ACT questions:

- basic laws of physics
    - principles of conservation
        - mass, momentum, energy, etc.
    - material models, constitutive equations
    - basic types of description of physical processes
        - Lagrange description
        - Euler description

- types of second order partial differential equations
    - elliptic, parabolic, hyperbolic - basic characteristics
        - elliptic - space, smooth
        - parabolic - time and space, smooth
        - hyperbolic - time and space, characteristics
    - convection-diffusion problems
        - general form, boundary conditions
    - (quasi-)linear and non-linear equations

- mathematical well-posedness conditions
    - sets of boundary and initial conditions
        - required conditions for different types of differential equations
    - compatibility of initial and boundary conditions
    - proof of existence and uniqueness of solutions

- modelling (approximation) of boundary and initial-boundary value problems
    - general idea of discretisation and discretisation error
    - FDM, FEM, FVM
    - accuracy, stability, consistency -> convergence (order of convergence)
    - modelling errors (types of errors, sources, ways to reduce):
        - modelling error
        - input data error
        - discretisation error
        - round-off error

- idea of the finite element method for elliptic problems
    - FEM approximation
        - weak statement (integral formulation)
        - shape functions
            - polynomials of degree *p*: Lagrange, hierarchical
        - basis functions
            - "gluing" of shape functions, requirements
        - FEM solution construction
    - approximation error
        - "best approximation property"
        - a priori estimation (based on interpolation error and "best approximation property")
            - convergence to the exact solution for element sizes going to zero
            - rate of convergence dependence on the degree of approximating polynomials
    - adaptation
        - idea
        - a posteriori error estimation
        - types of adaptation: r, h, p, hp, remeshing - convergence

- triangulation of the computational domain
    - requirements for subdivision into elements
    - quality of the grid (and its effect on the approximation error)
    - types of meshes (structured, unstructured) and elements (in 2D, in 3D)

- integration over time
    - concept of FDM
    - types: explicit, implicit, order of magnitude

- solving non-linear equations
    - idea of Newton's method and Picard's iterations (fixed point iterations)

- procedures for solving systems of linear equations
    - form of equations in the PDE approximation
        - large, sparse systems of linear equations
    - direct methods, computational complexity and its dependence on system structure, "fill-in"
    - iterative methods
        - simple iteration methods, convergence
        - Krylov subspace methods, preconditioning

- convection-diffusion-reaction equations, flow modelling
    - differential equations and boundary + initial conditions
    - application of FDM - discretisation in time and space
        - stencil, template
    - FEM (spatial discretisation) + temporal discretisation (e.g. FDM, DG, etc.).
        - the method of lines - temporal discretisation after spatial discretisation
            - spatial discretisation assumptions
            - time discretisation for the system of equations obtained from spatial discretisation (with the unknowns being the values of the degrees of freedom and the time derivatives of the degrees of freedom)
    - FVM - concept of the finite volume method
        - cells, fluxes, modification of discrete values
        - cell centred, vertex centred control volumes
    - Peclet number = (h*v)/(2k)
        - dependence of stability and convergence of approxiation methods on Peclet number
        - stabilisation of equations and numerical methods for problems with dominating convection
    - pseudo-transient continuation (solution of stationary problems by convergence towards steady state using methods for non-stationary problems)

- modelling of incompressible flows
    - differential equations and boundary + initial conditions
    - non-stationary and non-linear problems
        - approximation techniques
            - components: spatial discretisation, temporal discretisation, solution of nonlinear problems, solution of systems of linear equations