TIME TABLE FOR CIMPA PRE-SCHOOL
VENUE: LCH 302

WEEK 1: 24 JUNE - 27 JUNE, 2015

Time	9-10.30	10.30-11	11-12.30	12.30-14	14-15.30	15.30-16	16 -17.30
Wed	SK	B	Lab	B	SK	B	AKP
Thu	SK	B	Lab	B	SK	B	AKP
Fri	SK	B	TG	B	SK	B	TG
Sat	AKP	B	TG	B	Lab	B	TG

- SK - S. Kesavan (6)
- AKP- Amiya K. Pani (3)
- TG- Thirupathi Gudi (4)
- Lab- Lab Sessions (3)
- B-Break

WEEK 2: 29 JUNE - 4 JULY, 2015

Time	9-10.30	10.30-11	11-12.30	12.30-14	14-15.30	15.30-16	16 -17.30
Mon	AV	B	RKG	B	Lab	B	AV
Tue	AV	B	RS	B	Lab	B	RKG
Wed	RS	B	RKG	B	RS	B	AKP
Thu	AKP	B	MV	B	MR	B	MV
Fri	MV	B	AKP	B	MV	B	MR
Sat	MV	B	MR	B	Lab	B	AKP

- AV- A. VasudevaMurthy (3)
- RKG- Raju K. George (3)
- RS- Rajen Sinha (3)
- AKP- Amiya K. Pani (4)
- MV- M. Vanninathan (5)
- MR-M. Ramaswamy (3)
- Lab- Lab Sessions (3)
- B-Break

PRE-SCHOOL COURSES

- A quick introduction to Sobolev spaces; Lax-Milgram Lemma; Review of Elliptic PDE: existence of unique weak solution, Babuska Brezzi theorem, regularity results.

  Prof. S. Kesavan (The Institute of Mathematical Sciences, Chennai)

- Quick review of FEM for elliptic PDE, Approximation properties, Error estimates, Adaptive FEM for elliptic PDEs: A posteriori error analysis, reliability, efficiency.

  Prof. Amiya K. Pani (IIT Bombay), Dr. Thirupathi Gudi (IISc Bangalore)

- Heat equation & FEM for Heat equation

  Prof. A. S. Vasudeva Murthy (TIFR CAM, Bangalore), Prof. Rajen Sinha (IIT Guwahati)

- Stokes Equation, Navier Stokes Equations & FEM for Navier Stokes Equations

  Prof. M. Vanninathan (TIFR CAM, Bangalore), Prof. Amiya K. Pani (IIT Bombay)

- Controllability, Stabilizability & Observability; Introduction to Optimal Control Problems governed by PDE, feedback stabilisation method for heat equation.

  Prof. Raju K. George (IIST Thiruvannanthapuram), Prof. Mythily Ramaswamy (TIFR CAM, Bangalore)

Lab sessions in Freefem++

FEM for elliptic boundary value problems, heat equation, Stokes equation, Navier Stokes equation, Adaptive FEM

Resource person: Dr. Sai Jagan Mohan (BITS Pilani)

TIME TABLE FOR CIMPA MAIN SCHOOL
VENUE: LCH 302

WEEK 1: JULY 6-12, 2015

Time	9-10	10-11	11-11.30	11.30-12.30	12.30-13.30	13.30-15	15-15.30	15.30-16.30	16.30-17.30
Mon	SB	LY	B	FH	B	Lab	B	BM	JPR
Tue	SB	LY	B	FH	B	Lab	B	BM	JPR
Wed	AL	JPR	B	GA	B	B	B	B	B
Thu	FH	JPR	B	AV	B	Lab	B	AL	GA
Fri	FH	JPR	B	BM	B	Lab	B	AL	GA
Sat	FH	AV	B	BM	B	Lab	B	AL	GA

- SB - Sussanne Brenner (2)
- LY- Li Yeng Sung (2)
- JPR- J. P. Raymond (5)
- FH- F. Hecht (5)
- AL- A. Lozinski (4)
- GA- G. Allaire (4)
- BM- B. Maury (4)
- AV-A. Veeser (2)
- B-Break

WEEK 2: JULY 13-17, 2015

Time	9-10	10-11	11-11.30	11.30-12.30	12.30-13.30	13.30-15	15-15.30	15.30-16.30	16.30-17.30
Mon	MV	RB	B	AV	B	Lab	B	CC	AV
Tue	MV	RB	B	AV	B	Lab	B	CC	OP
Wed	SB	LY	B	OP	B	B	B	B	B
Thu	MV	RB	B	CC	B (12.30- 2PM)	CC (2-3)	B	HS	OP
Fri	MV	RB	B	CC	B	Lab	B	HS	OP

- SB - Sussanne Brenner (1)
- LY- Li Yeng Sung (1)
- AV-A. Veeser (3)
- CC-C. Carstensen (5)
- OP- O. Pironneau (4)
- MV-M. Vohralik (4)
- RB-R. Becker(4)
- HS-H. Suito (2)
- B-Break

COURSES

COURSE 1 : FEM : conforming and non standard including non-conforming, mixed, DG, etc with applications

Susanne Brenner & Li-Yeng Sung (Louisiana University)
Finite element methods for higher order elliptic problems will be presented, with applications to solid mechanics and optimal control problems. Fast solution techniques for the discrete problems will also be discussed.

