

## Exam Topics

Applied Physics (GEFIT054-MSE)  
for Space Engineer MSc students

1. Description of motion in different coordinate systems. Uniform circular motion, uniformly changing circular motion.
2. Galilean relativity and Special relativity. Galilean transformation formulas and Lorentz transformation formulas. Relativity of simultaneity. Time dilation. Length contraction.
3. Fundamental equation of dynamics. Inertial forces in an accelerating reference frame, centrifugal force.
4. Uniformly changing motion and projectile motion.
5. Newtonian gravitational force and weight force. Drag force. Free fall with drag.
6. Conservative force fields. Definition of potential energy. Potential energy of weight force and Newtonian gravitational force.
7. Principle of minimum energy. Mechanical energy.
8. Dynamics of uniform circular motion. The definition of torque, angular momentum, and moment of inertia.
9. Movements of planets and moons. Kepler's laws.
10. Low Earth orbit, geostationary orbit, Lagrange points. Effective potential energy. Gravity assist.
11. Equation of motion for harmonic oscillation. Kinetic and potential energy. Damped vibration. Forced vibration.
12. Waves. Transversal and longitudinal waves. Standing waves on a string. Doppler effect.
13. Momentum-force law for mass point systems. Collisions. Coefficient of restitution. Rocket propulsion.
14. Spinning top and gyroscope. Torque acting on a current loop. Potential energy of the current loop. DC electric motor.
15. Hydrostatic pressure. Pascal's law. Buoyant force. Surface tension.
16. Methods of hydrodynamics. Continuity equation. Bernoulli equation.
17. Microscopic Hooke's law. Speed of a transversal wave on a string. Speed of a longitudinal wave in metals. Intensity of the wave.
18. Internal energy of gases and ideal gases. Volumetric work. Heat transfer. Calorimetry. The first law of thermodynamics.
19. Equipartition theorem, the concept of degrees of freedom. Equation of state for ideal gases.
20. Combined gas law. Special changes in the state of ideal gases. Isobaric and isochoric molar heat, adiabatic process.
21. Speed of sound in air. The barometric formula.
22. Microstates, state sum, entropy. The second law of thermodynamics.
23. Comparison of ideal gases to real materials. Van der Waals equation of state for real gases. Thermal expansion.
24. The birth of modern physics. Propagation of light. The concept of ether. The Michelson experiment.
25. Equivalence principle. Gravitational mass and inertial mass. Eötvös pendulum. Light deflection in gravitational field. Gravitational lensing. Gravitational time dilation and redshift.
26. The spectrum of thermal radiation. The concept of an ideal black body. The birth of quantum physics. Planck's constant. The energy quantum. Wien's displacement law. Stefan-Boltzmann law.
27. Intensity and pressure of light. Emission and absorption spectra of gases. Bohr's postulates. Discrete energy levels in the Bohr model of hydrogen-like ions. Lasers.
28. X-rays: creation, properties, components.
29. The structure of the atomic nucleus. Fundamental building blocks and fundamental interactions. The nuclear interaction.
30. Radioactivity. Types of radioactive decay. Law of radioactive decay, half-life, activity.
31. Mass defect, mass-energy equivalence, binding energy. Fission and fusion.