Numerical Methods and Simulation in Photonics

Review of Electromagnetic Theory and Maxwell's Equations

- Integral Maxwell's equations
- Time–domain differential Maxwell's Equations and the Wave equation
- Time harmonic Maxwell's equation and Helmholtz Equations

Optical Waveguides

- Slab waveguides
- Multi-layer slab waveguides
- Numerical computations of the modes and field distribution
- Channel Waveguide and the effective index technique

Periodic Structures

- One and two-dimensional grating structures
- Modal Approach
- Rigorous Coupled-Wave Analysis (RCWA)
- Eigenmode formulation
- S-matrix approach in layered periodic structures
- Diffraction efficiency and field distribution within the structure
- Guide-mode resonant (GMR) devices

The RCWA in Integrated Optics

- The modal approach and effective medium theory
- Guide-mode resonant (GMR) devices
- Artificial periodic structures
- Perfect matching layers and absorbing boundaries
- Application to integrated waveguide output grating coupler

Finite Difference Analysis

- Finite difference approximations
- Taylor expansions for deriving math operators
- Absorbing boundary conditions, perfectly matched layers
- Eigenmode formulation
- Scattering matrices for discontinuities

Beam Propagation Methods

- FFT Beam Propagation Method (FFT-BPM)
- Finite Difference Beam Propagation Method (FD-BPM)
- TE and TM Formulations – equidistant discretization – mtability condition
- Transparent boundary condition

Finite-Difference Time-Domain Method:

- Discretization of the electromagnetic fields
- Yee grid
- Absorbing boundary condition
- Stability conditions, rate of conference, resolution, numerical artifacts