Advanced Fluid Mechanics, 7.5 hp, 2022

Chapters and problems refers to “Lectures on Fluid Dynamics” by Vitaly Bychkov.

L	Date	Time / Place	Contents/Activity	Problems
1	25/3	8.15 - 10.00	Course introduction Ch1: 1.1-1.2 Basic ideas and equations	
2	28/3	8.15 - 10.00	Ch1: 1.3-1.4 Basic ideas and equations	1.4*, 1.5
3	30/3	8.15 - 10.00	Ch2: 2.1-2.2 Rotations in flows	1.8, 1.9, 1.11
4	1/4	8.15 - 10.00	Problem discussion session 1	
5	4/4	8.15 - 10.00	Ch2: 2.3-2.4 Bernoulli eq. & Potential flow	1.4**, 2.3, 2.4, 2.6, 2.7, 2.10, 2.14
6	6/4	8.15 - 10.00	Ch2: 2.5 Drag and lift (potential flow)	2.13, 2.15
7	8/4	8.15 - 10.00	Problem discussion session 2	
8	11/4	8.15 - 10.00	Ch3: 3.1-3.4 Waves and instabilities	Additional problems not in book
9	13/4	8.15 - 10.00	Ch4: 4.1-4.2 + Extra material Geophysical flow	Additional problems not in book
10	20/4	8.15 - 10.00	Ch5: 5.1-5.2 Viscosity, dynamical similarity	5.1, 5.3, 5.4, 5.7
11	22/4	8.15 - 10.00	Ch5: 5.3 Viscous flow in pipes	5.10, 5.11, 5.12
12	25/4	8.15 - 10.00	Problem discussion session 3	
13	27/4	8.15 - 10.00	Ch5: 5.3-5.4 Viscous flow in pipes	5.13, 5.14, 5.15
14	29/4	8.15 - 10.00	Ch5: 5.5-5.7 Relaxation, viscous drag	5.24, E1
15	29/4	10.15 - 12.00	Preparation for labs	

L	Date	Time / Place	Contents/Activity	Chapters / Problems
16	2/5	8.15 - 10.00	Ch6: 6.1-6.3 Boundary layers, wakes and jets	6.1
17	4/5	8.15 - 10.00	Ch8: 8.1-8.3 Turbulence	
18	6/5	8.15 - 10.00	Problem discussion session 4	
19	9/5	8.15 - 10.00	Ch7: 7.1-7.3 Thermal conduction	7.3, 7.4
20	11/5	8.15 - 10.00	End Ch7 + Summary of course	
	11/5	13.00 - 17.00	LAB	
	12/5	8.15 - 17.00	LAB	
21	13/5	8.15 - 10.00	Problem discussion session 5	
	13/5	13.00 - 17.00	LAB	
	16/5	8.15 - 17.00	LAB	
	17/5	8.15 - 17.00	LAB	
22	18/5	8.15 - 10.00	Problem discussion session 6	
	18/5	13.00 - 17.00	LAB	
	19/5	13.00 - 17.00	LAB	
23	20/5	8.15 - 10.00	Problem discussion session 7	
	20/5	13.00 - 17.00	LAB	
24	23/5	8.15 - 10.00	LECTURE BACKUP	
	23/5	13.00 - 17.00	LAB BACKUP	
	24/5	8.15 - 17.00	LAB BACKUP	
	27/5	8.15 - 17.00	LAB BACKUP	
	30/5	8.00 - 14.00	EXAM ÖP	

1.4* Find only velocity (*ur* and *uz*). Note that the flow is incompressible.

1.4** Using the results of 1.4* and assuming a quasi-stationary flow ($H0 >> Ut$) find pressure distribution at the *bottom* plate, pressure at the plate center and the total pressure force on the plate produced by the flow (for brevity, neglect the gravitational force).

E1: A ball of radius R and density $\rho 0$ is sinking in a viscous fluid of viscosity μ and density $\rho f = \alpha\rho 0$ with $\alpha < 1$. Initial ball velocity is zero. Find the ball velocity versus time assuming that the flow is quasi-stationary and $Re << 1$.