

Monitoring

Advanced course

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Content

- Force & torque
- Convergence / residual monitoring

Force & torque

- controlDict: include the “forces” function

```
functions
{
    #include "forces"
}
```

- \system\forces: extra file

When are the forces calculated & written

Keep log file

Patches to be monitored

Reference for torque calculation

```
forces
{
    type            forces;

    functionObjectLibs ( "libforces.so" );

    outputControl   outputTime;

    log             yes;

    patches         ( rotor );
    pName           p;
    UName           U;
    rhoName         rhoInf; // Indicates incompressible
    log             true;
    rhoInf          1; // Redundant for incompressible

    CofR            (0 0 0); // Rotation around centre line of propeller
    pitchAxis       (0 0 1);
}
```

Multiple entries possible

Force & torque

- Output
 - Subfolder “postProcessing” is created
 - Subfolder for every patch that is monitored
 - Subfolder named after the start time of the monitoring
 - Example

```
# Forces
# CofR      : (0.000000e+00 0.000000e+00 0.000000e+00)
# Time     forces(pressure viscous porous) moment(pressure viscous porous)
5.000000e+01 ((4.646483e-04 1.956928e-03 7.004669e-01) (-2.113155e-04 -4.675707e-05
-1.288362e-02) (0.000000e+00 0.000000e+00 0.000000e+00)) ((5.118211e-04 4.901398e-05
-4.016098e-02) (4.517382e-06 2.385995e-05 -2.157845e-03) (0.000000e+00 0.000000e+00 0.000000e
+00))
1.000000e+02 ((7.406310e-04 6.984634e-04 6.159650e-01) (-3.112000e-05 6.264073e-05
-1.233162e-02) (0.000000e+00 0.000000e+00 0.000000e+00)) ((2.115976e-04 -2.878363e-06
-3.733265e-02) (1.037353e-05 3.619293e-07 -1.949961e-03) (0.000000e+00 0.000000e+00 0.000000e
+00))
1.500000e+02 ((1.072443e-04 2.842288e-04 6.423858e-01) (6.462959e-06 1.694370e-05
-1.111829e-02) (0.000000e+00 0.000000e+00 0.000000e+00)) ((1.269377e-04 4.606769e-05
-3.834054e-02) (1.339221e-06 -3.783591e-06 -1.715801e-03) (0.000000e+00 0.000000e+00 0.000000e
+00))
2.000000e+02 ((5.104872e-04 2.164580e-04 6.458248e-01) (1.413001e-05 1.468324e-05
-1.099838e-02) (0.000000e+00 0.000000e+00 0.000000e+00)) ((1.108439e-04 9.673436e-06
-3.868132e-02) (6.360376e-07 -4.768868e-06 -1.684861e-03) (0.000000e+00 0.000000e+00 0.000000e
+00))
2.500000e+02 ((2.484496e-04 3.900162e-04 6.430943e-01) (1.480155e-05 1.252896e-05
-1.099714e-02) (0.000000e+00 0.000000e+00 0.000000e+00)) ((1.123629e-04 4.792790e-05
-3.854361e-02) (1.707922e-07 -4.838065e-06 -1.686284e-03) (0.000000e+00 0.000000e+00 0.000000e
+00))
```

- $T_{\text{pressure}} + T_{\text{viscous}} + T_{\text{porous}}$ (around Z-axis) = $-3.85e-2 + -1.68e-3 + 0 = -4.02e-2$
- multiply by density of $1000 \text{ kg/m}^3 \rightarrow T = 40.2 \text{ Nm}$
- $P = T \cdot n = 40.2 \text{ Nm} * 151.784 \text{ rad/s} = 6.1 \text{ kW}$