MAJOR TEST , PHL-891, MAY-8, 2007
(Guided Wave optical Components and Devices)

Max. Marks: 100 **Time : 2 hour**

Note: Attempt any 3 questions out of 1-4, any 4 out of 5-9. Last two questions are compulsory

1. A directional coupler is made with two non-identical waveguides such that the difference between the propagation constants of the two waveguides at wavelength λ is:

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

where $\alpha = \pi \times 10^5$ mm^{-2} and $\lambda_0 = 0.6$ μm. The two waveguides interact over a length of 1 mm, which is also equal to the coupling length of the coupler at $\lambda = \lambda_0$. Assuming that the coupling coefficient does not depend on the wavelength, calculate (i) coupling length and (ii) the powers at the output ports when unit power is coupled at one of the input ports at $\lambda = 0.61$ μm. **10**

2. Describe the working principle of a Mach-Zehnder Interferometer based fiber optic wavelength interliver and obtain an expression for the minimum wavelength separation between the wavelengths which can be multiplexed/ demultiplexed by it. **10**

3. Show that a dielectric ($\varepsilon_d = \varepsilon_1$) / metal ($\varepsilon_m = -\varepsilon_r - \varepsilon_i$) interface can support a TM like surface wave. Obtain expressions for the propagation constant and the absorption coefficient of such a wave. **10**

4. Consider a left elliptically polarized light wave oriented at 15^0 with the horizontal and having ellipticity $1/\sqrt{3}$,

(i) Obtain the x, y, z coordinates of the corresponding point on the Poincare sphere, where x, y, z, axes are taken along the lines joining the center to the points representing the linear horizontal, linear $+45^0$, and the left circular SOPs respectively,
(ii) Is it possible to convert the SOP of the given light to left circular with the help of two quarter wave plates only. If yes , how? **5+5**

5. Describe briefly how a bi-conical tapered multimode optical fiber can be used as a refractive index sensor. Derive an expression for its range of operation for a given tapered ratio. **10**

6. Derive an expression for the phase shift developed between clockwise and anti-clockwise signals traveling an a fiber coil of radius R and rotating with an angular velocity Ω **10**

7. Consider a Mach-Zehnder fiber optic interferometer set its quaderature point of operation. If the temperature of10 cm length of the sensing fiber is raised by one degree, calculate the change in intensity from any of the output ports. It is given that the effective index of the fiber mode is 1.45 and values of its thermo-optic and thermal expansion coefficients are 10^{-5} and 5×10^{-7} respectively. **10**

8. What is the basic function of an optical circulator? Describe briefly the working principle of a fiber optic polarization independent circulator. **10**

9. Write five important characteristics of Holey (PCF) fibers giving their physical explanation in 2-3 lines only. **10**

10(a). In a fiber Bragg grating of length 5mm, the peak reflectivity is observed 90% at wavelength 1532 μm. Calculate its period, coupling coefficient, effective index modulation Δn and the corresponding bandwith $\Delta\lambda$. You may assume that the transverse overlap integral $I = 1$ and the effective index of the fiber mode as 1.45. **7**

(b) In a two mode fiber the effective indices of its LP_{01} and LP_{11} modes are 1.45 and 1.445 respectively. If a grating is written on this fiber with a period of 0.52 μm, (i) how many resonant peaks or dips do you expect in its transmission spectrum? (ii) calculate the micro-bend period required to couple energy from one mode to the other at wavelength 1.5 μm. **8**

11. Consider an AWG with identical input and output slab regions with arc length $f = 12$mm, effective index $n_s = 1.476$, center to center input/output waveguide separation as 10 μm. Assuming that the arrayed waveguides have a constant path difference of 62 μm, minimum center to center waveguide separation as 30 μm, effective index and group index of each waveguide at central wavelength 1.55 μm is $n_c = 1.45$ and $N_c = 1.44$ respectively, obtain (i) Diffraction order being used (ii) Channel spacing in terms of wavelength and (iii) Total number of channels possible. **15**