). Teacher: Carlos Gorria.

- Overview of some computer practices about some experiments of random walk.

2021/03/08, Monday, 9:30-12:00 (2 hours). Teacher: Carlos Gorria.

- Reading pages 15-44 of the notes “Fluid Equations under stochastic forces”, without taking care of the mathematical proofs rigorously.

- Became aware of the applications of the stochastic phenomena and the tools for calculating the forecast of some stochastic processes. The reading of the notes could be complemented with other resources:

  https://en.wikipedia.org/wiki/Stochastic_process

  https://en.wikipedia.org/wiki/It%C3%B4_calculus

- Became aware of some examples of systems of differential equations in real life as Lotka-Volterra equations. The reading of the notes could be complemented with other resources:

  https://en.wikipedia.org/wiki/Lotka%E2%80%93Volterra_equations

- Became aware of some examples of stochastic differential equations and the numerical methods for solving these problems. The reading of the notes could be complemented with other resources:

  https://en.wikipedia.org/wiki/Stochastic_differential_equation

2021/03/22, Monday, 8:30-11:30 (3 hours). Teacher: Carlos Gorria.

- Reading pages 45-52 of the notes “Fluid Equations under stochastic forces”, without taking care of the mathematical proofs rigorously.

- Became aware of the numerical schemes for solving partial differential equations and explore some examples as the well-known Burger’s equation as an example of wave propagation in fluid dynamics. The reading of the notes could be complemented with other resources:

  https://en.wikipedia.org/wiki/Burgers%27_equation

  https://en.wikipedia.org/wiki/Finite_difference_method

2021/04/16, Friday, 10:30-13:30 (3 hours). Teacher: Luis Vega.

- Expository lecture showing different examples where turbulence is present. Special emphasis will be made on those related to vortex filaments, like smoke rings, tornados and the reconnection process due to the interaction of two antiparallel filaments. Also we will devote some attention to the turbulence created by non-circular jets.

2021/04/21, Wednesday, 8:00-11:00 (3 hours). Teacher: Luis Vega.

- Introduction of the elemental mathematical objects to describe vortex filaments: Velocity Field, Particle trajectories, Vorticity field: the Biot-Savart Law. Description of the ideal objects: circular smoke rings and straight line bath tube vortices.

2021/04/23, Friday, 8:00-11:00 (3 hours). Teacher: Francisco De La Hoz.

- Introduction to the vortex filament equation and its numerical simulation with Matlab/Octave. We will teach online by means of eGela. Therefore, the students are

requested to connect to eGela with their own laptops at the time of the course, i.e., at 8:30 a.m. At least a working version of Octave is compulsory, but a working version of Matlab is strongly advised. In the unlike event of technical problems, the students will be given notes on the topic, and an assignment to do by themselves.

2021/04/26, Monday, 11:00-14:00 (3 hours). Teacher: Luis Vega.

- Stokes theorem and Helmholtz laws.
- The role of viscosity: from ideal vortex filaments to real vortex tubes. Selfstreching of vortex tubes and reconnection.

2021/04/30, Friday, 8:30-11:30 (3 hours). Teacher: Francisco De La Hoz.

- Introduction to vortex patches and its numerical simulation with Matlab/Octave. We will teach online by means of eGela. Therefore, the students are requested to connect to eGela with their own laptops at the time of the course, i.e., at 11:00 a.m. At least a working version of Octave is compulsory, but a working version of Matlab is strongly advised. In the unlike event of technical problems, the students will be given notes on the topic, and an assignment to do by themselves.

2021/05/03, Monday, 8:30-11:30 (3 hours). Teacher: Francisco De La Hoz.

- Depending on the evolution of the course, we will continue working on the vortex filament equation and vortex patches, or we will introduce vortex sheets. We will teach online by means of eGela. Therefore, the students are requested to connect to eGela with their own laptops at the time of the course, i.e., at 8:30 a.m. At least a working version of Octave is compulsory, but a working version of Matlab is strongly advised. In the unlike event of technical problems, the students will be given notes on the topic, and an assignment to do by themselves.

1.2 SEMINARS

1.3 LABORATORY PRACTICES AND COMPUTER PRACTICE

2021/03/03, 12:30-14:00. Teacher: Carlos Gorria

- Run the following codes under matlab or octave software: centrallimittheorem.m, centrallimittheorem1.m. There are under the folder “Practices - Computer programs” => “Practices 1.”

2021/02/17 and 2021/02/17, 12:30-14:00. Teacher: Francisco De La Hoz.

- The online eGela session will combine theory and computer practice. The students will be requested to program short pieces of code.

2021/03/08, 9:30-12:00. Teacher: Carlos Gorria.

- Run the following codes under matlab or octave software: fixpointG.m, fpgeombrow.m, geometricbrownian.m, lotka.m, maineuler.m, solgeombrow.m. There are under the folder “Practices - Computer programs” => “Practices 2.”

2021/03/22, 8:30-11:30. Teacher: Carlos Gorria.

- Run the following codes under matlab or octave software: burgerscharacteristics.m, burgerscharacteristics_school.m. There are under the folder “Practices - Computer programs” => “Practices 3.”

2021/04/23, 8:00-11:00. Teacher: Francisco De La Hoz.

- The online eGela session will combine theory and computer practice. The students will be requested to program short pieces of code.

2021/04/30, 8:30-11:30. Teacher: Francisco De La Hoz.

- The online eGela session will combine theory and computer practice. The students will be requested to program short pieces of code.

2021/05/03, 8:30-11:30. Teacher: Francisco De La Hoz.

- The online eGela session will combine theory and computer practice. The students will be requested to program short pieces of code.

2. CONTINUOUS ASSESSMENT

- Complete all the task done during the online eGela sessions concerning the vortex filament equation, vortex patches (and possibly vortex sheets) and solve a report explaining the theoretical and numerical aspects involved.

- Answer the 8 exercises proposed under the link “Assignment: stochastic forces”. Those exercises consist in some modifications over the codes shown in the folder “Practices - Computer programs”. The objective is to analyze the success of the formulation and possible applications. Write a dossier explaining the results obtained.

3. TUTORSHIPS

By email or skype in a date previously agreed:

FRANCISCO DE LA HOZ francisco.delahoz@ehu.eus (Numerics on vortex dynamics)

CARLOS GORRIA carlos.gorria@ehu.eus (Fluid equations under stochastic forces)

LUIS VEGA luis.vega@ehu.eus (Theoretical frame)

4. ACTIVITY PLANNING

The activity planning is explained together with the distribution of the sessions along the calendar in section 1.

5. ASSESSMEN

The deadline for the submission of assignments for assessment will be 15th of June 2021.