KUMARAGURU
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Register Number: ……

B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2009)

Seventh semester

ELECTRONICS AND COMMUNICATION ENGINEERING

ECE120 : Optical Communication

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. A single mode optical waveguide reduces
   a) propagation loss b) waveguide dispersion
   c) material dispersion d) transmission data rate
2. Numerical aperture of an optical fiber represents
   a) the cone outside which the light is incident on fiber end b) the cone within which the light is incident on fiber end
   c) whether the fiber is single mode or not d) the phase changes of propagating light
3. The fundamental mode of an optical fiber is
   a) TE01 b) TM01
   c) HE11 d) LP11
4. Lithium Niobate is a widely used material for integrated optic devices because of its
   a) low loss b) high electro-optic coefficient
   c) easy fabrication method d) low cost
5. The following process is used to make waveguide in glass
   a) Ion exchange b) Titanium diffusion
   c) Epitaxial d) Photolithography
6. High speed optical modulators make use of
   a) lumped electrodes b) travelling wave electrodes
   c) split-electrodes d) Compensation for C effects
7. Avalanche photodiode offers the following advantage
   a) low noise b) Higher signal current

c) low operating voltage d) high gain

8. Which one of the following acts as a tunable filter in WDM system?
   a) Dielectric thin film b) acoustic optic device
   c) diffraction grating d) none of the above
9. Solitons are a result of
   a) fiber dispersion b) fiber non-linearity
   c) non-linear Schrodinger equation d) Chirping
10. In an optical amplifier using Erbium doped fiber , the amplifier gain is best in
   a) 850 nm b) 980 nm
   c) 1550 nm d) 1300 nm

PART B (10 x 2 = 20 Marks)

11. A silica optical fiber has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine
   (i) Critical angle at the core – cladding interface
   (ii) Numerical aperture and acceptance angle
12. A multimode step index fiber with a relative index difference of 1.5% is operating at a wavelength of 0.85 µm. If the core refractive index is 1.48 for single mode operation, estimate the maximum core diameter.
13. Bring out the cause and effects of macro and micro bends in optical fibers.
14. A multimode graded index fiber exhibits total pulse broadening of 0.1µs over a distance of 15km. Estimate pulse dispersion / length, maximum possible BW of the link.
15. Differentiate LED and Laser diodes
16. A double hetero-junction InGaASP LED emitting at a peak wavelength of 1310 nm has radiative and non radiative recombination times of 30 and 100 ns respectively. Calculate the bulk recombination lifetime, internal quantum efficiency and the internal power generated by the LED.
17. Determine the Quantum efficiency and the responsivity of the photodiode at 0.75µm when $2x10^{11}$ photons with 0.75 µm wavelength incident on photodiode, on average 1.2×10^{11} electron – hole pairs are generated at the terminals of the device?
18. What are the factors affecting the response time in an optical receiver?
19. Given the connector loss = 1.4dB, system link power margin = 8 dB, fiber attenuation = 6 dB/km, transmission distance = 6 km, calculate total optical power loss.
20. What in SONET?

PART C (5 x 14 = 70 Marks)

21. a) (i) What are the different types of optical fibers? Explain the types of fibers with relevant sketches of ray propagation and refractive index profile. (7)

(ii) Consider a fiber with a 25 µm core radius , a core index n1=1.48, and $\Delta = 0.01$ (7)

a) if $\lambda = 1320$ nm , what is the value of V and how many modes propagate in the fiber ?

b) What is the % of optical power flows in the cladding?

c) When Δ reduced to 0.003, how many modes does the fiber support and what fraction of the optical power flows in the cladding?

(OR)

b) (i) Bring out the differences between single mode and multi mode fibers. Draw the schematic diagrams of (i) cross section and (ii) refractive index profile for step-index single mode and multi mode fibers and graded index fibers and explain. (7)

(ii) Discuss and illustrate the various types of mismatch and the resulting loss that occurs when two fibers are connected or spliced. (7)

22. a) (i) What are macro bending losses and micro bending losses? Explain with suitable diagrams. (7)

(ii) 2 step index fibers exhibit the following parameters: a) A multimode fiber with core refractive index of 1.5, a relative refractive difference of 3% and an operating wavelength of 0.82 µm b) A 4µm core diameter single mode fiber with a core refractive index of 1.5 and relative refractive index difference 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. (7)

(OR)

b) (i) Explain the terms dispersion shifted and dispersion flattened fibers. Bring out the need for such types of fibers. (7)

(ii) Using ray theory, derive the guidance condition and expression for multi path pulse dispersion for a step-index fiber. Explain how modal dispersion is reduced by the use of graded index fibers (7)

23. a) (i) Describe the factors responsible for the losses in source to fiber and fiber to fiber coupling. (7)

(ii) A laser has a cavity of length 0.3 mm , internal absorption of 10/cm and reflectivity of both facets is 33% .If the gain coefficient is related to the forward current density by the proportionality factor 0.05 cm/A , what is the threshold current density of the laser diode? How will it change if the reflectivity of both (7)

facets is increased by 66%?

(OR)

b) (i) Draw any two structures for LED and LD. Compare the properties of LED and LD and discuss about their suitability for optical communication. (10)

(ii) An LED with a circular emitting area of 50 μm diameter and axial brightness of 50 W-cm^2 is connected to a step-index fiber of 50 μm diameter and NA = 0.2. Assume the source to be Lambertian and find the coupling efficiency. (4)

24. a) (i) Explain the various noise mechanisms that limit the frequency response of a photodiode and derive an expression for the SNR for the case of direct detection using a photodiode. (8)

(ii) A GaAIAs LED has a band-gap of 1.5 eV and the light emitted by it strikes a p-i-n photodiode with an intensity of 100 μW. Detector quantum efficiency is 0.6. Find the photocurrent. If a recombination life of 2ns is reported for the detector, find its modulation bw if the d.c optical power is 1 mW. (6)

(OR)

b) (i) An InGaAs pin photodiode has the following parameters at a wavelength of 1200nm. I_D =4nA. , η= 0.80, RL = 1000 Ω and the surface leakage current is negligible. The incident optical power is 300 nw, and the receiver bandwidth is 20 MHz. Find out primary photocurrent, Mean square quantum noise current, mean square dark current and mean square thermal noise current. (7)

(ii) Briefly explain the importance of link power budget. Explain the loss calculation using optical power loss model. (7)

25. a) (i) With required sketches, explain the principles involved in the optical WDM network. (7)

(ii) Explain the significance and principle of SONET/SDH network. (7)

(OR)

b) (i) Discuss in detail about the working of EDFA with relevant figures. (7)

(ii) Discuss in detail about the structure and working principle of APD with necessary sketches. (7)

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