



Reg. No. :

Name :



IV Semester M.Sc. Degree (C.B.S.S. – Reg./Suppl. (Including Mercy Chance)/Imp.) Examination, April 2021 (2014 Admission Onwards)

PHYSICS
PHY 4E06 : Optoelectronics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer **both** the questions (Either **a** or **b** or **c**).

1. a) Discuss

- i) the formation of bands in semiconductors
- ii) the effect of doping and
- iii) how bands get modified when a p-n junction is formed, using neatly drawn diagrams.

OR

b) Discuss the working and basic characteristics of a LED. Differentiate between homojunction and heterojunction LEDs.

OR

c) Explain, Q switching in lasers and the various techniques to achieve it.

2. a) What is mode locking, in the context of lasers ? Discuss the different methods to achieve mode locking.

OR

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

OR

c) Differentiate between avalanche and PIN photodiodes. (2×12=24)



SECTION – B

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

3. a) How is conduction in metals different from that in semiconductors ?
 b) What is (i) compensation doping, (ii) degenerate semiconductor and (iii) non-degenerate semiconductor ?
 c) Calculate the conductivity of an n type Si crystal that has been doped uniformly with 10^{16} cm^{-3} phosphorus atoms if the drift mobility of electrons is $1350 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$.
4. a) What is line-width of emission of a LED ?
 b) Plot LED drive current Vs output power of a LED.
 c) Calculate the line width of a LED in terms of its emission wavelength. Given that the width of relative light intensity Vs photon energy spectrum is $3 k_b T$ approximately.
5. a) How is responsivity of a photodiode defined ?
 b) Plot the typical responsivity Vs wavelength curve of a Si photodiode and explain the shape of the curve.
 c) A Si pin photodiode has an active light receiving area of diameter 0.4 mm. For red light (700 nm) with 0.1 W/cm^2 intensity, a photo current 56.6 nA is generated. What is the responsivity and quantum efficiency of the photodiode ?
6. a) What is noise ?
 b) Explain avalanche noise in an APD.
 c) Consider a APD with $x = 0.7$ and biased to operate at $M = 10$. The unmultiplied dark current is 10 nA and bandwidth is 700 MHz. What is APD noise current for a bandwidth of 700 MHz ? If the responsivity (for $M = 1$) is 0.8, what is the minimum optical power for a SNR of 10 ?
7. a) Briefly discuss how a p-n junction can act as photovoltaic device.
 b) Give the expression for total current through a solar cell and explain the terms.
 c) Photovoltaic operation of a p-n junction is always in the negative current region. Why ?



8. a) State how the term solar constant is defined.
 b) Discuss what is meant by AMm.
 c) A family consumes on an average 500 W per day. If their location receives 5.5 kWh/m^2 per day and their solar panel has an efficiency of 14%, what is the required solar panel area of a photovoltaic system which can be used to power their home ?
9. a) What is birefringence ?
 b) Differentiate between quarter and half wave plates.
 c) Find the thickness of a calcite crystal ($n_o = 1.658$ $n_e = 1.468$) that can act as a half wave plate for 546 nm.
10. a) What is non-linear optics ?
 b) What is second harmonic generation ?
 c) Discuss the theory of second harmonic generation.

(9×4=36)