

Laboratory tasks I.

Programming

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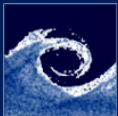
- 1 Modify icoFoam with additional temperature field (Reference)
 - Create the application directory in your OF home dir
 - Copy icoFoam solver to your application directory
 - Modify the file names and Make properties
 - Add the required modifications to the files

Listing 1: make a copy from original solver

```
1 cd $FOAM_SOLVERS/incompressible
2 mkdir -p $WM_PROJECT_USER_DIR/applications/solvers
3 cp -r icoFoam $WM_PROJECT_USER_DIR/applications/solvers/icoFoamT
4 cd $WM_PROJECT_USER_DIR/applications/solvers/icoFoamT
5 mv icoFoam.C icoFoamT.C
6 rm icoFoam.dep
```

Listing 2: modify Make/files

```
1 icoFoamT.C
2
3 EXE = $(FOAM_USER_APPBIN)/icoFoamT
```



Laboratory tasks II.

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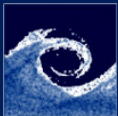
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Listing 3: test compilation

```
1 wclean
2 wmake
3 ls $FOAM_USER_APPBIN
```

Listing 4: add thermal diffusion coeff. to createFields.H

```
1     ...
2     dimensionedScalar nu
3     (
4         transportProperties.lookup("nu")
5     );
6     // Add DT thermal diffusion
7     dimensionedScalar DT
8     (
9         transportProperties.lookup("DT")
10    );
11    // end modifications
12    ...
```



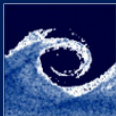
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Listing 5: add temperature field to createFields.H

```
1    ...
2
3    // Add this temperature declaration
4    Info<< "Reading field T\n" <<endl;
5    volScalarField T
6    (
7        IObject
8        (
9            "T",
10           runtime.timeName(),
11           mesh,
12           IObject::MUST_READ,
13           IObject::AUTO_WRITE
14        ),
15        mesh
16    );
17    // end modifications
18    # include "createPhi.H"
19    ...
```



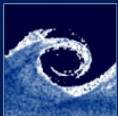
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Listing 6: add temperature eq. to icoFoamT.C

```
1      ...
2      U = HbyA - rAU*fvc::grad(p);
3      U.correctBoundaryConditions();
4      }
5
6      // Add temperature eqs.
7      fvScalarMatrix TEqn
8      (
9          fvm::ddt(T)
10         + fvm::div(phi, T)
11         - fvm::laplacian(DT, T)
12     );
13
14     TEqn.solve();
15     // end of modifications
16
17     runTime.write();
18     ...
```



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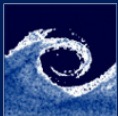
- 2 Perform a simulation with the new solver
 - Create a copy from the original cavity case (new name: cavityT)
 - Add thermal diffusion coeff. to transportProperties
 - Copy 0/p field as 0/T, and modify the required parts

Listing 7: make a copy from original solver

```
1 cd $FOAM_RUN/tutorials/incompressible/icoFoam
2 cp -r cavity cavityT
3 cd cavityT
4 cp 0/p 0/T
```

Listing 8: add thermal diffusion coeff. transportProperties

```
1 ...
2 // Thermal diffusion coeff.
3 DT          DT [ 0 2 -1 0 0 0 0 ] 0.002;
4 ...
```



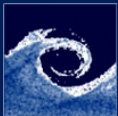
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Listing 9: modification of 0/T

```
1 ...
2     object      T;
3 }
4 ...
5 dimensions      [0 0 0 1 0 0 0];
6 internalField   uniform 300;
7 boundaryField
8 {
9     movingWall
10    {
11        type      fixedValue;
12        value     uniform 350;
13    }
14    fixedWalls
15    {
16        type      fixedValue;
17        value     uniform 300;
18    }
19    frontAndBack
20    {
21        type      empty;
22    }
23 }
24 ...
```



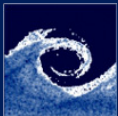
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Listing 10: modification of system/fvSchemes

```
1 ...
2 divSchemes
3 {
4     default          none;
5     div(phi,U)       Gauss linear;
6     div(phi,T)       Gauss upwind limited; // This line added
7 }
8
9 laplacianSchemes
10 {
11     default          none;
12     laplacian(nu,U)  Gauss linear orthogonal;
13     laplacian((1|A(U)),p) Gauss linear orthogonal;
14     laplacian(DT,T)  Gauss linear orthogonal; // This line added
15 }
16 ...
```



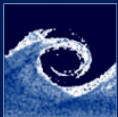
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Listing 11: modification of system/fvSolution

```
1  p
2  {
3      solver          PCG;
4      preconditioner  DIC;
5      tolerance       1e-06;
6      relTol          0;
7  }
8
9  T
10 {
11     solver          BICCG;
12     preconditioner  DILU;
13     tolerance       1e-7;
14     relTol          0;
15 };
16
17 U
18 {
19     solver          PBiCG;
20     preconditioner  DILU;
21     tolerance       1e-05;
22     relTol          0;
23 }
```

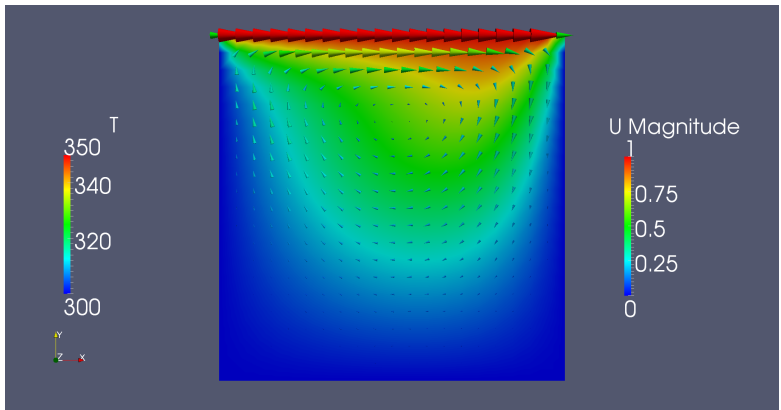



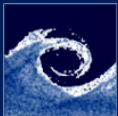
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3 Perform the simulations and visualize the results



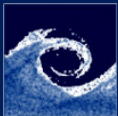


Assignments

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- 1 What is the symbolic form of the temperature equation?
- 2 Which solver should be modified in order to take into account turbulence?
- 3 How can you add technically non-uniform thermal diffusion to the simulation?
- 4 How can you add heat flux on the walls? Which BC should be used?



Homework

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- 1 Read Chapter 3 in the [User Guide](#)