**Assigment 1**: Due date Tuesday, 18 March 2014 at 14.30, 1 group 2 students

Solve the following problems and write down the answer using your handwriting.

1. Describe with the aid of simple ray diagrams:
   1. Multimode step index fiber
   2. Single mode step index fiber

Compare the advantages and disadvantages of these two types of fiber for use as an optical channel

1. A graded index fiber with the core axis refractive index of 1.5 has a characteristic index profile (α) of 1.90, a relative refractive index difference of 1.3% and a core diameter of 40 µm. Estimate the number of guided modes propagating in the fiber when the transmitted light has a wavelength of 1.55 µm, and determine the cut off value of the normalized frequency for single mode transmission in the fiber.
2. A single mode step index fiber which is designed for operation at a wavelength of 1.3 µm has core and cladding refractive indices of 1.447 and 1.442 respectively. When the core diameter is 7.2 µm, confirm that the fiber will permit single mode transmision and estimate the range of wavelengths over which this will occur.
3. Skew rays are accepted into a large core diameter (compare to the wavelength of the transmitted light) step index fiber in air at maximum axial angle of 42o. Within the fiber, they change direction of 90o at each reflection. Determine the acceptance angle for the meridional rays for the fiber in the air

Note:

* Skew rays = the rays trajectory that never cross the axis of optical fiber core.
* Meridional rays = the rays trajectory that always cross the axis of the optical fiber core

1. The mean optical power launched into an optical fiber link is 1.5 mW and the fiber has an attenuation of 0.5 dBkm-1. Determine the maximum possible link length without repeaters (assuming lossless connectors) when the minimum optical power level required at the detector is 2 µW.
2. An 15 km optical fiber link uses fiber with a loss of 1.5 dBkm-1. The fiber is jointed every kilometer with connectors which give an attenuation of 0.8 dB each. Determine the minimum mean optical power which must be launched into the fiber in order to maintain a mean optical power level of 0.3 µW at the detector.
3. A single-mode fiber has an index step n1−n2 = 0.005. Calculate the core radius if the fiber has a cutoff wavelength of 1 μm. Estimate the spot size (FWHM) of the fiber mode and the fraction of the mode power inside the core when this fiberis used at 1.3 μm. Use n1 = 1.45.
4. Assume that a digital communication system can be operated at a bit rate of up to 1% of the carrier frequency. How many audio channels at 64 kb/s can be transmitted over a microwave carrier at 5 GHz and an optical carrier at 1.55 μm?

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