JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATIONS-2022

B.Tech-VI Semester (ECE)

COURSE CODE (CREDITS): 18B1WEC633 (3) MAX. MARKS: 35

COURSE NAME: Optical Communication Systems

COURSE INSTRUCTORS: Dr. Shweta Pandit

MAX. TIME: 2 Hours

Note: All questions are compulsory. Marks are indicated against each question in square brackets.

Q1. What are different optoelectronic sources? Describe the methods of light emission from various optoelectronic sources with the help of energy level band diagram. An injection laser has a GaAs active region with a bandgap energy of 1.44 eV. Estimate the wavelength of injection laser's optical signal and determine its linewidth in hertz when the measured spectral width is 0.3 nm. **[1+2+2]**

Q2. a) A double heterojunction injection laser has an optical cavity of length 50 μm and width 15 μm. At normal operating temperature, the loss coefficient is 5 cm^{-1} and the current threshold is 50 mA. When the mirror reflectivity at each end of the optical cavity is 0.3, find the gain factor $\bar{\beta}$ for the device. Assume that the current is confined to the optical cavity. **[3]**

b) Describe the various LED structures existing in the market. A GaAs planar LED has an internal quantum efficiency of 60% and is emitting at a wavelength of 0.85μm when passing a forward current of 30 mA/s. Estimate the optical power emitted by the device into air, and hence determine the external power efficiency if the potential difference across the device is 1 V. It may be assumed that the transmission factor at the GaAs–air interface is 0.68 and that the refractive index of GaAs is 3.6. **[2+3]**

Q3. a) What are the requirements that need to be considered while fabricating LEDs? Name at least three semiconductor materials used for designing LEDs. The radiative and nonradiative recombination lifetimes of the minority carriers in the active region of a double-heterojunction LED are 65 ns and 90 ns, respectively. Determine the total carrier recombination lifetime. **[3+2]**

b) Explain the photo detection process in p-n photodiode and compare its performance with p-i-n photodiode. Consider 700 photons per second are incident on a p–i–n photodiode which is operating at a wavelength of 1.3 μm and they generate on average 550 electrons per second. Calculate the responsivity of this p-i-n photodiode. **[3+2]**

Q4. a) A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it. Calculate the incident optical power required to obtain a photocurrent of 2.5μA for this photodiode. **[3]**

b) What are electro-optic and acousto-optic effect? How can these effects be used for designing optical modulators? **[3]**

Q5. a) Calculate the change in refractive index due to the longitudinal electro-optic effect for a 4 mm long crystal of lithium niobate for an applied voltage of 110 V. If the wavelength of light propagating through the crystal is 550 nm, calculate the net phase shift between the two polarization components after they emerge from the crystal. **[3]**

b) Calculate the output signal power for forward pumping and the overall gain in dB for a fiber Raman amplifier of length 2 km if the input signal power is 1μW. The attenuation coefficients α_s and α_p for signal and pump wavelengths for this fiber are 0.15 and 0.20 dB/km, respectively. Assume that $a_p=60\mu m^2$ and $g_r=5x10^{-14}$m/W. This amplifier is pumped by a laser of 1W power. **[3]**