Blended Intensive Program - Template

Important note:

Students interested in this program have to apply to their home university according to the internal procedure.

Student applications made directly to the hosting institution will not be considered.

General information

Course Title	**SEA-EU School on Computational Mathematics**
Coordinating institution	University of Split
Partner institutions	University of Cadiz, University of Kiel, University of Algarve and University of Gdansk
BIP Code	2023-1-HR01-KA131-HED-000122123-1
Abstract: (a few lines describing the course that SEA-EU partners can use for dissemination)	The school is designed for young students up to master's and doctorate level seeking to acquire skills in the latest trends in mathematical and computational modeling. We place strong emphasis on practical applications in science and engineering, with a focus on modeling spatiotemporal variations of physical quantities using partial differential equations (PDEs), and related topics topics such as the finite element methods, neural networks and numerical optimization.
Calendar	• Application deadline: 10.06.2024. • Confirmation of acceptance by: 11.06.2024. • Virtual component dates: 2 Sept – 6 Sept 2024 • Physical component dates: 9 Sept – 13 Sept 2024 • Submission of final project (required for ECTS credits): 20 Sept 2024
Total number of hours:	40 hours (13 virtual and 27 on-site)
Teacher(s) in charge	• Francisco Ortegon Gallego, J. Rafael Rodriguez Galvan, M. Victoria Redondo Neble, M. Concepction Muriel Patino (University of Cadiz) • Malte Braak (University of Kiel) • Hermenegildo Borges de Oliveira (University of Algarve) • Karolina Kropielnicka (Polish Academy of Sciences)

	• Andrijana Curkovic, Sasa Kresic-Juric (University of Split)
Number of participants	The máximum number of participants is 20. Each SEA-EU university can propose up to four participants.
Mobility costs	This mobility is eligible for Erasmus+ funding. Please contact your university for more information.
Contact	Organisational aspects: Sasa Kresic-Juric Email: sea-eu.comp.math@pmfst.hr Pedagogical aspects: Sasa Kresic-Juric Email: sea-eu.comp.math@pmfst.hr

Pedagogical content

Target group / Expected student profile	Master's and beginnig doctorate students.
Requirements Academic background	Strong background in mathematics and computer science.
Selection of participants	Students will be selected by the organizing committee of the school attending to the selection criteria below. In all cases, students from SEA-EU Universities, followed by students of other Erasmus+ Universities, will have preference.
Selection criteria	Students will be selected based on the following criteria listed in order of appearance: 1. Doctorate or master's students collaborating with the organizing committee of the school. 2. Doctorate students conducing research in areas related to the topics of the school. 3. Students in master's program related to the topics of the school. 4. Students with strong background in computational mathematics and computer science.
Description pf the physical component (please include any relevant information for the applicants)	The physical component consists of three courses: 1. Introduction to partial differential equations: examples and resolution by the finite element method (12 hours) 2. Physics informed neural networks: introduction and case study on fluid dynamics (12 hours)

	3. Numerical optimization (11 hours) Each course is supplemented by one-hour lectures on selected topics.
Description of the virtual component (please include any relevant inforamtion for the applicants)	The virtual part consists of introductory lectures designed to prepare the students for the courses offered in the physical component of the school. The virtual component includes individual study and work in groups.
Learning objectives/outcomes:	Upon completion of the program, the student is expected to: • describe relevant PDEs arising in physics and engineering: heat equation, wave equation, Stokes system, linear elasticity, • acquire basic skills in using the software package Freefem++ for meshing 2D and 3D domains, • solve numerically variational formulations of elliptic equations and plot their solutions, • apply relevant numerical methods for the time semidiscretization of an evolution problem and to compute the approximate solution of the wave equation, • apply classical methods for unrestricted optimization, • improve understanding of classical methods for restricted optimization, • understand the mathematical theory of convex optimization, • develop and test computer programs for solving restricted optimization problems, • become familiar with the concept of neural networks (NN) as mathematical and computational objects minimizing a deep cost functional, • understand the basics of physics informed neural network (PINN) for solving PDE models, • program computer scripts for basic NN and apply PINN to solve convection, diffusion, and fluid dynamics models.
Any required material/software to take part to the course:	Open-source software will be utilized throughout the courses, specifically: FreeFem++, Python, and numerical libraries such as NumPy, Matplotlib and Tensorflow. During the preliminary virtual sessions, students will receive comprehensive instructions on the installation process, enabling them to set up the software on their personal computers or laptops. Additionally, all necessary software will be installed in the computer lab for the face-to-face sessions, ensuring that every student has access to the required tools.

