P438

Name:.....Reg. No.....

MSc DEGREE END SEMESTER EXAMINATION MARCH 2016

SEMESTER – **4: PHYSICS**

COURSE: **P4PHYT16EL - OPTOELECTRONICS**

Time: Three Hours Max. Marks: 75

PART A

(Objective Type, Answer **all** questions. Each question carries 1 mark)

1. In a degenerate n-type semiconductor, Fermi energy is located
   (a). Midpoint of band gap (b) very close to the bottom of conduction band and inside the band gap (c) very close to the top of valance band and inside the band gap (d) inside the conduction band.
2. Band gap energy of LED material is E_g. What is the energy of the emitted photon with relative high intensity.
   (a) E_g (b) $E_g/2$ (c) E_g-k_BT (d) E_g+k_BT.
3. How does series resistance of the solar cell affect its fill factor.
   (a) does not affect (b) increase (c) decrease (d) depends on biasing voltage.
4. Conditions to get ultra short high intense laser pulses in mode-locking
   (a) large number of modes, short cavity length (b) large number of modes, large cavity length (c) short number of modes, short cavity length (d) short number of modes, large cavity length.
5. Small reverse voltage across pin photodiode ensures
   (a) a small depletion layer (b) large depletion layer (c) depletion layer over entire region of i- layer (d) depletion region in n layer.

(1 x 5 =5)

PART B

(Answer **any five** question, each question carries 2 mark)

6. Distinguish between direct and indirect bandgap semiconductors.
7. Briefly explain the laser diode characteristics.
8. What are the advantages of a PIN photodiode over a conventional pn junction photodiode?
9. What do you mean by self-focusing?
10. What is meant by Pockels electro-optic effect?
11. Explain the bending losses in optical fiber.
12. Show that responsivity of a photodiode depends on wavelength.
13. Write a short note on two photon absorption.

(2x 5 = 10)

Part C

(Answer **any three** questions, each question carries 4 marks)

14. Atypical single mode optical fiber has a core of diameter 8μm and refractive index of 1.46. The normalized index difference is 0.3%. The cladding diameter is 125μm. Calculate the numerical aperture and acceptance angle of the fiber.
15. What is the conductivity of an n-type Si crystal that has been doped uniformly with 10^{16} cm^{-3} phosphorous atoms if the drift mobility of electrons is about 1350 cm^2 V^{-1} s^{-1}?.
16. Given that refractive index n of GaAs has a temperature dependence $dn/dT = 1.5x10^{-4}K^{-1}$ estimate the change in the emitted wavelength 870nm per degree change in the temperature between mode hops.
17. Calculate the change in refractive index due to longitudinal electro optic effect for a 1cm wide KDP crystal for an applied voltage of 5kV. If the wavelength of light being propagated through the crystal is 550nm, calculate the net phase shift between the two polarization components after they emerge from the crystal. Given that $n_o=1.51$ and $r_{63}=10.5x10^{-12}m/V$.
18. Obtain Ramo's theorem of a semiconducting material and total external current.

(4 x 3 = 12)

Part D

(Answer **all** question, 12 marks each)

19. (a). Explain the working principle of LEDs. Discuss the advantages of heterojunction LEDs overhomojunction LEDs. Also explain the external efficiency of LED.

    OR

    (b). Explain the different types dispersion in single mode fiber. Also write a short note on
    dispersion flattened fiber.

20. (a). Discuss the working principle of a laser diode. Explain how the carrier and photon confinement is achieved in double heterostructure laser diodes

    OR

    (b). Using suitable theory, discuss the mode locking mechanism for generating high power lasers.

21. (a). Derive the expression for photoconductive gain of photoconductor.

    OR

    (b). Compare the I-V characteristics of an ideal and practical solar cell

22. (a). Discuss the working principle of a transverse electro-optic modulator. Explain the term half wave voltage.

OR

(b). Discuss the second order nonlinear processes (i) SHG and (ii) show how sum and difference of input optical frequencies can be achieved.

(12 x 4 = 48)

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