PART - A

Answer all questions. Each question carries 4 marks.

1. Determine radiative lifetime in GaAs having equilibrium electron density = 10^{14}/cc under high level injection level of 10^{18}/cc.

2. Give an account on Quantum Confined Stark Effect.

3. An avalanche photodiode detects 1.5 μm photo excitation with a responsivity of 0.7 A/W when operated with a gain of 30. 10^{11} photons are incident on the device per second. Compute quantum efficiency of the device.

4. Compare PIN diode and avalanche photodiode with respect to different performance parameters.

5. Draw the energy band diagram of a heterojunction modulated barrier photodiode with a simple layer schematic corresponding to it.

6. What are the features of high efficiency design of a heterojunction solar cell made of GaAs/AlGaAs?

7. What do you mean by ‘Image Force Lowering Effect’ in MSM photodiode?

8. Compare the ratio of threshold current densities at 20°C and 80°C for a AlGaAs injection laser with T_0 = 160 K.

9. What are the causes and nature of homogeneous and inhomogeneous line broadening mechanisms?

10. Explain the equilibrium and non-equilibrium population distributions in a simple two level lasing medium. (10×4=40 Marks)

P.T.O.
PART – B

Answer any two questions from each Module. Each question carries 10 marks.

Module – 1

11. a) Explain deep level transitions and Auger recombination in semiconductors. 5
   b) Derive an expressions for NEP of a p-i-n photodiode. 5

12. Elucidate different techniques commonly used for measuring high speed response of photodetectors. 10

13. a) Explain the structure of SAGM APD. How grading improves the performance? 5
   b) The quantum efficiency of a RAPD is 80% for detection of radiation at wavelength of 0.9µm. When incident optical power is 0.5µW, the output current from the device is 11 µA. Determine multiplication factor of the photodiode under this condition. 5

Module – 2

14. a) Explain illumination geometry of multiquantum well (MQW) p-i-n photodiode and how wavelength selective detection is carried out by photocurrent subtraction? 6
   b) Elucidate the principle of multicavity photodiode with relevant mathematical support. 4

15. a) With neat diagram, explain the principle of surface Emitting LEDs and compare its features with edge emitting LEDs. 7
   b) A light emitting diode gives 500 µw output power when minority carrier lifetime is 4ns. Determine the output optical power when LED is modulated with 50MHz frequency with rms current equal to same dc current. 3

16. a) Derive an expression for the spectral response of a photocell. 5
   b) What are the important features of a high efficiency design of a photocell? 5
Module - 3

17. a) Write notes on axial and transverse laser modes.  
   b) Compute the number of modes of an AlGaAs laser supported by the gain spectrum which has bandwidth of 6 nm. Cavity length is 200 μm and emission wavelength is 800 nm. Assume R.I. as 3.6.

18. a) Explain threshold condition for lasing with mathematical support.  
   b) Calculate mirror reflectance (assumed same) in a laser 10 cm long under threshold conditions given that net gain coefficient of the lasing medium is 0.01 cm⁻¹.

19. With layer structure and schematics, explain the principle and operation of heterojunction lasers.

(6×10=60 Marks)