Questions of the oral exam in Fluid Mechanics

for the English course of BME GEÁT AG01 (intentionally the same as for the Hungarian course)

1. Give the integral form of the continuity theorem and show what physical principle is expressed in it! Explain the meaning of the terms! How and in what conditions can this form be applied to a stream tube?
2. Give the differential form of the continuity theorem and explain what physical principle is expressed in it! Explain the meaning of the terms! What simplified forms of the equation are there and what assumptions of the conditions are made in applying them?
3. How can the volume flow rate be computed in a pipe of circular cross-section if the v=v(r), the velocity distribution (as a function of the radius), is given (for fully developed flow)?
4. Give the equation of hydrostatics and explain what physical principle is expressed in it! Explain the meaning of the terms! Show the solution of the equation for incompressible fluid!
5. Show a manometer which is based on the change of fluid levels (U tube manometer)! Draw a sketch of it when it is attached to a system! List and explain the methods by which the accuracy of the pressure measurement made with the manometer can be increased!
6. Define the expressions pathline, streamline and streak-line! Define what it means if the flow is steady of unsteady?
7. Explain the concept of velocity potential! What are the properties of potential flows?
8. Give and explain the total acceleration of a fluid particle using the Eulerian description!
9. Give the Euler equation! Explain what physical principle is expressed by it and for what conditions the equation is valid! Explain the meaning of the terms!
10. Give the Euler equation for steady flows in the streamline (also referred to as natural or streamwise) coordinate system! What conclusions can be drawn from the equations components? Show the advantage of using the streamline coordinate system through application examples.
11. Give the general form of the Bernoulli equation! Analyze the meaning of each term and show the conditions by which they can be dropped and reformulated!
12. Give the Bernoulli equation in a rotating coordinate system! Analyze the meaning of each term and show the conditions by which they can be dropped and reformulated!
13. Define static, dynamic and total pressure and explain how they can be measured!
14. Explain the use of Pitot and Pitot-static (Prandtl) probes for velocity measurements! Make a draft for your explanation!
15. Give the way of measuring volume flow rate based on velocity measurements for rectangular and circular cross-sectioned pipes!
16. Introduce the volume flow rate measurement techniques which use orifice and Venturi contraction pipes! Explain in detail how the contraction coefficient (α) is to be selected!
17. Compare the advantages and disadvantages of volume flow rate measurement techniques using velocity measurements to those using contraction elements!
18. Give the Euler turbine equation for turbomachinery and explain the meaning of the terms! List the conditions for the application of the equation!
19. Give the general form of the integral momentum equation, and explain the basic physical principle which is expressed by the theorem! Explain the meaning of the terms!
20. Give the Joukowski theorem and explain its physical meaning!
21. Draw the lift and drag force vectors acting on an airfoil in a flow! Give the definitions for the lift and drag coefficients of bodies placed in a flow! Draw the character of the change of the lift and drag coefficient as a function of the angle of attack!
22. Introduce the expression for computing the pressure rise using the Allievi theorem! What are the conditions for its validity? List some practical application for the use of the expression!

23. Introduce and explain Newton's law of viscosity and plot typical rheological curves (for Newtonian fluids)!
24. What is meant by the laminar and turbulent nature of a flow? Introduce the mixing length model used for the description of a turbulent boundary layer!
25. Give the Navier-Stokes equation! Introduce the physical content of the equation and the required conditions for writing it in the given form! Explain the meaning of the terms of the equation!
26. Introduce the concept of boundary layer and the process of boundary layer separation! What methods can be used to influence the separation of the boundary layer?
27. Give the Bernoulli equation which is extended by the friction term, and give its physical meaning!
28. Give the expressions for determining the pressure drop across a straight pipe section, a diffusor, a Borda-Carnot expansion and a valve or bend!
29. Define the friction factor for pipes and plot its dependency on the Reynolds number and the roughness of the pipe! Explain the concept of a hydraulically smooth and rough pipe!
30. Explain how the pressure loss coefficient of an element (e.g. a bend) can be determined with measurements!
31. How can be the efficiency of a diffuser be determined with measurements?
32. Give the energy equation and explain the conditions for which it is valid? Explain the physical principle which is expressed by the equation!
33. What is the meaning of the similarity of two flows? Give the conditions for the similarity of incompressible flows!
34. What is the meaning of the similarity of two flows? Give the conditions for the similarity of compressible flows!
35. Determine the velocity of the air released from a pressurized air reservoir for a simple discharge nozzle at different pressure ratios!
36. Why is the Laval nozzle used when the pressure ratio is under the critical value? What is the value of the flow velocity at the narrowest section of the Laval nozzle and at the outlet section?
37. Explain the concept of speed of sound! Give the differential expression of the equation for the speed of sound and that which can be applied for gases in isentropic conditions! Analyze the expressions!
38. Introduce the concept of interfacial surface tension and give examples for phenomena in which the surface tension has a role!
39. Introduce the concept of cavitation and give technical examples for when it is present! How can the cavitation be avoided?
40. Introduce the Thomson and Helmholtz 1st and 2nd theorems!