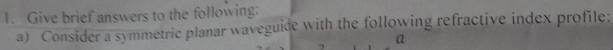
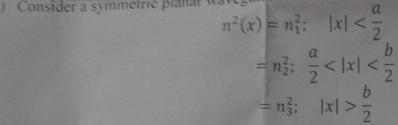


August 29, 2016 Maximum marks: 20

(5)

## ALL QUESTIONS ARE COMPULSORY





with  $n_1 > n_3 > n_2$ . Write down the expression for  $E_y$  of the TE<sub>0</sub> guided mode in all regions. (2)

b) Draw schematic diagrams of the transverse intensity patterns of  $E_{21}^x$  and  $E_{13}^y$  modes of a channel waveguide. (2)

Show that for the  $TE_0$  mode in a planar waveguide with refractive index variation n(x) there is no power flow along the x-direction. (3)

- 2. The fundamental TE mode in a planar step index waveguide operating at 1000 nm with  $n_1 = 1.5$  and  $n_2 = 1.48$  has  $n_{\text{eff}} = 1.49$ .
  - a) Obtain the thickness of the film.
  - b) What is the depth of penetration of the mode in the lower index region?
  - c) If the operating wavelength is increased to 1300 nm, will the effective index of the same mode be lesser than or greater than 1.49? (4)
- 3. Consider a rectangular channel waveguide with  $n_1 = 1.51$  and  $n_2 = 1.50$  with a = 4 µm and b = 8 µm operating at a wavelength of 1µm.
  - a) Write down expressions for the separable refractive index profile which can be used as an approximation to evaluate the propagation characteristics of the given waveguide.
  - b) Write down an expression for the Ey field of the  $E_{12}^y$  mode in the core region of the waveguide ( $|x| < 2 \mu m$ ,  $|y| < 4 \mu m$ ) and in the region  $|x| > 2 \mu m$ ,  $|y| < 4 \mu m$  in terms of  $\beta_x$  and  $\beta_y$ , where symbols have their usual meanings.
- 4. Consider a directional coupler made up of two single mode channel waveguides. Given that the coupling coefficient between the waveguides is  $\pi/2$  cm<sup>-1</sup>,
  - a) What should be the length of the coupler so that entire power transfer can take place between the waveguides if they are identical?
  - b) What is the value of  $\Delta\beta$  (=  $\beta_1 \beta_2$ ) between the two waveguides so that the maximum transfer of power between the two waveguides is 50%?
  - c) What is the corresponding length of the coupler where power launched in waveguide I gets divided equally between the two waveguides?