KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B. E.
Year : IV

Course : ETEG 422
Semester: I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : MAR 1 2 2018

SECTION "A"
[20 Q × 0.5 = 10 marks]

Choose the most appropriate option.

1. For a graded index optical fiber, which of the following value for profile parameter is most suitable for optical fiber communication?
   a. 0 b. 2 c. 9 d. 100

2. An optical fiber has core and cladding refractive indices as 1.46 and 1.44 respectively. If this fiber is to be used as a single mode fiber at a wavelength of 1300 nm then the core diameter of the fiber should be less than _____
   a. 1.45 μm b. 0.43 μm c. 2.43 μm d. 4.13μm

3. The total efficiency of an injection laser with a GaAs active region is 18%. The voltage applied to the device is 2.5 V and band gap energy for GaAs is 1.43 eV. The external power efficiency of the device is_____
   a. 10% b. 20% c. 30% d. 40%

4. Type of light used in optical fiber communication is _____
   a. Ultraviolet b. Green c. Red d. Infra red

5. The laser which produce pulses of coherent visible light at a wavelength of 694.3 nm is _____
   a. DFB laser b. Ruby laser c. He Ne laser d. CO_2 laser

6. For given V- number, the number of modes that can be carried by graded-index multimode fiber is given by
   a. $V^2/2$ b. $V^2/4$ c. $V^2/3$ d. $V^2/5$

7. If the core and cladding refractive indices for a step index fiber is 1.47 and 1.46 respectively, what will be the broadening of a pulse after a distance of 5 km?
   a. 0.17 μs b. 1.17 μs c. 2.17 μs d. 0.027μs

8. Optical fiber operates on the principle of _____
   a. Total internal reflection b. Tyndall effect
   c. Photo-electric effect d. Diffraction

9. If a fiber optic system has a rise time of 16 ns, the source rise time is 1.50 ns and the detector rise time is 2 ns, what is the cable rise time?
   a. 12 ns b. 9 ns c. 15 ns d. 6 ns

10. Photodiodes used as fiber optic detectors are _____
    a. Unbiased b. Thermoelectrically cooled
    c. Forward biased d. Reverse biased

11. The optical regenerators are used for _____
    a. Signal amplification
    b Modulation
    c. Noise reduction
    d. Both amplification and noise reduction

12. Fiber bandwidth is generally specified as the _____
    a. Quotient of bandwidth and distance
    b. Sum of bandwidth and distance
    c. Difference between bandwidth and distance
    d. Product of bandwidth and distance

13. The main benefit of light wave communications over microwaves or any other communications media is _____
    a. Lower cost
    b. Better security
    c. Free from electromagnetic interference
    d. Wider bandwidth

14. If L represents the length of modulator, λ represents the operating wavelength and N_e represents the effective refractive index, which of the following expression is correct for the phase difference that occurs in MZI optical biosensor?
    a. $\Delta\Phi = \frac{2\pi}{\lambda} N_e L$
    b. $\Delta\Phi = \frac{\lambda}{2\pi} N_e L$
    c. $\Delta\Phi = 2\pi \lambda N_e L$
    d. $\Delta\Phi = \frac{2\pi}{\lambda L} N_e$

15. Wavelength division multiplexing is used for _____
    a. Signal amplification
    b. Noise reduction
    c. Modulation
    d. Capacity enhancement

16. For a homodyne optical receiver, if w_1 is frequency of local oscillator and and w_2 is frequency of input signal that has to be detected, which of the following expression is correct?
    b. $w_1 = w_2$
    b. $w_1 = 2w_2$
    c. $w_1 = 3w_2$
    d. $w_1 = 4w_2$

17. In an optical fiber, the concept of Numerical aperture is applicable in describing the ability of _____
    a. Light collection
    b. Light scattering
    c. Light dispersion
    d. Light polarization

18. An optical fiber link of length 4 km comprises a fiber cable with an attenuation of 5 dB per kilometer. The splice losses for the link are estimated at 2dB per kilometer and the connector losses at the source and detector are 3.5 and 2.5 dB respectively. Ignoring the effect of dispersion on the link, the total channel loss is given by
    a. 14 dB
    b. 24 dB
    c. 34 dB
    d. 54 dB

19. Which method determines the dispersion limitation of an optical link?
    a. Budget power amplifier
    b. Power budget analysis
    c. Rise time budget analysis
    d. Both b and c

20. In Kerr effect, induced index change has its proportionality with respect to _____
    a. One fourth power of electric field
    b. Cube root of electric field
    c. Cube of electric field
    d. Square of electric field

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SECTION "B"

[4 Q.× 10 = 40 marks]

Attempt *ANY FOUR* questions. Figure in the margin indicates the full mark. Symbols have their usual meaning. Students are required to answer in their own words as far as practicable.

1. a. Describe the homodyne and heterodyne detection technique used in optical fiber communication system. [5]
   b. A transmitter has an output power of 0.1 mW. It is used with a fiber having NA = 0.25, attenuation of 6 dB/km and length 0.5 km. The link contains two connectors of 2 dB average loss. The receiver has a minimum acceptable power (sensitivity) of –35 dBm. The designer has allowed a 4 dB margin. Calculate the link power budget. [5]

2. a. Classify the optical fiber based on the refractive index profile, materials used and modes of propagations. Also explain dispersion phenomenon in each type of fiber. [4]
   b. Describe the drawing process in glass optical fiber fabrication technique with the help of diagram. [3]
   c. A Ruby laser contains a crystal length of 4 cm with refractive index of 1.78. The peak emission wavelength from the device is 0.55μm. Determine the number of longitudinal modes and their frequency separation. [3]

3. a. How are the optical amplifiers used in optical network? Explain the working principle of fiber optical amplifier (FOA) with suitable figures. [5]
   b. Differentiate between the heterostructure and homostructure of laser. Also explain the construction, operating principle and applications of CO_2 laser. [2+3]

4. a. What are the noises related to photo detector? How do PiN diode and avalanche photodiode work? Make comparative analysis. [6]
   b. What are the advantages of indirect modulation of laser? Explain the working principle of acousto-optic modulator. [4]

5. a. Write some dissimilarities between Michelson interferometer and MZI interferometer. How does MZI optical sensor work as a biosensor? Describe with the help of suitable diagram. [5]
   b. Write short notes on: [2 × 2.5]
      i) Optical directional coupler
      ii) Wavelength division multiplexing (WDM)