PROGRAM OF THE ENTRANCE TEST FOR THE SPECIALTY IN THE GROUP OF SCIENTIFIC SPECIALTIES 2.2 ELECTRONICS, PHOTONICS, INSTRUMENT ENGINEERING AND COMMUNICATIONS

At the entrance test, questions will be asked on the final qualificationwork and questions from the section corresponding to the direction of future research activities of the applicant. Graduation questions qualification work (master 's degree or specialty):
1. Main provisions.
2. Novelty.
3. Relevance.

1. Quantum Mechanics

1.1. Basic principles of quantum mechanics. The uncertainty principle. The superposition principle. Operators. Discrete and continuous spectra. The Hamiltonian. Stationary states. The Heisenberg representation.Uncertainty relations.
1.2. The Schrodinger equation. Basic properties of the Schrodinger equation. One-dimensionalmovement. One-dimensional oscillator. Flow density. Quasi-classical the wave function. Passing through the barrier.
1.3. The moment of the amount of movement. Eigenfunctions and eigenvalues момента of the angular momentum. Parity. Adding up moments. Decomposition Clebsha-Gordana.
1.4. Traffic in the central field. Spherical waves. Plane wave decomposition.The radial уравнение Schrodinger equation. A hydrogen atom.
1.5. Perturbation theory. Perturbations that do not depend on time. Periodic disturbances. Semiclassical perturbation theory.
1.6. Spin. The spin operator. Fine structure of atomic levels.
1.7. Identity of particles. Symmetry in the permutation of particles. Secondary quantization for bosons and fermions. Exchange interaction.
1.8. The atom. The state of the electrons of an atom. Energy levels. A self-consistent field. The Thomas-Fermi equation. Fine structure of volume levels. The periodic table.
1.9. Motion in a magnetic field. The Schrodinger equation for motion in a magneticfield. Flux density in a magnetic field.
1.10. Particle collisions. General theory. Bohr's formula. Resonant scattering. Collision of identical particles. Elastic scattering in the presence of inelastic processes. The scattering matrix. The Breit—Wigner formula.

2. Quantum entanglement

2.1. Pure and mixed quantum entangled states. Schmidt decomposition and purification of the state. State EPR, Einstein locality, and hidden variables. Bell's inequality. GC states. Quantum systems pseudo -telepathic games.
2.2. Quantum communication protocols. Quantum teleportation protocol.Super-dense encoding protocol.
2.3. Measures of quantum entanglement. Consistency. Witnesses of entanglement. Partial footprint. Negativity. Entanglement of formation and distillation.

3. Fundamentals обработки of quantum information processing

3.1. Positive operator-valued measures. Symmetric positive operator-valued measures. Information -complete positive operator-valued measures.
3.2. Quite positive mappings that preserve the trace. Expansionof

Steinspring. Kraus representation. Open quantum systems
3.3. Quantum entropy and information quantities. Von Neumann entropy,quantum conditional entropy. Relative entropy. Quantum mutual information. Monotonicity of relative entropy. The quantum H-theorem. Compression of quantum information. Кодирование Schumacher coding.
3.4. Classical bandwidth of a quantum communication channel. Kholevo border.Transfer of classical information с using the concatenated state.
3.5. Quantum tomography. Quantum tomography protocols. Informationally complete observables. The maximum likelihood method. Bayesian methodsof quantum tomography. Tomography of quantum processes. Tomography of measurements.

4. Quantum Cryptography
4.1. Basic protocols of quantum cryptography. Information and theoreticalstability. One-time notepad protocol.
4.2. Proof of the secrecy протокола of the quantum cryptography protocol. The quantum copying prohibition theorem. Effects of finite length. Entropy parameters uncertainty relations. Secret classical bandwidthand coherent information.
4.3. Experimental implementation of quantum cryptography protocols. Coherent radiation. Noise model. Real single-photon detectors.The method of deceptive states. Attack with a beam splitter.
4.4. Classical post-processing in quantum cryptography. Correction of errors. Evaluation of the error level. Increased security. Information -theoretically-strong authentication.

5. Quantum computing
5.1. Quantum systems valves. Universal set quantum systems valves. The theorem Nightingale- Kitaeva street.
5.2. Reversible quantum systems calculations. Quantum the oracle. Class BQP.
5.3. Algorithm Deutsch-Joji. Algorithm Bernstein-Vizirani. Algorithm Simon. Algorithm Shora.
5.4. Algorithm Grover. Generalization on algorithm amplifications amplitudes. Algorit hm evaluations amplitudes.
5.5. Quantum systems codes, corrective actions mistakes.
5.6. Adiabatic quantum systems calculations. Variations quantum systems calculations.

