Syllabus

Week	Topic
1	Introduction to electrodynamics: Maxwell equations, vector and scalar potentials, presentation of the electromagnetic field as a superposition of the plane waves, electromagnetic field energy.
2	Canonical variables, electromagnetic field as a superposition of harmonic oscillators, quantization of the field, photons. Thermal (black) radiation, Plank equation, Einstein theory of spontaneous and stimulated emission.
3	Quantum theory of spontaneous and stimulated emission. Perturbation theory for probabilities of transitions. Electro-dipole transitions.
4	Spontaneous emission, expression for the spontaneous emission probability. Oscillator strength. Introduction to line broadening. Natural broadening.
5	Pressure (collisional) broadening for the quasi-static and impact approximations. Doppler broadening.
6	Voigt function. Radiation transfer. Beer-Lambert law and expression for the absorption coefficient. Optically thick and thin layers. Self-reversal of the line.
7	Rate equations. Three and four level systems. Conditions for population inversion in both systems.
8	Gain saturation for the cases of Doppler and Lorentz broadening. Hole burning. Absorption spectroscopy in gases.
9	Laser amplification. Amplifier as a filter: narrowing of the line in the amplifier. Amplification of the strong signal: homogeneous and inhomogeneous broadening.
10	Laser oscillation. Self-excitation condition. Single and multimode oscillation for homogeneous and inhomogeneous saturation, respectively. Optical resonator modes, width of the mode, Q-factor.
11	Power extraction in the case of homogeneous broadening. Small outcoupling and constant intraresonator intensity approximation. Optimal mirror transmission and optimal power.
12	Rigrod model for the laser power in the case of the arbitrary outcoupling. Q-switching.