Physical Sciences - Principles of the recruitment interview

During the interview, the following are assessed:

1. A 10-15 minute presentation by the candidate of his/her scientific achievements to date and an outline plan for the dissertation.
2. Candidate knowledge. The candidate draws two questions from general physics and one question from one specialised discipline of their choice..

Examination subjects

Classical Mechanics

1. The Kinetic of Material Point
2. Newton's Principles. Force, Work, Power
3. Potential Energy and Conservation of Energy
4. Many Body Dynamics. Conservation of Momentum
5. Many Body Dynamics. Conservation of Angular Momentum
6. Dynamics of Rigid Body
7. Harmonic Vibrations
8. Mechanical Waves
9. Special Relativity

Thermodynamics

1. Statics and Dynamics of Fluids
2. The Kinetic Theory of Gases
3. Temperature. Heat. First Law of Thermodynamics
4. Entropy. Second Law of Thermodynamics

Electricity and Magnetism

1. Electric Field and Potential
2. Gauss' Law
3. Magnetic Field. Lorentz Force
4. Ampere's Law
5. Induction and Inductance. Faraday's Law
6. Maxwell's Equations. Waves Equation
7. Electromagnetic vibrations
8. Electromagnetic Waves
9. Images. Nature of Light. Reflection and refraction.
10. Interference and Diffraction

References:

1. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics Wiley, 2010
2. R. P. Feynman, R. B. Leighton, M. Sands, Feynman Lectures on Physics, Addison-Wesley, 1964
3. A. K. Wróblewski, J. A. Zakrzewski, Wstęp do fizyki PWN, Warszawa 1989
4. I. W. Sawieliew, Wykłady z fizyki, PWN, Warszawa 2000

Specialist Discipline

Quantum mechanics

1. Observables and states in quantum mechanics. Superposition principle. Uncertainty principle.

2. Probability and projective measurement.

3. Position and momentum space in quantum mechanics.

4. Quantum dynamics: Schrödinger equation. State evolution for time-independent Hamiltonians.

5. Harmonic oscillator. Creation and annihilation operators.

6. Schrödinger, Heisenberg, and interaction pictures.

7. Heisenberg equation and perturbation theory.

8. Angular momentum and spin. Addition of angular momentum.

9. Hydrogen atom. Potential of the hydrogen atom in spherical coordinates.

10. Identical particles: fermions and bosons. Commutation relations and state symmetry

References:

1. R. L. Liboff, Introduction to quantum mechanics, Springer, 2010

2. R. Shankar, Quantum mechanics, Springer, 2004

3. J. J. Sakurai, Modern quantum mechanics, Cambridge University Press, 2018

4. G. Auletta, M. Fortunato, G. Parisi, Quantum mechanics, Cambridge University Press, 2012

Specialist Discipline

Statistical Physics

1. Equilibrium, temperature and entropy in thermodynamics and statistical physics
2. Continuous and discrete probability distributions; expected values and their role in statistical physics
3. The concept of a statistical ensemble: microcanonical, canonical and grand canonical ensemble.
4. Derivation of the probability distribution in the canonical ensemble
5. Relations between statistical physics and thermodynamics within the canonical and microcanonical ensembles.
6. Systems of non-interacting particles: ideal gas, "spins" in a magnetic field
7. The Fermi-Dirac and the Bose-Einstein distributions, and the classical limit
8. The Ising model
9. Classification of phase transitions
10. Monte Carlo Simulations in statistical physics (the law of large numbers, detailed balance condition, Metropolis algorithm)

References:

1. F. Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press Inc., 2009
2. D. Chandler, Introduction to modern statistical mechanics, Oxford University Press, Oxford, 1987
3. M. Plischke and B. Bergersen, Equilibrium Statistical Physics, World Scientific, 2006
4. H. Gould and J. Tobochnik, Statistical and Thermal Physics, Princeton University Press, 2010

Specialist Discipline

Optics - Optical and photonic engineering

1. Resolution of optical systems
2. Optical filtration and its applications
3. Light interference, time and space coherence, application of interference in metrology
4. Light diffraction, scalar theory and applications in optics
5. The principle of laser operation, types of lasers, properties of laser radiation
6. Polarization of light, its representation and applications
7. Spontaneous and forced birefringence
8. Ray aberrations and wave aberrations
9. Light propagation in optical fibers, types of optical fibers
10. Nonlinear phenomena in optics

References

1. E. Hecht. Optics, Addison-Wesley, 2002
2. Optics 2f2. From Fourier to Fresnel, C. Adams, I. Hughes, Oxford University Press, 2019
3. Brooker, G. Modern Classical Optics Oxford University Press, Oxford, 2003
4. J. Goodman, Introduction to Fourier Optics, Roberts & Company Publisher, 2005

Specialist Discipline

Optics - Optometry

1. Resolution of optical systems
2. Optical filtration and its applications
3. Light interference, time and space coherence, application of interference in metrology
4. Light diffraction, scalar theory and applications in optics
5. The principle of laser operation, types of lasers, properties of laser radiation
6. Polarization of light, its representation and applications
7. Optical properties of materials: refractive index, dispersion, birefringence
8. Aberrations of the optical system of the eye, measurement methods
9. OCT principle of operation and its applications in eye diagnosis
10. Optical models of the eye

References:

1. E. Hecht. Optics, Addison-Wesley, 2002
2. J. Goodman, Introduction to Fourier Optics, Roberts & Company Publisher, 2005

Specialist Discipline

Solid State Physics

1. Electronic Band Structures. Calculations Methods
2. Density of States. Concentrations of Electrons and Holes in Solid States
3. Acoustic and Optical. Debye's Theory of Heat
4. Boltzmann Equation for Solid States. Relaxation Time. Complex Conductance and Refractive Index. Absorption Coefficient. Plasma oscillations
5. Landau Levels. Cyclotron Resonance. Quantum Hall Effect
6. Optical Transitions. Selection Rules
7. Low Dimensional Structures. Density of States. Selection Rules fo Inter- and Intra-Band Optical Transitions
8. p-n junction
9. Photovoltaic effect
10. Semiconductor devices – LED, Photodiode, Solar Cell, Tranzystor, Semiconductor Laser

References

1. H. Ibach, H. Luth, Solid State Physics, H. Ibach, H. Luth, Springer-Verlag, Berlin, 1992
2. W. Ashcroft , N. D. Mermin, Solid State Physics, N. W. Ashcroft , N. D. Mermin, Cornell University 1968
3. P. Y. Yu, M.Cardona, Fundamentals of Semiconductors, Springer-Verlag, Berlin, 1996
4. Donald A. Neamen, Semiconductor Physics and Devices, Basic Principles, ed. Mc Grow- Hill 2012
5. S. M. Sze, Physics of Semiconductor Devices, J.Wiley and Sons, NY, 1981,