Reg. No. : ....

Name : ....

IV Semester M.Sc. Degree (C.B.S.S. – Reg./Supple./Imp.)
Examination, April 2022
(2018 Admission Onwards)
PHYSICS
PHY 4E06 : Optoelectronics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer both questions (either a or b).

1. a) i) What is Fermi energy ? Arrive an expression for Fermi level in an intrinsic semiconductor.
   ii) Sketch and explain a degenerate n-type semiconductor.

OR

   b) i) Give an account of avalanche photodiode.
   ii) Deduce an expression for photoconductive gain of a photoconductor.

2. a) i) Explain the device structure of LED.
   ii) Briefly explain the LED characteristics.

OR

   b) Briefly explain the following non-linear optical process :
   i) Second harmonic generation
   ii) Sum and difference frequency generation
   iii) Optical parametric oscillation.

(2×12=24)

P.T.O.

SECTION – B

Answer any four.
(1 mark for part a, 3 marks for part b, 5 marks for part c)

3. a) Write and explain the diode equation.
   b) State and explain the law of mass action.
   c) What is the conductivity of an n-type Si crystal that has been doped uniformly with 10^{16} cm^{-3} phosphorous (P) atoms (donors) if the drift mobility of electrons is about 1350 cm^{2}V^{-1}s^{-1} ?

4. a) What is a PIN photodiode ?
   b) Give an account of LEDs for optical fiber communications.
   c) A Si APD has a QE of 75% at 830 nm in the absence of multiplication, that is M = 1. The APD is biased to operate with a multiplication of 100. If the incident optical power is 15 nW, what is the photocurrent ?

5. a) What is meant by passive mode locking ?
   b) Write a short note on noise in photodetectors.
   c) Compute the mode-locked pulse width Δt_p and the separation between the pulses Δt_{sep} for a Helium-neon laser operating at 632.8 nm with a mirror cavity spacing of d = 0.5 m. (gain bandwidth = 1.5×10^9 Hz)

6. a) What is Ramo's theorem ?
   b) Briefly explain the solar energy spectrum.
   c) With a sketch, explain the principle and operation of the solar cell.

7. a) What is meant by a biaxial crystal ?
   b) Explain the birefringence of calcite crystals.
   c) What should be the thickness of a quarter wave plate of calcite for a wavelength 589.3 nm ? Given the ordinary and extraordinary refractive indices are 1.652 and 1.488 respectively.

8. a) What is meant by two-photon absorption ?
   b) Explain the methods of achieving phase matching in birefringent materials.
   c) Write a short note on non-linear optical materials.

(4×9=36)