MAJOR TEST , PHL-891, May 2, 2008
(Guided Wave optical Components and Devices)

Max. Marks: 84

Note: Attempt any 7 questions **Time : 2 hour**

1) Consider a SMS structure consisting of a graded index MMF of length L. The propagation constants of various LP_{lm} modes of the fiber are given by

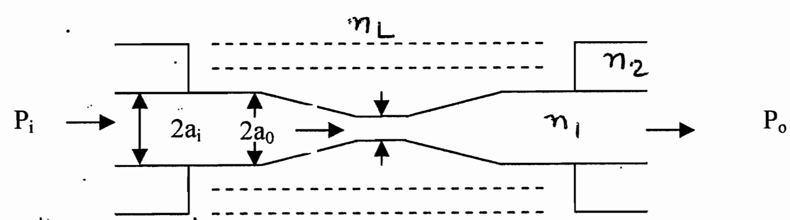
$$\beta_{lm} = k_0 n_0 - (2m+l-1)\frac{\sqrt{2\Delta}}{a} - (2m+l-1)^2 \frac{\Delta}{a^2 k_0 n_0}, \quad l=0,1,2,\ldots \;\&\; m=0,1,2,3\ldots.$$

where various symbols have their usual meanings. Draw schematically the wavelength response of such a structure and obtain the wavelengths at which various peaks/dips (if any) will appear. You may assume that the input and output SMFs are axially aligned with the MMF and that only first two modes of the MMF are coupled with the SMF.

12

2) Consider a multimode bi-conical fiber taper as shown in the figure with tapered portion covered by a liquid of refractive index n_L. Obtain an expression for the output power P_0 as a function of liquid refractive index n_L corresponding to an input power P_i assuming the refractive indices of the core and cladding to be n_1 and n_2 respectively. Draw schematically, the variation of P_0 with n_L^2 and obtain its range of operation if it is used as a temperature sensor.

12



3) Consider a chirped FBG of length L whose spatial frequency along the direction of propagation (z-axis) varies as:

$$K(z) = K_0 + \frac{F}{L^2} z ,$$

where K_0 and F are constants. If the effective index of the fiber mode is given by n_{eff}, obtain the dispersion compensated by the grating when used as a dispersion compensator.

12

4) What is an optical circulator? Explain briefly but clearly, the working principle of a polarizing circulator with strict sense behavior.

12

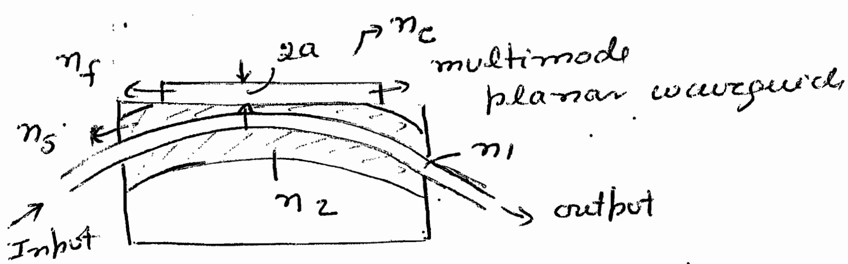
5) One thousand turns of an optical fiber (verdet constant V = 2.65 x 10^{-4} deg/Amp) are wound around a conductor carrying a current of 10 amperes. If an elliptically polarized light with coordinates (0, 2φ) on the Poincare sphere is launched in the fiber, obtain a) the output SOP b) the phase difference introduced between the fast and slow components in the coil. You may neglect the effect of bending induced birefringence. **12**

6) Obtain the Jones vectors of the normalized and orthogonally polarized left and right elliptically SOPs, assuming the coordinates of the left SOP as (2θ, 2φ) on the Poincare Sphere. Using these Jones vectors, derive a 2x2 matrix giving you the above two components of any general SOP from its x and y components.

12

7) A multimode planar waveguide is grown over a side polished fiber as shown in the figure. Draw schematically the wavelength response of the fiber explaining it physically. Obtain an expression for the wavelengths corresponding to various peaks or dips (if any) in the wavelength response in terms of the waveguide parameters and the effective index of the fibre mode.

10



8) A directional coupler is made with two non-identical SM wave-guides such that their propagation difference at wavelength λ is given by:

$$\Delta\beta = \beta_1 - \beta_2 = -\alpha\,(\lambda - \lambda_0),$$

where $\alpha = \pi \times 10^5\ \mathrm{mm}^{-2}$ and $\lambda_0 = 0.6\ \mu\mathrm{m}$. The interaction length between the two wave-guides is 1 mm, which is also equal to the coupling length of the coupler at λ_0. Assuming that the coupling coefficient does not depend on the wavelength, calculate (i) coupling length (ii) powers at the output ports for unit input power coupled in one of the input ports at $\lambda = 0.61\ \mu\mathrm{m}$. **10**