جامعة المنوفية
كلية الهندسة الالكترونية بمنوف
امتحان نهاية الفصل الدراسى الاول (دور يناير) ٢٠١٩ / ٢٠٢٠
قسم هندسة الإلكترونيات والإتصالات الكهربية
الزمن : ٣ ساعات من الساعة ١٠ الى الساعة ١
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إتصالات بصرية: هـ ٤١٥١
الفرقة : الرابعة
التاريخ : ٢ / ١ / ٢٠٢٠
عدد صفحات الاسئلة :- ٢

ANSWER THE FOLLOWING QUESTIONS [Total = 90 mark]

HINT:- ASSUME ANY MISSING DATA REQUIRED

QUESTION 1 [20]

1) Explain, with the aid of sketches and figures the operating wavelength regions (Transmission Windows) of optical fiber transmission systems.
2) Compare between LED and laser sources and explain the key differences between a LED and an ordinary diode. State the drawbacks of the avalanche photodiodes.
3) Illustrate briefly, with the aid of sketches, figures and equations the ray theory of light transmission through optical fibers.
4) A step index fiber with a large core diameter compared with the wavelength of the transmitted light has an acceptance angle in air of **20°** and a relative refractive index difference of **25%**. Estimate the numerical aperture and the critical angle at the core–cladding interface for the fiber.

QUESTION 2 [30]

a) State basic passive and active optical components. Explain in brief Mach-Zchnder Interferometer (MZI) and diffraction gratings.
b) Two multimode step index fibers have numerical apertures of **0.28** and **0.36**, respectively, and both have the same core refractive index of **1.5**. Estimate the insertion loss at a joint in each fiber caused by a **6°** angular misalignment of the fiber core axes. It may be assumed that the medium between the fibers is air.
c) A four-port (2 x 2) multimode fiber FBT coupler has **58 μW** optical launched at port 1. The measured output powers at ports 2, 3 and 4 are **0.005, 25** and **28 μW** respectively. Determine the excess loss, the insertion losses between the input and output ports, the crosstalk and the split ratio for the device.
d) Explain in brief with equations and figures the types and concepts of Electro-Optic Modulators.
e) Give the major reasons which have led to the development of optical amplifiers. Using an energy band diagram, briefly discuss the mechanism for the provision of stimulated emission in the erbium-doped silica fiber amplifier.

QUESTION 3:- [20]

a) Draw the block diagram and explain the operation principles of Direct Intensity Modulation (D-IM) and Direct Demodulation (IM/DD).
b) Define Sensitivity, Directivity and **NEP**(Noise Equivalent Power) for optical receivers. A Germanum PIN photodiode with active dimensions of 75 x 95 μm has quantum efficiency 0f 60% when operating at a wavelength of 1.3 μm. The measured dark current at this wavelength is 10

nA.Calculate **NEP** and specific Directivity for the device. It may be assumed that dark current is the dominant noise source.

c) Discuss, with the aid of a suitable block diagram and equations, coherent optical fiber communication systems. Comment on the differing system requirements to facilitate heterodyne detection in comparison with homodyne detection. Draw the block diagram and explain the Asynchronous FSK dual-filter heterodyne detection receiver.

QUESTION 4:- [20]

Design a point-to-point video system. The link of this system could deliver signals from a TV studio to a remote transmitter. The link could just serve as well as part of a closed-circuit security monitor in a building or a campus. Path length of the order of 900 m is required. The signal generated by the TV camera is to intensity-modulate the light source with 98%modulation. The signal covers a bandwidth of 8 MHz. To obtain a clear picture, a SNR (or S/N) ratio of 60 dB is required. Do not include the modulator circuit or the receiver preamplifier in your design. Assume that:-

For LED:P_{LS}=2 mW; λ=0.85 µm; I_{av}= 70 mA; τ_{LS}=10 ns; and $\Delta\lambda$=30 nm.

For multimode SI fiber: NA=0.25, f^{o}_{3dB}=30 MHz.km, α_f= 4 dB/km, D_M=-90 ps/nm.km, and D_g=-2ps/nm.km.

For connectors η_c=0.9dB/km.

For system ι_M= 6 dB.

For Si PIN photodetector :$\Re$=0.65 at λ=0.85 µm, I_d=12 nA, τ_{drift}=1.2 nA, C_d= 5 pF, and V_B=5V.

Take T = 300 K, k_B=1.38 x 10^{-23} J/K, e=1.6 x 10-19 C. Assume that the system is to be thermal noise limited and check for this assumption.

Equations:=

$$\eta_{NA} = (NA)^2, \qquad \eta_R = 1 - \left(\frac{n - n_1}{n + n_1}\right)^2$$

$$\tau_{RC} = 2.2 R_L C_d, \qquad B_{PD} = \left(\frac{1}{2\pi R_L C_d}\right)$$

$$SNR = \frac{\frac{m^2}{2} R_L \Re^2 P^2}{4 K_b T B}, \text{ Assume the system is to be thermal noise limited.} \qquad \tau_{sys} = \frac{0.35}{B},$$

$$\sigma_s = 2e(\Re + I_d) B_{PD} \qquad \sigma_T = 2e\left(\frac{4 k_B T}{R_L}\right) B_{PD}$$

$$P(t) = P_{PD}(1 + m\cos\omega t) \qquad P_{sat} = \frac{V_B}{\Re R_L},$$

$$\tau_{PD} = \sqrt{\tau_{drift}^2 + \tau_{RC}^2}, \qquad \tau_F = \sqrt{\tau_{mod}^2 + \tau_{chr}^2}$$

$$\frac{\tau_{chr}}{L} = (D_M + D_g)\Delta\lambda, \qquad \frac{\tau_{mod}}{L} = \frac{0.44}{f^0_{3dB}}$$

Best Wishes