UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

| September 27-december 23General information | | |
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| Academic subject | Elements of Advanced Mathematical Physics | |
| Degree course | *LM 40 - Mathematics* | |
| Academic Year | *2021-2022* | |
| European Credit Transfer and Accumulation System (ECTS) | | 7 |
| Language | *Italian* | |
| Academic calendar (starting and ending date) | *September 27- December 23* | |
| Attendance | *Not compulsory attendance* | |

| Professor/ Lecturer | |
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| Name and Surname | Lidia Rosaria Rita Palese |
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| Telephone | +39 0805442675 |
| Department and address | Department of Mathematics<br>*Via E. Orabona 4, 70125 Bari* |
| Virtual headquarters | *Microsoft team:* **wddtavc** |
| Tutoring (time and day) | In department (by e-mail appointment): Monday, Wednesday, and Friday from 10 to 12.<br>On line with Microsoft Teams, code: awa1at0 |

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| ***Syllabus*** | |
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| **Learning Objectives** | Acquiring language and techniques of mathematical physics, especially of theory of mathematical modeling, hydrodynamic stability theory, existence of linearization principles. |
| **Course prerequisites** | Mathematical knowledge which usually is acquired during the three years of a degree of L–35 class. |
| **Contents** | Elements of spectral theory of linear operators in normed spaces: resolvent and spectrum. Multiplicity and rank. Spectral properties of some classes of linear operators in Hilbert spaces. (0.25 ECTS)<br>Elements of variational calculus: linear and continuous functionals. Maximum and minimum value of a functional. Variation of a functional. Euler equations. Isoperimetric problems. (0.25 ECTS)<br>Setting of the problem of the motion for a continuous system: the constitutive equations. The Cauchy-Poisson constitutive equation.(1 ECTS)<br>Setting of the problem of classical hydrodinamic stability. Classical solutions of the Navier Stokes equations. Stability in the small. Stability in the mean. Eigenvalue problems of linear stability. Classical solutions of the Navier-Stokes equations: Couette, Poiseuille and Couette-Poiseuille motions. The di Orr-Sommerfeld equation. Rayleigh e di Squire theorems. Global and conditional stability. Actractivity. Serrin criteria of hydrodynamic stability. (2 ECTS) |

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| | Generalized solutions in hydrodynamic stability: generalized solutions of linear and nonlinear problems. Motions in bounded domains. Turbulent solutions and strong solutions of the nonlinear problem. The linear problem. Completeness of normal modes perturbations. The linearization principle in hydrodynamic stability. The stability of the Couette plane motion. The principle of exchange of stabilities. (1.50ECTS)<br>The Bénard problem: setting of the problem. Linearized Bénard problem near the thermodiffusive equilibrium. Proof of the principle of exchange of stabilities for the Bénard problem with the definite integrals method. Exact solutions of the eigenvalue problem governing linear stability for particular boundary conditions. Linear stability and detection of the Rayleigh function. Critical Rayleigh number of the linear stability. Solution of the linear stability problem with the direct Chandrasekhar Galerkin method. (2 ECTS) |
| **Books and bibliography** | A. Georgescu: Hydrodynamic Stability theory, Kluwer, 1985.<br>S. Chandrasekhar: Hydrodynamic and Hydromagnetic Stability, Clarendon Press, Oxford, 1968.<br>S. G. Mikhlin: Mathematical Physics, an advanced course,<br><br>North Holland, 1970. |
| **Additional materials** | Didactic material provided by the teacher. |

| **Work schedule** | | | |
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| Total<br>150 | Lectures<br>52 | Hands on (Laboratory, working groups, seminars, field trips)<br>8 | Out-of-class study hours/ Self-study hours<br>90 |
| **Hours** | | | |
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| **ECTS** | | | |
| *7* | *6.5* | *0.5* | |
| **Teaching strategy** | | | |
| | *Lectures and supplementary distance learning* | | |
| **Expected learning outcomes** | | | |
| **Knowledge and understanding on:** | Acquiring fundamental concepts in mathematical physics and of mathematical modeling. Acquiring mathematical proof techniques. | | |
| **Applying knowledge and understanding on:** | Ability to use theoretical knowledge in various mathematical physics problems. | | |

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| **Soft skills** | • *Making informed judgments and choices*<br>Ability to identify mathematical tools and techniques to study physical problems written as mathematical models.<br><br>• *Communicating knowledge and understanding*<br>Students should acquire the mathematical language and formalism necessary to read and comprehend mathematical models, to explain the acquired knowledge.<br><br>• *Capacities to continue learning*<br>Acquiring suitable learning methods, supported by the ability to understand and solve particular problems. |

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| **Assessment and feedback** | |
| Methods of assessment | |
| Evaluation criteria | • *Knowledge and understanding*<br>Oral exam including an application exercise<br><br>• *Applying knowledge and understanding*<br>Oral exam including an application exercise<br><br>• *Autonomy of judgment*<br>Oral exam including an application exercise<br><br>• *Communicating knowledge and understanding*<br>Oral exam including an application exercise<br><br>• *Communication skills*<br>Oral exam including an application exercise<br><br>• *Capacities to continue learning*<br>Oral exam including an application exercise |
| Criteria for assessment and attribution of the final mark | *The final grade is awarded out of thirty, the exam is passed when the grade is greater than or equal to 18.*<br>*The final evaluation is formulated considering the knowledge acquired by the student, the ability to understand and use it for the purpose of formulating and solving a physical problem.* |
| **Additional information** | |
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