LifeV and Multiscale

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Work done!

Organizing and merging previous work [1] (now I frequently do commits and updates...)

- Flux computation (`NavierStokesSolverPC.hpp`) and BC Vector (`bcCond.hpp`, `bcCond.cpp`, `bcVector.hpp`, `bcVector.cpp`, `bc_manage.hpp`) (`test_ns_bcvec`)

- Coupling 3D (NS - non compliant) and 0D models applying two coupling strategies (`test_coupling_3d0d`)

- How to code the 0D model in lifev?

[1] CEMRACS 2004 - Marseille, joint work with Miguel Fernandez

The 3D and 0D Models

3D model:

$$\begin{cases} \dfrac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} - \text{div}\,(2\nu \mathbf{D}(\mathbf{u}) - p\mathbf{I}) & = & f & \text{in } \Omega^f \\ \mathbf{div}\mathbf{u} & = & 0 & \text{in } \Omega^f \\ \mathbf{u} & = & 0 & \text{in } \Gamma_W \end{cases}$$

0D model:

$$\begin{cases} \dot{\mathbf{y}} & = & \mathbf{A}\mathbf{y} + \mathbf{b} \\ \mathbf{y}(0) & = & \mathbf{y_0} \end{cases}$$

The 0D model (lumped parameters model) is obtain by integrating the Navier-Stokes equations (3D model) and can be regarded as an electric network.

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Coupling Strategies [2]

The mean pressure problem:

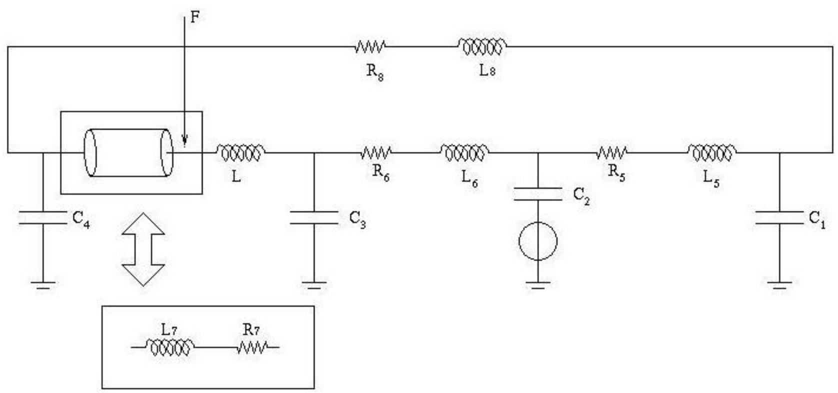
$$\mathbf{y}_7 = \int_{\Gamma_{out}} \mathbf{u}\cdot\mathbf{n}\, d\gamma$$

$$p\mathbf{n} - \nu\frac{\partial \mathbf{u}}{\partial \mathbf{n}} = \begin{cases} \mathbf{y}_4 - \mathbf{y}_3 & \text{in } \Gamma_{in} \\ 0 & \text{in } \Gamma_{out} \end{cases}$$

The flow rate problem:

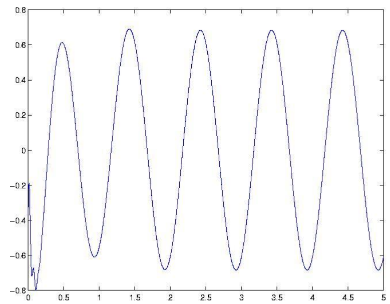
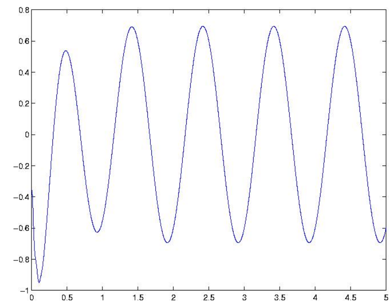
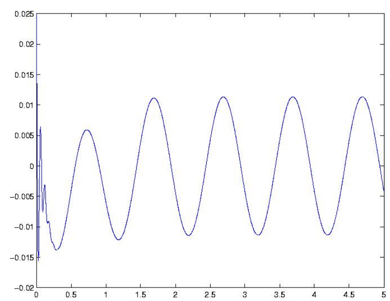
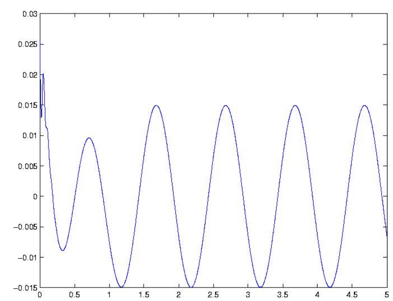
$$L\dot{\mathbf{y}}_7 = \mathbf{y}_4 - \mathbf{y}_3 - \int_{\Gamma_{in}} p(x,t)\mathbf{n}\, d\gamma$$

$$\int_{\Gamma_{in}} \mathbf{u}\cdot\mathbf{n} = \mathbf{y}_7$$



[2] For the flow rate problem is used the work of A.Veneziani and C.Vergara on *defective boundary conditions*

Results - The mean pressure problem

Coupling 3D - 0D models	The equivalent 0D model
	
pressure max value $= 0.690$	pressure max value $= 0.694$
	
flow max value $= 0.0114$	flow max value $= 0.0149$

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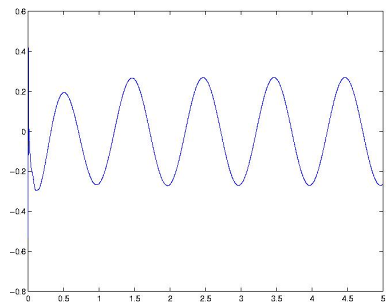
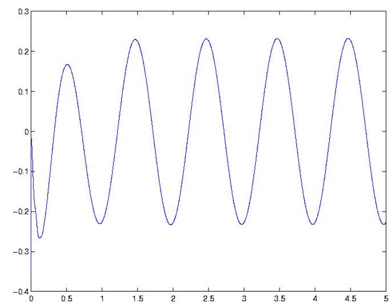
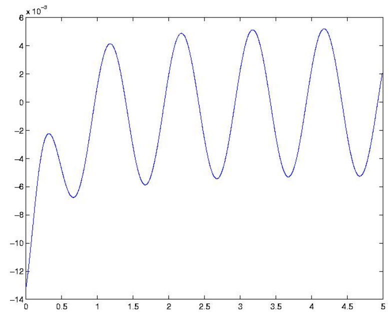
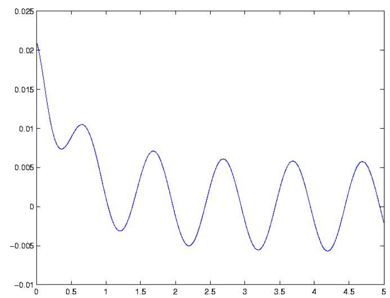
Results - The flow rate problem

Coupling 3D - 0D models	The equivalent 0D model
	
pressure max value $= 0.269$	pressure max value $= 0.232$
	
flow max value $= 5.2047 \times 10^{-3}$	flow max value $= 5.7515 \times 10^{-3}$

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Ongoing Work. . .

- Coupling 3D (NS - non compliant) and more sofisticated 0D models (Vuk's net)
- Coupling 3D (FSI - compliant) and 0D models

. . . Next steps

- Coupling 3D (NS at first and then FSI) and 1D models
  1. Test several coupling strategies
  2. Coupling on the proximal and distal boundaries
  3. To use more complex geometries
  4. To consider other 1D models

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