

Optical Communications - written examination test

Part I

19/6/45

3 point questions

1. Discuss the causes of dispersion in optical fibers and their relative importance in the three transmission windows. Specify the typical dispersion values in the three transmission windows.
2. A star LAN employs a 6 dBm laser at 850 nm to transmit 25 TV channels (each having a bandwidth of 4 MHz). Find the number of users than can be served with $BER=10^{-9}$, using p-i-n photodiodes, for a maximum distance of $L=3$ km between the star center an a user. Could you use a multi-mode fiber in this LAN?
3. An EDFA amplifier has a 10nm linewidth. What is its ASE? What is the ASE noise level on a 10 GHz bandwidth? Which other noise sources are present in an EDFA optical amplifier? What is its minimum theoretical noise level? In which operating conditions?

2 point questions

4. You must design a fiber link to transmit 1000 channels, each of 5 MHz bandwidth, between two towns, being 150 km apart. You may select the fiber (multi-mode, single-mode or dispersion shifted), the wavelength (820, 1300 or 1500 nm), the laser source (Fabry-Perot or DFB). You may use either direct or external OOK modulation. What are the possible solutions? What is the best in your opinion? Why?
5. Draw the scheme of an optical amplifier with double-propagating pump and explain its operating principle and its advantages and drawbacks respect to other schemes.

1 point questions

6. Define the beating length of a HB fiber. What is its typical value? Why can a HB fiber maintain the polarization state better than a standard fiber?
7. An OTDR employs a 5 ns pulsed laser. What is its spatial resolution ? Why?

Part 2

4 Points questions

- Describe the applications of silicon photonics by describing some specific devices, their functions and their employment in modern optical communication systems.
- Describe the different methods for the compensation of the Group Velocity Dispersion.

3 Points questions

- Describe the physical structure and operating characteristics of a Semiconductor Optical Amplifier, highlighting the different applications for this device.
- Briefly describe the advantages of PSK modulation format in optical communications, and provide at least one example of systems where this format is currently used.

1 Point questions (provide the correct answer and its justification, in **maximum 5 written lines**)

- What is the main cause for which optical fiber transmission systems developed around year 1985 needed electro-optical repeaters?
(a) slow speed of directly modulated semiconductor lasers ; (b) dispersion of optical fiber ; (c) attenuation of optical fiber ; (d) optical amplifier noise

$$h=6.6 \cdot 10^{-34} \text{ J s}$$

$$k=1.38 \cdot 10^{-23} \text{ J/K}$$

$$c=3 \cdot 10^8 \text{ m/s}$$

$$V_t=25 \text{ mV @ 300 K}$$

$$e=1.6 \cdot 10^{-19} \text{ C}$$