Mansoura University
Faculty of Engineering
Department of Electronics &Telecomms. Engineering

Optional Module: Photonics II
Final Exam, Jan. 2013
Level 4

ANSWER THE FOLLOWING QUESTIONS MAXIMUM MRAK IS 90 TIME ALLOWED: 3 HOURS

Question One (14 marks)

a) What is meant by the modal orthogonality property? (3 marks)
b) Show that the guided TM modes propagating in a symmetric slab dielectric waveguide are orthogonal. (6 marks)
c) Explain with the aid of diagrams, how a directional coupler-based polarization splitter operates. (5 marks)

Question Two (14 marks)

a) What is meant by solitons in optical fibers? (4 marks)
b) Explain briefly the mechanism of soliton formation in optical fibers (5 marks)
c) Fundamental soliton propagation in optical fibers is described by the nonlinear Schrödinger equation (NLSE):

$$-j\frac{\partial E}{\partial z} = \frac{1}{2}\frac{\partial^2 E}{\partial t^2} + |E|^2 E - j\frac{\alpha}{2}E$$

where E(z,t) is the electric field amplitude, z is the propagation distance along the fiber and α represents energy loss. Show that the following is a solution to the NLSE (taking $\alpha = 0$)

$$E(z,t) = \mathrm{Sech}(t)\, e^{jz/2}$$ (5 marks)

Question Three (14 marks)

a) i. Draw a block diagram of a coherent photoreceiver. (3 marks)
   ii. Explain the advantages of coherent optical communications. (4 marks)
b) An incoming signal toa heterodyne binary PSK receiver operating at 1550 nm and its shot-noise limit is -50 dBm. When the photodiode in the receiver has a responsivity of 0.3 A/W at this wavelength and the received SNR is 60 dB, determine the operating bandwidth of the receiver. Repeat your calculation for a homodyne binary PSK receiver. Comment on the results. (7 marks)

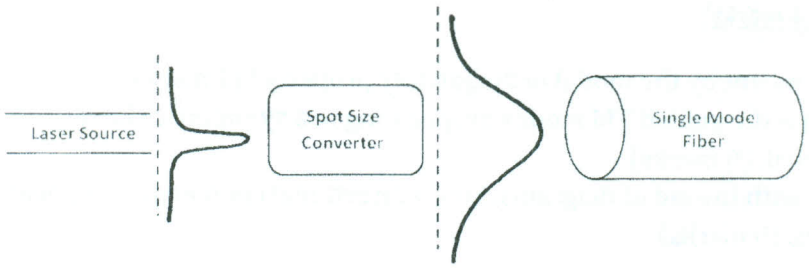
Question Four (14 marks)

a) Explain briefly the fabrication techniques of buried channel waveguide stating their relative advantages and disadvantages. (6 marks)
b) i. What is the main characterizing parameter of phase modulators? (2 marks)
   ii. How can this parameter be improved? (2 marks)
c) Explain briefly two of the applications of optical phase modulators. (4 marks)

Question Five (14 marks)

a) Prove that no mode conversion can occur in a symmetric tapered waveguide. (7 marks)
b) Show, with aid of diagrams, how tapers can be used to design a spot size converters as shown in Fig.1. (7 marks)

Fig. 1



Question Six (20 marks)

a) For the Y-junction shown in Fig. 2.a, and assuming single mode conditions, write down the electric field expression at z=L. (4 marks)
b) Figure 2.b shows two similar Y- junctions connected to each other at z=L, however, with a small misalignment, δ.
   i. Derive an expression for the electric field expression at z=2L. (6 marks)
   ii. Derive an expression for the input-output coupling efficiency in terms of the misalignment, δ. (10 marks)

Fig. 2.a

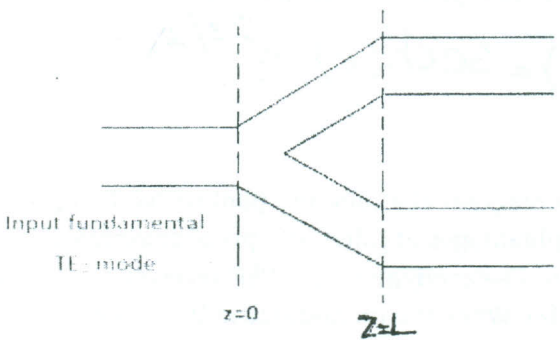
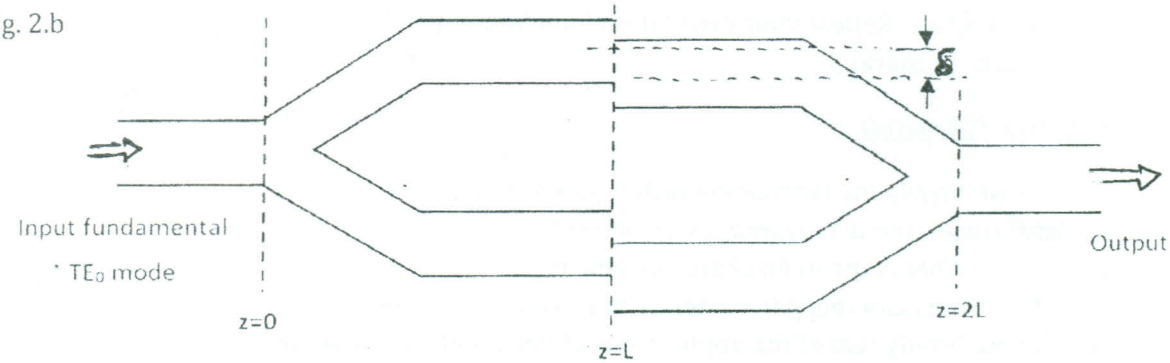


Fig. 2.b



Mansoura University — Fourth Year Electronics
Faculty of Engineering — Jan. 2013
Electronics& Comm. Dept. — Time: 3 hrs

ANN Final Exam [Total : 90 marks]

Attempt All Questions

1-a) Explain neural networks(NNs) are a form of multiprocessor computer system.Why use NNs ? and what are used for ?. How are chosen the activation functions ?
b) Derive expressions for sigmoid and tanh used as activation functions .
c) Define : - Neural Computing and Firing Rule - PCA.
- Artifial neural network properties.

2-a) Describe that feedforward TANs can be implemented for pattern recognition. Compare this model with the perceptron proposed by Rosenblatt..
b) A single neuron net using the perceptron rule has been trained using c= 1 and x_1 and d_1 are :

$$x_1 = \begin{bmatrix} 1 \\ -2 \\ 3 \\ -1 \end{bmatrix}, \; d_1 = -1 \quad , \quad x_2 = \begin{bmatrix} 0 \\ -1 \\ 2 \\ -1 \end{bmatrix}, \; d_2 = 1 \quad , \quad x_3 = \begin{bmatrix} -2 \\ 0 \\ -3 \\ -1 \end{bmatrix}, \; d_3 = -1$$

The final weights obtained are $W^4 = [3\ 2\ 6\ 1]^T$

Determine the following weights: w^3 , w^2 , w^1 by back-tracking the training.

3-a) Design nets of MCP neurons that implement logical NOT,AND,and OR.Draw each net and write its equations. Prove that XOR is so difficult.
b) Perform training steps using delta learning rule with the intial weight $w^1 = [1\ -1\ 0]^T$, $c = 0.25$, $\lambda = 1$ and its inputs are

$$x_1 = \begin{bmatrix} 4 \\ 0 \\ -2 \end{bmatrix}, \; d_1 = -1 \quad , \quad x_2 = \begin{bmatrix} 2 \\ -4 \\ -2 \end{bmatrix}, \; d_2 = 1 \quad , \quad x_3 = \begin{bmatrix} 4 \\ 4 \\ 6 \end{bmatrix} \quad , d_3 = -1$$

4-a) Describe multilayer perceptron(MLP), and explain why it is related to gradient descent. How setup MLP ?
b) Discuss the structure of Hopfield net , its operation and its applications?
c) Explain the radial basis function(RBF), main features and two serious problems. Can the XOR implement linearly separable form using RBF ?

5-a) Describe Backpropagation(BP),and how such algorithm is to be better and how it is able to speed up learning
b) Draw and describe the structure of ALVINN.
c) Explain structure diagram for neuron and activation function implementation using FPGA technology.Which multiplier accumulator (MAC) is better ?