

Tematické okruhy otázek pro volitelný předmět 2a
Laser Physics and Technology

Obsah tohoto předmětu státních závěrečných zkoušek je dán povinnými předměty studijního programu:

12FLA Laser Physics, 12ORE Open Resonators, 12UKP Ultra-short Pulse Generation, 12PDBL Solid-state, Diode and Dye Lasers

1. Physical model of a laser, damped quantum system, semi-classical theory of interaction of the resonant radiation with the environment, dispersion properties of two-level resonant environment, coherent and incoherent propagation of pulse through resonant environment.
2. Semi-classical description of a laser, short-resonator laser rate equation, laser threshold condition, methods of generation of giant laser pulses - active and passive Q-switching and Q-switches, gain switching, amplified spontaneous emission.
3. Fully quantum description of a laser, quasidistribution function and Fokker-Planck equation, laser in the Van der Pol oscillator approximation.
4. Transfer matrix formalism and its applications, ABCD formalism, Gaussian beam, its description and propagation, BPP parameter, M2 parameter, beam quality and its measurement, fundamental and higher modes of a stable resonator, mode volume, longitudinal modes.
5. Resonator stability and its possible definitions, Fabry-Perot resonator and its characteristics, resonators at the stability limit, unstable resonators, equivalent resonators and diffraction losses.
6. Characteristics of ultrashort pulses, time and frequency domain description and their mutual relation, dispersion phenomena and influence on the propagation of ultrashort pulses, methods for measuring the characteristics of ultrashort pulses and their limitations.
7. Possibilities of generation of ultrashort pulses, active and passive mode locking, possibility of amplification of ultrashort pulses, time expansion and compression, applications of ultrashort pulses.
8. Solid-state lasers, activators of solid-state lasers, transition metal ions, lanthanides, actinides, matrices of solid-state lasers - ordered and disordered structure, main characteristics of lasers - Ti:sapphire, alexandrite, Nd:YAP, Nd:YAP, lasers with Tm, Ho, Er ions.
9. Dye lasers - active media - properties, oscillators (special types - dispersion configuration, fs pulsed dye lasers, discharge pumped dye lasers - configurations), amplifiers, efficiency.
10. Semiconductor lasers, high-power diode lasers, lasers for solid state laser excitation, VCSEL and VECSEL semiconductor lasers.
11. Generation of radiation at new wavelengths using nonlinear phenomena, parametric processes and their description, optical parametric generators and oscillators, generation of new frequencies using SHG, SFG, DFG, suitable nonlinear materials, stimulated Raman scattering - basic characteristics, modes of generation, suitable media, characteristic parameters, threshold definition, experimental setups, up-conversion processes (ESA, ETU, PA, examples).