Theory of Relativity and Fields

(PhD entrance exam thematics)

1. Lagrangian formalism in classical field theory: variational principle, Euler–Lagrange equations, Noether Theorem, canonical energy-momentum tensor.
2. Foundations of Special Relativity: postulates, Minkowski space-time, Lorentz transformations, relativistic mechanics.
3. Relativistic invariance of the Maxwell equations. Energy-momentum tensor of the electromagnetic field.
4. Physical and mathematical foundations of General Relativity: Equivalence Principle, Riemann geometry, Einstein equations, Newtonian limit.
5. Geodetic motions, geodetic deviation equation, their relationship with Newtonian gravitational and tidal forces.
6. Spherically symmetric gravity: Schwarzschild space-time, event horizon, the concept of black holes.
7. Standard Cosmological Model, cosmological observations.
8. Gravitational radiation, detection of gravitational waves.
9. Yang–Mills fields. Global and local gauge transformations, field equations, Lagrangian density.
10. Fundamental bosonic and fermionic fields, their relativistic invariance (Klein–Gordon, Proca and Dirac equations, neutrinos).

Bibliography:

1. V. Faraoni: Special Relativity, Springer International Publishing Switzerland 2013
2. R. M. Wald: General Relativity, University of Chicago Press, 1984
3. L. H. Ryder: Quantum Field Theory, 2nd Edition, Cambridge University Press, 1996