

KATHMANDU UNIVERSITY
End-Semester Examination
March/April 2017

Marks Scored:

Level : B.E.

Year : IV

Exam Roll No. :

Time : 30 mins.

Course : ETEG 422

Semester: I

F.M. : 10

Registration No.:

Date

APR 07 2017

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose the most appropriate option.

1. What is the cut off wavelength for silicon PiN diode having the band gap energy of 1.1eV?
a. $4.13\mu\text{m}$ b. $3.16\mu\text{m}$ c. $2.16\mu\text{m}$ d. $1.13\mu\text{m}$
2. What is the acceptance angle for a silica fiber with refractive index of core 1.48 and refractive index of cladding 1.46
a. 13.88° b. 4.2° c. 10° d. 1.38°
3. A photodiode used as light source is _____.
a. forward biased b. reverse biased
c. either forward or reverse biased d. unbiased
4. Silicon is not suitable for fabrication of LED because it is _____.
a. an indirect band gap semiconductor b. a direct band gap semiconductor
c. a wideband gap semiconductor d. a narrowband gap semiconductor
5. Which of the following is used to remove tattoo?
a. semiconductor laser b. Ruby laser
c. He Ne laser d. LED
6. A particular green LED emits light of wavelength 5490 \AA , the energy band gap of the semiconductor material is _____.
a. 2.26 eV b. 1.98 eV c. 1.17 eV d. 0.74 eV
7. The number of doped region in PiN diode is _____.
a. 1 b. 2 c. 3 d. 1 or 2
8. Wavelength division multiplexing is done for _____.
a. wavelength conversion b. filtering
c. amplification d. capacity enhancement
9. Optical fiber operates on the principle of _____.
a. total internal reflection b. Tyndall effect
c. photo-electric effect d. Compton effect

10. If V is normalized frequency then which of the following is true for single mode fiber?
 a. $V < 5.405$ b. $V < 4.405$ c. $V < 3.405$ d. $V < 2.405$
11. A graded index fiber has $NA = 0.275$ and $N_1 = 1.487$. What is the bit rate restricted by modal dispersion for a 1 km length?
 a. 5.4 Gbps b. 4.2 Gbps c. 10 Mbps d. 1.38 Gbps
12. A communication system uses an optical fiber whose attenuation is 0.5dB/km. If input power is 1 mW and link length is 15 km, what is the output power?
 a. 0.17mW b. 0.57mW c. 0.87mW d. 0.97mW
13. Which of the following wavelength range can be used in optical fiber communication?
 a. 800 nm -1550 nm b. 400 nm-800 nm
 c. 200 nm-400 nm d. 1310 nm-2000 nm
14. When temperature increases, what will happen in laser diode threshold current?
 a. Either increases or decreases b. Decreases
 c. Increases d. Remains constant
15. An OTDR is _____.
 a. light detector b. light emitter c. point sensor d. distributed sensor
16. When the optical power launched into an 8 km length of fiber is $120 \mu\text{W}$. The average input power at output is $3 \mu\text{W}$ then signal attenuation per kilometer for the fiber is _____.
 a. 2.0 dB/km b. 4.0 dB/km c. 6.0 dB/km d. 8.0 dB/km
17. Silica has an estimated fictive temperature of 1400 k with an isothermal compressibility of $7 \times 10^{-11} \text{ m}^2/\text{N}$. The refractive index and photoelastic coefficient for Silica are 1.46 and 0.286 respectively. The theoretical attenuation in decibel per kilometer due to the Rayleigh scattering in silica at optical wavelength of $0.63 \mu\text{m}$ is given by _____.
 a. $1.19 \times 10^{-3} \text{ m}^{-1}$ b. $3.19 \times 10^{-3} \text{ m}^{-1}$ c. $4.19 \times 10^{-3} \text{ m}^{-1}$ d. $5.19 \times 10^{-3} \text{ m}^{-1}$
18. For given v - number, the number of modes that can be carried by graded-index fiber is given by _____.
 a. $V^2/2$ b. $V^2/4$ c. $V^2/3$ d. $V^2/5$
19. Which of the following light source in general has the narrowest spectral width?
 a. LED b. Fabry-Perot laser c. VCSEL d. DFB laser
20. The carrier velocity in a silicon PiN photodiode with a $25 \mu\text{m}$ depletion layer width is $3 \times 10^4 \text{ m/sec}$. What is the maximum response time for the device?
 a. 2.27 ns b. 3.32 ns c. 4.46 ns d. 5.23 ns

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Level : B.E.
Year : IV
Time : 2 hrs. 30 mins.

