PHYS3720 OPTOELECTRONICS
MIDSESSION TEST 2016

QUESTION 1. (20 marks)

Light from the end of an optical fibre creates an illuminated spot of 10 cm diameter when projected onto a screen placed at a distance of 30 cm from the fibre tip. The wavelength of the light is 1300 nm and the refractive index of the core is 1.48.

i. Calculate the total number of supported propagating modes of the fibre if it has a diameter of 40μm.
ii. Calculate the modal dispersion for this fibre expressed in ns/km.
iii. Determine the diameter of the fibre required for single mode operation at 1300nm.
iv. The mode field diameter (MFD) is defined as the distance between the two points where the field amplitude reduces to a factor of e^{-1} of the field at the core / cladding interface. Calculate the MFD for a mode propagating approximately parallel to the axis of the fibre with core diameter equal to the value specified in part iii.
v. What physical parameters of the fibre could be adjusted to increase the modal confinement, which is given by the ratio of the core diameter to the MFD?

QUESTION 2. (16 marks)

a. Explain why the transmission rates in optical communications depend on the spectral properties of the emitter.
b. Discuss strategies that can be used to compensate for different types of dispersion and thereby improve transmission rates in optical fibre networks.
c. Calculate the material dispersion coefficient in $ps.nm^{-1}.km^{-1}$ at 1500nm for a particular fibre where the effective refractive index, $n(\lambda)$, of the glass is given by $n^2 - 1 = b + a\lambda^2$, where b=0.36 and a=0.04μm^{-2}.
d. Calculate the maximum transmission rate for the fibre in part 2c if the length is 500m and the spectral line width is 0.2nm.

QUESTION 3. (8 marks)

a. A Mach-Zender interferometer is used to monitor the intensity of a laser beam propagating along a fibre. This is achieved by having a small section of fibre with an intensity dependent refractive index in the sensing arm given by, $n = n_o + n_1 I$. Derive an expression for the phase shift as a function of Intensity.
b. Calculate the incident intensity required to reduce the output intensity by half if n_0 = 1.45, n_1 = 0.05W^{-1}, the length of the sensor arm is 10cm and the incident wavelength is 500nm.