

## Exam questions Tef02EN

1. Classification of quantities with respect to their transformation properties (scalars, vectors, tensors, densities), Groups of transformations  $GL(n)$ ,  $SL(n)$ ,  $O(n)$ ,  $SO(n)$ , invariant tensors, tensor operations, metric tensor, raising and lowering indices
2. Affine space, rectilinear and curvilinear coordinates of point and their transformations, symmetry of affine space, orientation, pseudotensor,
3. Space and time in Newtonian mechanics, Inertial frame of reference, Newton's first law, Galilei transformation and Galilei group,
4. Newton's second law in the non-inertial frame, angular velocity vector
5. Rigid body, angular velocity of rotation, kinetic energy and moment of inertia tensor, principal axes of inertia
6. Motion of a rigid body, Euler's rotation equations, Euler's angles and their relation to angular velocity, rotation, precession, nutation
7. Continuum mechanics, types of forces, stress tensor, equations of motion of a continuum, Euler's hydrodynamic equations
8. Strain tensor, Hooke's law, Lamé's equations
9. Principles of STR, special Lorentz transformation and its consequences, Minkowski spacetime, light cone, interval, four-vectors
10. Lorentz group, its properties and structure
11. Relativistic generalization of Newton's equations of motion for a single particle, four-momentum, four-acceleration, relativistic energy
12. Lagrange and Hamilton functions for a charged particle in an electromagnetic field relativistically and classically
13. Hamilton's principle in field theory and derivation of equations of motion for fields
14. Maxwell-Lorentz equations and Maxwell equations in matter, continuity equation, elmag. wave equation
15. Solving Maxwell's equations using potentials, Calibration transformations, d'Alembert equations, Lorenz calibration condition
16. Covariant form of d'Alembert equations, four-current, four-potential
17. Covariant form of Maxwell-Lorentz equations, electromagnetic field tensor, Lorentz four-force
18. Lagrange function for charged particle system and electromagnetic field
19. Conservation laws in field theory, four-flux conservation and the corresponding "charge", Noether's theorem, energy-momentum tensor
20. Symmetric energy-momentum tensor, Maxwell's stress tensor and conservation laws of energy and momentum for electromagnetic fields
21. Solution of the inhomogeneous wave equation for the charge at the origin, retarded potentials and their dipole approximation
22. Dipole radiation, static zone, wave zone, power and radiation intensity for a harmonic dipole