Course : ETEG 422
Semester: I
F.M. : 40

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) How light is launched into optical fiber? Explain with suitable figure and derivation relating to acceptance angle and numerical aperture. [4]
 - b) How optical biosensor is used for drug identification? [3]
 - c) What are the impacts of optical fiber in telecommunications engineering? Justify your answer with suitable examples. [3]
- 2)
 - a) Write the effects of pulse broadening in optical fiber communication. How dispersion is related with the length of step index optical fiber and numerical aperture? [1+3]
 - b) Mention losses that occur in optical fiber communication and describe the different transmission windows used in optical fiber communication with the attenuation versus wavelength graph. [1+3]
 - c) A silicon PiN photodiode incorporated into an optical receiver has quantum efficiency of 60% when operating at wavelength of 0.9 μm . The incident optical power at this wavelength is 200nW. Find the photocurrent. [2]
- 3)
 - a) Derive the internal and external quantum efficiency of a LED. [4]
 - b) How intensity modulation is converted into phase modulation in electro-optic modulator? Explain with reference to MZI electro-optic modulator. [3]
 - c) Two step index fibers exhibit the following parameters: [3]
 - (i) A multimode fiber with a core refractive index of 1.5, a relative refractive index of 3% and an operating wavelength of 0.82 μm .
 - (ii) An 8 μm core diameter single mode fiber with a core refractive index of 1.5, a relative refractive index of 0.3% and an operating wavelength of 1.55 μm .

Estimate the critical radius of curvature at which large bending losses occur in both cases.

4)

- a) The following parameters are established for a long-haul single mode optical fibers system operating at a wavelength of $1.3\mu\text{m}$. [4]

Mean power launched from the laser transmitter = -3dBm

Cabled fiber loss = 0.4dB/km

Splice loss = 0.1dB/km

Connector losses at the transmitter and receiver = 1 dB each

Mean power required at the APD receiver when operating at 400 Mbps = -44dBm

Required safety margin = 7dB

Estimate

- (i) The maximum link length without repeaters when operating at 400 Mbps
(Assume that there is no dispersion- equalization penalty at this bit rate)
- (ii) The reduction in the maximum possible link length without repeaters without repeaters of (i) when there is a dispersion-equalization penalty of 1.5 dB

- b) Explain the construction, working principle and applications of HeNe laser. [4]

- c) A directional coupler has an excess loss of 1 dB and splitting ratio of $1:1$. How much of the input power reaches to the two output terminals? [2]

5)

- a) Describe the wavelength division multiplexing (WDM) technique and write its significance in optical fiber communication. [3]

- b) Explain the perform preparation and drawing mechanism in fiber fabrication process. [5]

- c) An EDFA is pumped at 980nm . Determine the threshold pump intensity for amplifying the following two signal wavelengths, 1550 nm and 1580 nm . Use the data given below for the calculation: [2]

(i) Absorption cross-section area at pump wavelength = $3.1 \times 10^{-25}\text{ m}^2$

(ii) Spontaneous emission life time = 12 ms

(iii) Absorption cross-section area at 1550 nm = $2.6 \times 10^{-25}\text{ m}^2$

(iv) Absorption cross-section area at 1580 nm = $0.654 \times 10^{-25}\text{ m}^2$

(v) Emission cross-section area at 1550 nm = $3.41 \times 10^{-25}\text{ m}^2$

(vi) Emission cross-section area at 1580 nm = $1.33 \times 10^{-25}\text{ m}^2$