6. Fundamentals of physical optics
6.1. Equations Maxwell. Material resources equations. Wave field the equation. Approximation flat areas Waves. Phase speed of light.
6.2. Effect The Doppler for audio files and light sources Waves.
6.3. Approximations geometric form opticians. The equation akonal. Main features beams, laws of reflection and refraction
6.4. Interference Sveta. Dual-beam interferometers. Multipath interference. Interferometer Fabry-Perot.
6.5. Coherence light sources fields. Temporary version and spatial information coherence. The theorem Van Zitterta – Zernike.
6.6. Diffraction Sveta. Scalar theory diffraction patterns. Diffraction gratings
6.7. Optical devices the waves in anisotropic the environment. Birefringence and optical activity.

6.8. Single-axis systems and biaxial structures crystals.

7. Fundamentals of oscillation theory
7.1. Main postulate classic mechanics. Function The Lagrange equation. Equations The Lagrange equation. Generalized values coordinates.
7.2. Kinetic energy and potential energy sources, forces resistances, dissipative energy function Rayleigh. Conditions applicability criteria linear theories fluctuations.
7.3. Forced ones fluctuations, methods their analysis. Development fluctuations. Resonance.
7.4. Non-linear ones the system. Anharmonicity fluctuations. Features resonances.
7.5. Self-oscillations, classification generators. Method slowly changing ones amplitudes and phases. Condition occurrences and process generation development the laser.

8. Physical basis of lasers
8.1. Gaussian values bundles and their parameters.
8.2. Mods open the resonator with spherical mirrors.
8.3. Losses in the resonator. Unstable ones resonators.
8.4. Spontaneous ones and forced ones click-throughs in quantum systems systems. Expansion
8.5. spectral lines. The effect of gain saturation for homogeneous and inhomogeneous line broadening.
8.6. Modulation Q-factor values. Methods modulations Q-factor values.
8.7. Synchronization Maud. Principle. Synchronization Maud in lasers with homogeneous and heterogeneous expanded ones click-throughs. Methods synchronization Maud.

9. Lasers
9.1. Quantum the generator. Conditions excitements. Frequency generation options. Spectral information width generation lines.
9.2. Solid-state devices lasers on the monk of chrome. Injection systems lasers on based on semiconductors and heterostructures.
9.3. Principle works gas stations lasers. Methods pumping stations gas stations lasers. Main features of the gas active medium. Gas-dynamic, chemical, optical excitement.
9.4. Lasers on inert materials gases. He-Ne the laser. Mechanism excitations and educational institutions inversions.
9.5. Lasers with non-linear absorbing by cell internal and external. Stabilization frequencies radiation sources using absorbing cells.
9.6. Molecular components gas stations lasers

Literature:

1. M. A. Nielsen, And. Chang. Quantum systems calculations and quantum information. World2006.
2. A. S. Kholevo. Quantum systems the system, channels, information. ICNMO 2010.
3. J. Preskill. Quantum information and quantum systems calculations. Tom 1-2. —Izhevsk: RHD, 2008-2011. — 464+312 with.
4. F. Rila. Standards frequencies. Principles and applications / Per. with eng . —M.:FIZMATLIT, 2009. - 512 with

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6. About. Zvelto. Principles lasers, M., 2008.
7. B. Saleh, M. Teikh. Optics and photonics, Principles and applications, t 1, 2. – M, Intelligence,2012.

Additional literature:

1. P. A. M. Dirac, Principles quantum mechanics. The science, 1970.
2. A. Kitaev, A. Shen, M. Vyalyy, Classical and quantum computing. ICNMO1999.
3. J. background Neumann, Math problems the basics quantum mechanics. The science 1964.
4. L. D. Faddeev, O. Ya. Yakubovsky. Lectures by quantum mechanics for students-mathematicians. RHD 2001.
5. R. Feynman, R. Leyton, M. Sands. Feynman models lectures by physics. Quantummechanics. Mir Publ., 1986.
6. To. Helstrom. Quantum theory verifications hypotheses and ratings. World 1979.
7. Yariv But. Quantum electronics and non-linear optics. M., Owls. radio, 1980.