OPTICS

Foundations of Optics:
Maxwell's equations, wave equations,
Fermat principle, Huygens principle
Concept of phase and group velocity

Classical Electron Oscillator including Drude model, plasma frequency, *etc.*).
Dispersion of the index of refraction
Reflection and transmission

PARAXIAL OPTICS
Simple lenses, doublets, lens formulae,
magnification (longitudinal and transverse)
Ray tracing, Matrix method
Coatings, Matrix methods for multilayer coatings,
Antireflection coating, reflective coating

Spherical Aberration, chromatic aberration.
Microscope, Telescope

Polarization, Jones Matrices
Polarizers, Wave plates, quarter, half, Faraday rotators

Basic knowledge of fiber optics

DIFFRACTION Huygens diffraction integral

Fresnel diffraction
Fraunhofer diffraction
Fourier transforms and their properties, convolutions, correlations

Applications of the above (for instance, diffraction from slits, grating, apertures, measurement of coherence)

Basic imaging and filtering

Basic knowledge of holography

Basic knowledge of spectrometer

INTERFEROMETERS
Fabry-Perot, Gires Tournois, ring resonator, Mach Zehnder, Michelson

LASER PHYSICS

Classical oscillator model including Drude model, plasma frequency, *etc.*).

Einstein Coefficients

Rate equations

Line broadening, homogeneous, inhomogeneous

Small signal gain, depletion of gain, beam propagation through saturable media

Gaussian beam propagation

Matrix method (same as in Optics) applied to cavities, and Gaussian beam propagations

Complex beam parameter q, and application to the calculation of the propagation of a Gaussian beam

Resonators: stability, modes, mode matching

Simple laser model, threshold, output power, laser parameters as they refer to Fabry-Perot parameters [free spectral range (FSR), quality factor (Q)]
Laser linewidth limitations

Pulsed operation of lasers (such as modelocking, Q-switching, gain switching, *etc.*)

-Basic knowledge of the operation of common specific laser systems (solid-state, gaseous and diode lasers)

ELECTROMAGNETISM

Basics of EM:
Maxwell's equations, wave equations,
Electric and magnetic susceptibility
Conductivity
Complex dielectric constant
Dispersion in dielectric, conductive and dissipative media
Kramers Krönig relations
Time varying fields
Vector and scalar potentials
Poynting vector

Solutions to the wave equation
Cartesian, cylindrical and spherical coordinates

Plane waves and propagation in homogeneous media
Polarization
Reflection and refraction

Waveguides and resonators
Electromagnetic fields and attenuation in conductors
Slab waveguides, cylindrical waveguides (metallic, dielectric, TE/TM modes)

Radiating systems, scattering, diffraction
Electric dipoles, quadrupoles, magnetic dipoles and their radiation
Cylindrical wave function expansion of plane waves and Hankel function
Scalar diffraction theory