

## PMT17 - Fundamentals of Non-Newtonian Fluid Mechanics (Fundamentos da Mecânica dos Fluidos Não-Newtonianos)

### Syllabus

- Newtonian fluids and the Navier-Stokes equations. Forms of the N-S equations in cartesian, cylindrical, and spherical coordinates.
- Analytical solutions of steady unidirectional Newtonian flows. Unidirectional flows in Cartesian coordinates. Axial, rotational, and radial axisymmetric flows.
- Flow phenomena in polymeric liquids. Experimental observations. Material functions.
- Elementary constitutive equations. Generalized Newtonian fluids. The power-law, the Carreau, the Bingham, the Herschel-Bulkley, and other models.
- Analytical solutions of steady unidirectional generalized Newtonian flows. Unidirectional flows in Cartesian coordinates. Axial, rotational, and radial axisymmetric flows. Viscometric flows.
- Thixotropic models.
- Viscoelastic materials. Linear viscoelasticity. Differential and integral constitutive equations.
- Shear and extensional viscoelastic flows.
- A brief introduction to the numerical solution of flow problems with the finite element method.
- Case studies.

### Textbooks

1. R.B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, John Wiley, New York (2002).
2. R.B. Bird, R.C. Armstrong and O. Hassager, [Dynamics of Polymeric Liquids](#), John Wiley, New York (1987).
3. M.M. Denn, Polymer Melt Processing, Cambridge University Press, Cambridge, 2008.
4. R.R. Huilgol, Fluid Mechanics of Viscoplasticity, Springer-Verlag, Berlin, 2015.
5. T. Papanastasiou, G.Georgiou and A. Alexandrou, [Viscous Fluid Flow](#), CRC Press, Boca Raton (1999).
6. R.I. Tanner, Engineering Rheology, 2<sup>nd</sup> ed., Oxford University Press, Oxford (2000).

### Indicative Schedule

<b>Monday 26.2.2018</b> 09:00-12:00	<i>Review of Newtonian Fluid Mechanics/Equations of flow and analytical solutions.</i>
<b>Tuesday 27.2.2018</b> 09:00-12:00	<i>Solution of Newtonian flow problems in different coordinate systems</i>
<b>Wednesday, 28.2.2018</b> 09:00-12:00	<i>Non-Newtonian flows; Generalized Newtonian fluids. Introduction to Rheology</i>
<b>Thursday, 1.3.2018</b> 09:00-12:00	<i>Solutions of power-law and Bingham-plastic flows</i>
<b>Friday, 2.3.2018</b> 09:00-10:30	<i>Viscoelastic materials. Equations of state and rheometric flows.</i>
10:30-12:00	<b>FINAL EXAM</b>