



K18P 0265

Reg. No. : .....

Name : .....

**Fourth Semester M.Sc. Degree (Reg./Suppl./Imp.)**  
**Examination, March 2018**  
**(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 pn junction principles under open circuit, forward and reverse bias.

OR

- b) What is meant by Q-switching ? Discuss the evolution of a Q-switched laser pulse.

2. a) Explain the principle and operation of a pn junction photodiode. Give an account of quantum efficiency and responsivity of a photodiode.

OR

- b) What is meant by electro-optic effects ? Briefly explain Pockels effect and Kerr effect. (2×12=24)

**SECTION – B**

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

3. a) Write the semiconductor diode equation and explain the symbols used.  
b) Explain the double-heterostructure LED.  
c) Given that the width of the relative light intensity vs. photon energy spectrum of an LED is typically around  $\sim 3k_B T$ , what is the line width  $\Delta\lambda_{1/2}$  in the output spectrum in terms of wavelength ?

P.T.O.



4. a) What is a PIN photodiode ?  
b) Explain the principle of operation of a phototransistor.  
c) A Si PIN photodiode has an active light receiving area of diameter 0.4 mm. When radiation of wavelength 700 nm (red light) and intensity  $0.1 \text{ m W cm}^{-2}$  is incident it generates a photocurrent of 56.6 nA. What is the responsivity and QE of the photodiode at 700 nm ?
5. a) What is the role of finger electrodes on the surface of a solar cell ?  
b) Sketch and explain the principle and operation of a solar cell.  
c) A family house in a sunny geographic location over a year consumes a daily average electrical power of 500 W. If the annual average solar intensity incident per day is about  $6 \text{ kW hm}^{-2}$  and a photovoltaic device that converts solar energy to electrical energy has an efficiency of 15%, what is the required device area ?
6. a) What are retardation plates ?  
b) State and explain Malus's law.  
c) What should be the thickness of a half-wave quartz plate for a wavelength  $\lambda = 590 \text{ nm}$ . Given the ordinary and extraordinary refractive indices as 1.5442 and 1.5533 respectively.
7. a) What is meant by optical parametric oscillation ?  
b) What is meant by two-photon absorption ?  
c) Explain the second harmonic generation.
8. a) What are extrinsic semiconductors ?  
b) Give an account of non-linear optical materials.  
c) What is the conductivity of an n-type Si crystal that has been doped uniformly with  $10^{16} \text{ cm}^{-3}$  phosphorus (P) atoms (donors) if the drift mobility of electrons is about  $1350 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$  ? (4×9=36)