Optical Communications [Level 4 Half- Course]

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Have you ever wondered why optical fibres are the technology that underpins the internet? This course aims to answer this question by looking at the concepts and physics behind data communication and in particular the technologies used for communicating with light! And of course, the developments in optical fibres that won Charles Kao, an Imperial alumnus, the 2009 Nobel Prize for Physics.

Pre-requisites:
There are no strict pre-requisites for this course, other than the material which is in the core courses. Courses such as Light and Matter, Solid States Physics, Electrodynamics/Optics (refraction and reflection of light etc.) form the basis of the physics underlying the technology used in optical communications systems.

Objectives:

1. Explain the operation principles and technology of optical fibre networks
2. Explain the factors that limit light transmission and the information it carries over optical fibres and the methods commonly used to mitigate them.
3. Explain the operation of semiconductor light sources and detectors used in optical data communications systems.
4. Explain the implementation of optical fibre communications systems and the factors that affect wavelengths of operation, information capacity and likely future developments.
5. Describe the factors that limit bit-rates in optical fibre communications

Physics Content

- Ray picture of light propagation in optical fibres: Fresnel’s Equations / Total Internal Reflection
- Guided mode solutions of cylinder from Maxwell’s equation: optical fibre modes
- Light propagation in optical fibres: dispersion, attenuation
- Fibre Amplifiers (Erbium doped and Raman)
- Dispersion compensation in optical fibres
- Revision of semiconductor physics
- Revision of light emission from semiconductor materials (LEDs)
- Principles of laser action and introduction to semiconductor lasers
- Laser modulation (direct and indirect): Laser ringing & chirp, Electro-Absorption (Franz-Keldysh, Quantum Confined Stark Effects, Electro-Refraction and Mach Zehnder Interferometers)
- Photodiodes: efficiency, speed & noise
- Noise in optical communications systems, bit error rates and eye diagrams
- Data encoding strategies to maximize data capacity over optical links