K17P 0398

Reg. No. : ....

Name : ....

Fourth Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, March 2017
(2014 Admission Onwards)
PHYSICS
PHY 4E06 : Optoelectronics

Time : 3 Hours   Max. Marks : 60

SECTION – A

Answer both questions (either **a** or **b**).

1. a) Explain the direct and indirect band gap semiconductors with the help of E-k diagram. Discuss the conductivity of a forward biased pn junction.

   OR

   b) Explain how mode locking is achieved. Deduce the expressions for the separation between pulses Δt_{sep} and pulse width Δt_p for a mode locked laser.

2. a) Deduce the expression for photo conductive gain of a photoconductor in terms of transit times. Explain the noises in pn, pin and avalanche photo diodes.

   OR

   b) What is acousto-optic effect ? Explain the Raman-Nath and Bragg acousto-optic modulators.

                                                                                                           (2×12=24)

SECTION – B

Answer **any four**.

(1 mark for part **a**, 3 marks for part **b**, 5 marks for part **c**)

3. a) What is a double heterojunction LED ?

   b) Show that the recombination life time is inversely proportional to the injected carrier concentration.

   c) A semiconductor is known to have a band gap of 1.25 eV and intrinsic carrier concentration of 1.6×10^{16} m^{-3} at room temperature. If ratio of effective masses of electrons to holes is 4 ($m_e^* : m_p^* = 4 : 1$) and kT = 0.025 eV, estimate effective density of state at conduction band edge N_c and at valence band edge N_v.

                                                                                                           P.T.O.

4. a) What is meant by Q switching ?

   b) Explain the different types of electro-optic shutters.

   c) Calculate the Q switched maximum power output from a ruby laser operating at 694.3 nm if it is pumped to a factor of five times the threshold inversion density with the threshold population $M_t = 4.96 \times 10^{18}$ and decay time $t_c = 15.8$ ns.

5. a) What is a photo diode ?

   b) What is quantum efficiency and responsivity of a photo diode ?

   c) The responsivity of a photo diode at 940 nm is 0.56 AW^{-1}. Calculate the quantum efficiency.

6. a) What is avalanche photo diode ?

   b) Explain impact ionization and avalanche multiplication factor.

   c) A Si avalanche photo diode has a quantum efficiency of 70% at 830 nm in the absence of multiplication. The APD is biased to operate with a multiplication of 100. If the incident optical power is 10 nW, What is the multiplied photo current ?

7. a) What is Pockels effect ?

   b) Explain the working of a quarter wave plate.

   c) Calculate the thickness of a quarter wave plate made of calcite and to be used with sodium light of wave length 589.3 nm. It is given that the principal refractive indices n_o and n_e for calcite are 1.658 and 1.486 respectively.

8. a) What is meant by parametric oscillation ?

   b) Explain the second harmonic generation.

   c) Explain the sum and difference frequency generation. $(4 \times 9 = 36)$

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