

Three Days Workshop on: FINITE VOLUME SCHEMES FOR DIFFUSION- CONVECTION EQUATIONS IN POROUS MEDIA

Instructor: Prof. Mazen Saad, École Centrale de Nantes, France

Hosted by: Department of Mathematics, KFUPM

Organizer: Dr. Manal Alotaibi

Instructor Biography

Prof. Mazen Saad is a Full Professor of Applied Mathematics at École Centrale de Nantes, France, where he has been a faculty member since 2006. He currently serves as Director of the Department of Mathematics, Computer Science, and Biology, and has been President of the Scientific Council of Centrale Nantes since 2017.

He received his Ph.D. in Applied Mathematics from the University of Bordeaux I in collaboration with the French Petroleum Institute (IFP). His research focuses on multiphase flow in porous media, including modeling and simulation of water-gas flow, radionuclide transport, hydrogen storage, and the development of numerical methods for nonlinear PDEs. He also works on modeling in biomathematics.

Prof. Saad has authored more than 90 publications, supervised over 20 Ph.D. theses, and led numerous national and international research projects.

Workshop Overview

This short course introduces finite volume methods for the approximation of diffusion-convection equations, with a focus on their application to porous media flow. Emphasis is placed on the Two-Point Flux Approximation (TPFA) scheme on triangular and orthogonal meshes. The course highlights theoretical foundations, stability and convergence properties, and practical implementation through MATLAB-based sessions.

The finite volume method ensures local conservation of mass, momentum, and energy, guarantees continuity of fluxes across control volume interfaces, and is applicable to polyhedral and unstructured meshes. It is particularly well-suited for nonlinear PDEs and strongly transport-dominated problems.



22, 24 & 29 September 2025 8:30-10:30AM (Lecture Session)
4:00-6:00PM (Lab Session)



5-103 (Lecture)
5-202 (Lab)



SCAN FOR REGISTRATION



Workshop on:

FINITE VOLUME SCHEMES FOR DIFFUSION–CONVECTION EQUATIONS IN POROUS MEDIA

Workshop Plan

Day 1

Monday, September 22, 2025

8:30 AM-10:30 AM

Finite Volume Schemes for Diffusion Equations, Part I,

- General meshing
- Two-Point Flux Approximation (TPFA) scheme for diffusion equations
- Associated linear system

4:00 PM-6:00 PM

Lab Session I (MATLAB)

- Using Triangle software to generate meshes
- Mesh connectivity (neighborhood, edges, etc.)
- Application: computing double integrals and verifying order of convergence

Day 2

Wednesday, September 24, 2025

8:30 AM-10:30 AM

Finite Volume Schemes for Diffusion Equations, Part II

- Energy estimates
- Weak convergence of the TPFA scheme

4:00 PM-6:00 PM

Lab Session II (MATLAB)

- Assembly of the linear system on general triangular meshes
- Solving the Laplacian equation and comparing results

Day 3

Monday, September 29, 2025

8:30 AM-10:30 AM

Finite Volume Schemes for Transport Equations

- Approximation of the transport equation in 1D: schemes and stability
- Finite volume methods on triangular meshes for nonlinear hyperbolic equations
- Positive finite volume schemes for diffusion–convection equations

4:00 PM-6:00 PM

Lab Session III (MATLAB)

- Implementation of the diffusion–convection scheme on general meshes