



Solve all the following questions:-

Question One (25 mark)

- a. Drive an expression for maximum acceptance angle in optical fiber? (3 marks)
- b. State the main differences between (4 Marks)
 - i. Avalanche photodiode and LASER diode.
 - ii. Optical fiber Mie and Raman scattering.
- c. Explain what is meant by the critical bending radius for an optical fiber. A single mode step index fiber has a critical bending radius of 2 mm when illuminated with light at a wavelength of $1.3 \mu\text{m}$. Calculate the relative refractive index difference for fiber. (3 Marks)
- d. A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it. (3 Marks)
 - (i) At what wavelength is the photodiode operating?
 - (ii) Calculate the incident optical power required to obtain a photocurrent of $2.5 \mu\text{A}$ when the photodiode is operating as described above.
- e. Explain two types of power losses in optical fibers and how to face these factors?
- f. Calculate the ratio of the stimulated emission rate to the spontaneous emission rate for an incandescent lamp operating at a temperature of 1000 K. It may be assumed that the average operating wavelength is $0.5 \mu\text{m}$. (3 Marks)
- g. What is meaning of LASER, discuss the principle operation for laser diode? (3 Marks)

Question Two (25 mark)

- a. Define: population inversion- Responsivity – laser oscillation conditions- quantum efficiency of LASER diode and photodetector- stimulated and spontaneous emission of light - PIN photodiodes. (4 Marks)
- b. A ruby laser contains a crystal of length 4 cm with a refractive index of 1.78. The peak emission wavelength from the device is $0.55 \mu\text{m}$. Determine the number of longitudinal modes and their frequency separation. (3 Marks)
- c. The quantum efficiency of a particular silicon RAPD is 80% for the detection of radiation at a wavelength of $0.9 \mu\text{m}$. When the incident optical power is $0.5 \mu\text{W}$, the output current from the device (after avalanche gain) is $11 \mu\text{A}$. Determine the multiplication factor of the photodiode under these conditions.? (4 Marks)

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- d. A multimode graded index fiber exhibits total pulse broadening of $0.1 \mu\text{s}$ over a distance of 15 km. Estimate: (3 marks)
- (i) the maximum possible bandwidth on the link assuming no Intersymbol interference;
 - (ii) the pulse dispersion per unit length;
 - (iii) the bandwidth-length product for the fiber.
- e. An injection laser has an active cavity with losses of 30 cm^{-1} and the reflectivity of the each cleaved laser facet is 30%. Determine the laser gain coefficient for the cavity when it has a length of $600 \mu\text{m}$. (3 marks)
- f. Draw the block diagram of Endoscopy instrument and explain the different components? (5 marks)
- g. What are the main characteristics of flexible Endoscopes? (3 marks)

Best wishes of success
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