ECTS:	3 ECTS credits
Evaluation:	Students interested in credit recognition will be evaluated by classroom exercises and by a final group project which will be submitted by Friday, September 20, 2024.
Transcript of records will be issued …	University of Split
Language of the course	English language

Structure of the course

	Dates	**Program**
Virtual part	2 Sept 2024	9:00 – 10:00 Opening 10:00 – 12:00 Presentation of Course 1 **Introduction to partial differential equations: examples and numérical resolution by the finite element method**, Francisco Ortegon Gallego (University of Cadiz)
	3 Sept 2024	9:00 – 11:00 Presentation of Course 2 **Physics-informed neural networks: introduction and case study on fluid dynamics**, J. Rafael Rodriguez Galvan and Victoria Redondo Neble (University of Cadiz)
	4 Sept 2024	9:00 – 11:00 Presentation of Course 3 **Numerical optimization**, Malte Braak (University of Kiel)

	5 Sept 2024	9:00 – 11:00 Individual/group work and tutorial sessions
	6 Sept 2024	9:00 – 11:00 Individual/group work and tutorial sessions
	20 Sept 2024	Students interested in receiving 3 ECTS credits must submit a final project. The projects may be done individually or in small groups.
Physical part (On-site in Split):	9 Sept 2024	*9:00-10:30*. Course 1 **Introduction to partial differential equations: examples and numérical resolution by the finite element method** *11:00-12:30.* Course 2 **Physics-informed neural networks: introduction and case study on fluid dynamics** *14:00-15:00.* Lecture 1 **Theoretical and numerical analysis of Navier-Stokes equations arising in fluid confinement** 15:30-16:30. Lecture 2 **Split in Split** *16:30-18:30*. **Exercises I**
	10 Sept 2024	*9:00-10:30.* Course 1 **Introduction to partial differential equations: examples and numérical resolution by the finite element method** *11:00-12:30.* Course 2 **Physics-informed neural networks: introduction and case study on fluid dynamics** *14:00-15:00.* Lecture 3 **Solvable Structures and C-infinity Structures for Differential Equations** *15:30-16:30.* Lecture 4 **Introduction to Asymptotic Methods in Fluid Mechanics** *16:30-18:30.* **Exercises II**

	11 Sept 2024	*9:00-10:30.* Course 1 **Introduction to partial differential equations: examples and numérical resolution by the finite element method** *11:00-12:30.* Course 3 **Numerical optimization**
	12 Sept 2024	*9:00-9:45.* Course 1 **Introduction to partial differential equations: examples and numérical resolution by the finite element method** *9:45-10:30.* Course 2 **Physics-informed neural networks: introduction and case study on fluid dynamics** *11:00-12:30.* Course 3 **Numerical optimization** 12:30-14:00. Lunch 14:00-15:00. Lecture 5 **Introduction to Symplectic Methods for Hamiltonian Systems** 15:30-18:30. **Exercises III**
	13 Sept 2024	*9:00-10:30.* Course 2 **Physics-informed neural networks: introduction and case study on fluid dynamics** *11:00-12:30.* Course 3 **Numerical optimization**

Practical information

Accommodation recommendations	A limited number of rooms for participants is reserved in the student dormitory on the campus of the University of Split. Please contact rezervacija.smjestaja@scst.hr with reference to SEA-EU School on Computational Mathematics. Payment is at the front desk by cash or credit card.
The physical mobility will take place at… (address of the course)	Faculty of Science Department of Mathematics Rudjera Boskovica 33 21000 Split

	Croatia
Any tips?	Detailed information about the school and application form can be found on the web page https://sea-eu-school.github.io/ For more information about Split visit: visitsplit.com
Contact of the person in charge of signing the OLA	Prof. Gordan Radobolja, PhD Vice-dean for Academic Affairs, Erasmus coordinator