COURSE 2 : Adaptive FEM, Problem reductions with FEM, Multi scale FEM

1. Cartsen Carstensen (Humboldt University - Berlin)
A posteriori error analysis of nonstandard finite element methods such as nonconforming, mixed, dG, finite volume, least-squares, or dPG finite element schemes. Example of guaranteed error control and novel post processing operators. The convergence analysis of such schemes in general and for selected linear and nonlinear benchmark problems. The optimal convergence rates of nonstandard schemes in terms of nonlinear approximation classes and the medius analysis necessary for the proof of that.

2. Andreas Veeser (Milano)
The following topics will be discussed : Quantities and notions for describing convergence, Adaptive tree approximation, Localization of best errors with finite element functions, Mesh refinement with recursive bisection, Complexity of completion, Besov spaces and convergence speed. Thus, the goal is to provide instance-optimal algorithms in adaptive approximation with finite elements and an understanding of the regularity that matters for their convergence speed.

3. Martin Vohralik (INRIA)
- a unified framework for a posteriori error estimation :covers all standard numerical methods; fits especially all kinds of discontinuous Galerkin schemes; is based on equilibrated fluxes; covers basic linear/nonlinear and steady/unsteady PDEs
- robustness in a posteriori error estimation: with respect to the approximation polynomial degree; with respect to problem data (reaction or advection dominance)
- adaptive solvers: adaptive stopping criteria for algebraic and linearization solvers; adaptive Uzawa algorithm; adaptive regularization.
- applications to flows in porous media

COURSE 3 : Introduction to FEM for Finance, Parallel Computing & Applications

1. Olivier Pironneau (U-Paris VI)
F.E.M. for the equations of finance. The course will require a short introduction to the partial differential equations of finance. Then FEM for Black-Scholes equations, error estimates, comparison with other methods (Monte-Carlo and Tree Methods) will be discussed. Extension to local volatility models and to Dupire's equations, Mixed Monte-Carlo / PDE methods and solution with FEM Calibration of the volatility surface by variational methods.

2. Frederic Hecht (LJLL-UPMC)
Finite element methods for the Navier-Stokes equations will be presented in the context of fluid-structure interations and applications to hemodynamics. The Characteristic - Galerkin methods will be used and firs t and second order methods will be discussed with/without quadrature errors. Application to aortic flows using freefem++ will be given.

Various three dimensional finite element methods will be discussed especially from the point of view of their implementation. The general purpose software "freefem++" will be used to solve a variety of coupled problems from hemodynamics to aluminum ovens. Parallelization with domain decomposition will be explained.

COURSE 4 : Optimal control & Optimal shape design

1. Gregoire Allaire (Ecole Polytechnique)

The goal of this course is to recall the basic concepts of shape differentiation and to apply them in numerical algorithms. The topics proposed to be covered are Model of structural shape optimization problems, Hadamard method of shape differentiation, Numerical algorithm of shape deformation and various implementation issues (velocity and extension regularization, mesh movement, re-meshing), Level set method.

2. Jean-Pierre Raymond (Toulouse)

We shall study the stabilization of the incompressible Navier-Stokes equations by boundary controls. The numerical approximation by a mixed finite element method will be studied. We shall compare the controls obtained from approximate model and the one obtained by approximating the control of the infinite dimensional model. A review of avalaible results for error estimate of controls will be also given. The plan of the lectures will be:
(i) The incompressible Navier-Stokes equations with mixed boundary conditions and non homogeneous boundary controls, and their numerical approximation by a mixed finite element method.
(ii) The stabilization problem for the Navier-Stokes equations. Conditions for the existence of stabilizing controls. Characterization of stabilizing controls and their numerical approximation.
(iii) The different algorithms needed for finding stabilizing controls.
(iv) A review on error estimates for the control of the Navier-Stokes.

COURSE 5 : Fluid structure interaction, complex fluid, multi-scale simulations and applications of FEM.

1. Roland Becker (U Adour (Pau))

We will start with a review of the classical Nitsche method for elliptic problems. Since it allows for the implementation of Dirichlet-type boundary conditions without modifying the finite element space, it is natural to consider it for the singularly perturbed convection-diffusion and Dacy-Brinkman equations. Next we extend the Nitsche method to the Navier-Stokes at low and high Reynolds numbers. Here, we include spatial discretizations based on stabilised finite elements and discontinuous Galerkin methods. In the following lecture we discuss domain decomposition based on Nitsche's method, which gives here a natural framework for non-matching meshes and multi-physics coupling. Finally we present a method for the treatment of interfaces which are not necessarily matched by the mesh, including applications from the simulation of porous media flow.

2. Alexei Lozinski (U Besancon)

Multi scale finite element methods will be presented with emphasis on local zooming techniques. Error analysis and convergence for low order elements will be presented. Application to flow through porous media.

3. Bertrand Maury (U Paris-Sud)

F.E.M. for moving boundary problems. Fictitious domain methods: penalty approach, duality methods (with Lagrange multipliers), and more recent strategies preserving optimal space accuracy. Implementation issues (with Freefem++ and/or with dedicated codes). Application to fluid-particle flows, especially in the physiological context (blood flows, swimming entities).