School of Basic Sciences
Swiss Plasma Center

Nuclear Fusion and Plasma Physics Winter semester 2025

List of questions for the oral exam

Group 1

1) The DT fusion reaction, the sources of fuel for fusion, and the advantages of fusion
2) Power balance of a fusion reactor: conditions for energy production
3) Design of a fusion reactor: main elements, constraints and optimization process
4) Definition of plasma. Quasi-neutrality; Debye screening; plasma oscillations
5) Single particle motion in a constant magnetic field: gyro-motion and ExB drift
6) Single particle motion in a spatially varying magnetic field: the mirror effect
7) Time scales for relaxation processes (exchanges of energy and momentum)
8) Plasma resistivity and 'runaway' electrons
9) Fluid description of plasmas: discussion of the basic elements
10) Transition from multi-fluid to a single fluid description: the MHD model

Group 2

11) MHD equilibrium: choose and discuss a simple equilibrium configuration
12) Plasma stability: general discussion and an example of instability
13) The tokamak: basic concept, operating principles, and main components
14) MHD shear Alfvén waves: physical meaning and traces of the calculation
15) Cut-off points in the fluid model: physical meaning and examples
16) Resonances in the fluid model: physical meaning and examples (perpendicular propagation)
17) Waves in a fluid magnetized plasma, in perpendicular propagation: accessibility problem
18) Qualitative discussion of wave-particle interactions and resonant exchanges of energy
19) Ohmic heating and the need for additional (i.e. other than Ohmic) heating of fusion plasmas
20) Physical processes occurring when a neutral beam penetrates a plasma and criteria for designing a beam to heat fusion plasmas

Group 3

21) Heating using waves interacting with electrons
22) Heating using waves interacting with ions
23) Superconductors of Type I and II, Low and High-Temperature Superconductors, and normal conductors with zero electrical resistance
24) Main challenges for building fusion magnets using superconductors
25) Requirements and main issues associated with the fusion reactor first wall
26) Advantages of the magnetic divertor
27) Effects of neutrons on materials and the need for a neutron source to test fusion materials
28) Basic principles of inertial confinement fusion
29) Choose and discuss an important process characteristic of a burning plasma
30) Main issues associated with the use of Tritium in a fusion reactor

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