Advanced Optical Physics

Lecturers
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Course aims
To introduce the physics behind guided wave optics devices and ultra-fast lasers.
Students having completed this course will be able to understand and model the spatial and temporal characteristics of linear photonic devices (eg for telecommunication, computer connectics, biophotonics or astronomy), and understand the physics of ultrafast laser pulse generation and detection. Much of the physics and methods learned in this course can be applied to waves other than light, and examples outside of optics will also be used. The course also briefly introduces nonlinear pulse propagation.

Outline
1. Light, Information, Energy Concentration and Photonics. (1 lecture)
2. Waveguide theory: guiding waves, modeling waveguides, modal theory, cutoffs and number of modes. Slab waveguides, optical fibres. (5 lectures)
3. Linear pulse propagation: envelope approximations, phase and group velocity, dispersion, chirp, pulse widening and pulse distortion, effects of nonlinearity, fast light and slow light. (4 lectures)
4. Coupled mode theory: modes as an orthonormal basis, waveguide perturbations, single mode interactions; coupled mode equations, copropagating two-mode interactions, directional coupler, supermodes; counter-propagating two-mode interactions, fibre gratings (5 lectures)
5. Ultrafast lasers: Lasers 101; homogeneous and inhomogeneous broadening, Q switching, cavity dumping, gain modulation; active and passive mode locking; characterizing pulses: streak cameras, optical sampling, autocorrelators, FROG and other techniques. (4 lectures)
6. Photonic devices and systems. (1 lecture)

Assessment
Exam: 60%
Assignments: 40%

1 Reference books
There is no set textbook for this course. Useful references are: