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SB-3521

M. Sc. (Part - II) Examination

March / April – 2011

Electronics : Paper - I

(Quantum Electronics & Optoelectronics)

Time : **3** Hours] [Total Marks : **52**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **M. SC. (PART - 2)**

Name of the Subject :

☛ **ELECTRONICS - 1 (QUANTUM ELECTRONICS & OPTOELECTRONICS)**

☛ Subject Code No. : **3 5 2 1** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Use separate answer books for each section.

(3) Symbols used have their usual meaning.

(4) Figures to the right indicate full marks.

(5) Data : C = 3×10^{8}m/s ; h = 6.62×10^{-34} J-sec. ; k_B = 1.38×10^{-23} J.

SECTION - I

1 (a) What are the properties of a density matrix that is used to represent a quantum state ? **3**

(b) What is meant by line shape function ? **2**

(c) What is meant by relaxation processes and transport equations ? **2**

(d) Calculate the ratio of the number of spontaneous to stimulated emission for an optical source of wavelengths 5000 A° in equilibrium at 1000 K. **3**

2 (a) Discuss the quantum theory of spontaneous and stimulated emission in a system of two level molecules. **5**

(b) Using the matrix representation of energy spin operators $\hat{r}_1, \hat{r}_2$ and $\hat{r}_3$ find the matrix representation of an arbitrary linear Hamiltonian operator $\hat{O}$ that can be written as : **3**

$$\hat{O} = \bar{a}\hat{I} + \bar{b}\hat{r}_1 + \bar{c}\hat{r}_2 + \bar{d}\hat{r}_3 .$$

OR

2 (a) What is meant by pure and mined state of a quantum system? **2**

(b) What is meant by fundamental transverse mode of a laser ? Discuss its advantages. Describe one method to obtain laser in this mode. **3**

(c) consider He-Ne laser as a four level laser system, calculate to the threshold pump power required to start laser assuming the threshold population in version required to be 1.4×10^{9} cm^{-3} and tsp = 10^{-7} sec and $\nu_p = 5 \times 10^{15}$ Hz. **3**

3 (a) Describe the lasing action in a three level laser system and establish the laser rate equations for the above system. **5**

(b) Show that the ultimate linewidth of an oscillating laser is given by : **3**

$$\delta\nu_{sp} = \frac{2\pi\left(\Delta\nu_p\right)^2 h\nu_o}{Pout}$$

OR

3 (a) Discuss various methods for longitudinal mode selection. **4**

(b) Discuss working and various characteristics of a CO_2 laser. What are the applications of this laser. **4**

SECTION - II

4 (a) List advantages of fiber optic communication system. **3**

(b) Discuss various types of intrinsic connection loss in fiber when they are to be interconnected. **2**

(c) Explain how fiber end is prepared. **3**

5 (a) Describe the working of an OTDR and explain how it is used to datermine the attenuation and faults in an optical fiber. **5**

(b) Consider a source at frequency ω_o being sinusoidally modulated at frequency $\Omega << w_o$ with a field **4**

$\psi(t, z=0) = [A + B\cos\Omega t].e^{iw_o t}$.

If such a beam passes through a medium calculate the variation of the field at distance L.

OR

5 (a) Show that the propagation constant for the 9th mode group is given as $\beta_q = \left(\beta^2{}_1 - \pi q^2/4a^2\right)^{1/2}$ where 'a' is the radius of the core. **5**

(b) Calculate the value of $(NA)^2$, the angle α_m and Φ_m and the dispension parameters, $(\Delta T/l)$ and (Bl) for the following step index fiber $n_1 = 1.46$, $n_2 = 1.40$, $n_a = 1$. **4**

Where $\alpha =$ angle of incidence of the incoming ray on to the end face of the fiber.

6 (a) Discuss medical applications of fiber optics. **4**

(b) Describe the scattering and absorption loss measurement techniques. **5**

OR

6 (a) Derive the expression for intermode dispersion for graded index fiber in the presence of material dispersion. **4**

(b) What is pulse broadening ? Why does it occur ? Write down the relation between pulse broadening and length of fiber. Explain optical bandwidth of fiber. **5**
