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RE-3591-92

M. Sc. (Part - II) Examination

April / May – 2010

Electronics : Paper - I

(Quantum Electronics & Optoelectronics)

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

RE-3591

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. - 2

Name of the Subject :

☛ ELECTRONICS - 1

☛ Subject Code No. : 3 5 9 1 ☛ Section No. (1, 2,.....) : 1

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; $K_B = 1.38 \times 10^{-23}$ J.

1 (a) Why stimulated emission is used for laser transitions? - Explain. **2**

(b) Write the expression for intensity of spontaneous emission I_ν^s and stimulated emission I_ν^t. **2**

(c) Discuss fundamental transverse mode of laser. **3**

(d) What is longitudinal mode spacing? Calculate it for a laser resonator with 50 cm between the two mirrors. **3**

2 (a) Find the Hamiltonian of a system of charged particles in an electromagnetic field and also find the interaction energy in the dipole approximation. **5**

(b) Consider a system of two molecules in two energy levels. Initially molecule-1 is in an excited state E_+ and molecule-2 is in the ground state E_. Find the probabilities of various transitions. **3**

OR

2 (a) What are the properties of a density matrix? 2

(b) Define Q-factor of an optical resonator. 1

(c) Why is it much easier to obtain laser action at infrared wavelengths than in the ultraviolet region? - Explain. 2

(d) For Nd : YAG laser; 3

$\eta_0 = 1.82;\ t_{sp} = 0 \cdot 23 \times 10^{-3}$ sec; $\lambda_0 = 1 \cdot 06\,\mu m;$

$\Delta\nu = 1 \cdot 95 \times 10^{11} Hz.$ Calculate the population inversion required for a gain of $1\ m^{-1}$.

3 (a) Discuss the lasing action for a three level and a four level laser system. What are the advantages of a four level system over a three level one? 5

(b) Consider a laser which is oscillating simultaneously at two frequencies ν_1 and ν_2, (with $\nu_2 - \nu_1 \approx c/2d$). If this laser is used in an interference experiment, what is minimum path difference between the interfering beams for which the interference patter disappears? 3

OR

3 (a) What is meant by mode locking in lasers? Show how it effectively produces ultrashort pulses? 4

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

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Name of the Examination :

☛ **M. Sc. - 2**

Name of the Subject :

☛ **ELECTRONICS - 1**

☛ Subject Code No. : **3 5 9 2** ☛ Section No. (1, 2,.....) : **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; $K_B = 1.38 \times 10^{-23}$ J.

4 (a) Define the transfer parameters of PCP. **2**

(b) What is an optron? Describe the advantages and disadvantages of an optron. **3**

(c) Consider a parabolic index waveguide with core and cladding refractive indices are 1.750 and 1.667 respectively. The core diameter is 40 μm. Calculate the numerical aperture at the axis and at a point 20 μm from the axis. **3**

5 (a) Explain in detail the calorimetric technique used for the measurement of scattering and absorption loss in optical fiber. **5**

(b) Fiber 1 and Fiber 2 are described by the following parameters : **4**

Fiber 1, $n_2 = 1.45$, $\Delta = 0.0064$, $a = 3$ μm, $f = 1.94 \times 10^{14}$ Hz

Fiber 2, $n_2 = 1.45$, $\Delta = 0.0100$, $a = 2$ μm, $f = 2.33 \times 10^{14}$ Hz

Calculate the values of β for fiber 1 and fiber 2, where A = 1.1428, B = 0.996.

OR

5 (a) What is weakly guiding fibers? Show that the total number of modes propagating in step index fiber is **5**

$$M = \frac{2\pi}{\lambda^2}(NA)^2 A_c$$

where A_c is the cross section area of the core.

(b) A break occurs during installation of a fiber whose loss is 3 dB/km. The OTDR technique is used to locate the break. The output of the laser source in OTDR is 250 mW and the detected power from the break is 3 μW. Find out the distance of the break from the source : 4

Use R = 0.005 and T = –16 dB.

6 (a) Explain the behaviour of a skey ray with a graded index core in which refractive index has a radial symmetry. Derive the expressions of an axial distance Z_0 and angle ϕ. Comment upon the variations on Z_0 and ϕ. **6**

(b) Describe the applications of optical fibers in medical fields. **3**

OR

6 (a) Derive the expression of number of propagating modes in a graded index fiber. Show that the graded index fiber propagates half number of modes as compared to step index fiber. **5**

(b) (i) Consider a step index fiber for which n_1 = 1.475, n_2 = 1.460 and core diameter is 50 μm, what is the maximum value of ϕ for which the rays will be guided through the fiber? **4**

(ii) Corresponding to maximum value of ϕ, calculate the number of reflections that would take place in traversing two kilometer length of the fiber.