Questions

(about my lectures only)

1. Please, give examples on differencing and integration schemes of first order accuracy!
2. What we name an implicit scheme? Please, give an example!
3. Please, derive the CDS scheme by using Taylor series and show the order of accuracy!
4. Derive the Adams-Basforth scheme! What this scheme can be applied for?
5. How can we approximate the divergence, gradient and Laplacian operators by means of finite volume method?
6. Specify the governing equations for 2D, laminar, incompressible flows in conservation form! What is a segregated iteration process? Is this set of equations suitable for segregated iteration?
7. Briefly describe two possible ways for solving the problem of pressure-velocity coupling!
8. Specify governing equations of ψ-ω methods (for 2D incompressible flows)! Describe the segregated iteration procedure!
9. Derive the Poisson equation for the pressure!
10. Please, show how the numerical errors are accumulated in the continuity equation if the Poisson equation for the pressure is used as a substitution for the continuity equation in its original form! How can the accumulation of errors be avoided?
11. Describe the projection method!
12. Give an example on the pressure-velocity iteration procedure for steady flows!
13. How can the surface integral and volume integral of vector quantities be approximated in finite volume methods?
14. Apply the energy equation for a one-dimensional, steady, constant density flow with heat convection and conduction! How the graph of the analytical solution looks like? Define the Peclet number!
15. Demonstrate the finite volume discretization on a one-dimensional heat transport problem using the compass notation! Apply CDS for the convective fluxes! What is the structure of the system matrix in the case of 1D flows?
16. What is the transportivity of the numerical scheme and what is the stability condition for the CDS scheme?
17. Describe the first order upwind differencing scheme (UDS)! Is the transportivity criterion fulfilled? Derive the expression for the kind of error we call "the artificial heat conduction" introduced by the UDS scheme!
18. Outline the principles of the hybrid differencing scheme and the second order upwinding scheme!
19. Why the efficient solution of the Poisson equation is important in the case of compressible flow simulations? Show the discretization of the Poisson equation for a simple 2D situation!
20. Describe the iterative solution methods for linear algebraic systems in general! Define the residuals! What are the reasonable approximations of the system matrix?
21. Describe the Jacoby, Gauss-Seidel, and line relaxation methods! Why these methods are not efficient on fine meshes?
22. Derive the correction equation for a one-dimensional Poisson equation and it's reduced form for doubled mesh size! Show the algorithm of a multigrid "V" cycle!
23. Specify the governing equations for compressible, unsteady, 1D, isentropic flow! Reformulate this system of PDEs for the sound speed (a) and velocity (u) as field variables!

24. Derive the Riemann invariants of the unsteady, 1D, isentropic flow. Explain the method of characteristics! What are the problems with the practical applications? What are the expressions for "u" and "a" if the Riemann invariants are known.
25. Show the governing equations for a compressible, unsteady, 1D flow in conservation form! Describe the two step Lax-Wendroff method! What is the stability condition?

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