KINGS

COLLEGE OF ENGINEERING
PUNALKULAM.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

SUBJECT CODE : EC1402 **SEM / YEAR : VII/ IV**

SUBJECT NAME : OPTICAL COMMUNICATION

UNIT – I

INTRODUCTION TO OPTICAL FIBERS

PART- A (2 marks)

1. Among Microwaves and light waves which have high bit rate distance product?Why?
2. Mention the three advantages of optical fiber as waveguide over conventional metallic waveguide?
3. What is meant by mode and index profile?
4. Mention the advantages of Graded Index fiber.
5. Write the expression for the refractive index in Graded index fiber.
6. Define Numerical Aperture of step index fiber.
7. Give the expression of the effective number of modes that are guided by a curved multimode fiber of radius ' a'.
8. State Snells Law.
9. Define Critical angle?
10. Define TIR?
11. What is the need of Cladding?
12. Define core index difference.
13. Define refractive index?
14. What are leaky modes in optical fibers?
15. Define External reflection of light rays?

16. What is meant by modes of waveguide?
17. Define V number?
18. What is relation between V number and power flow in cladding?
19. What is the fundamental parameter of SM fiber?
20. Give the relation between rays and modes?
21. What are the advantages and disadvantages of SM fiber?
22. What are the advantages and disadvantages of MM fiber?
23. Define skew rays and merdional rays?
24. Define cutoff conditions?
25. What is meant by Degenerate modes?
26. What is meant by linearly polarized modes?
27. Define MFD?
28. Define Bi refrigence and beat length?
29. A point source of light is 12cm below the surface of a large body of water (n=1.33). What is the radius of the largest circle on the water surface through which the lights can emerge?
30. Consider a parabolic index waveguide with n_1=1.75,n_2=1.677 and core radius 52µm. Calculate the numerical aperture at the axis and at a point 20µm from the axis.
31. Why do we prefer step index single mode fiber for long distance communication?
32. Why do we use LP_{01} mode for long distance communications?
33. What are three operating windows?
34. Alight ray is incident from glass to air. Calculate critical angle?

PART - B

1. What are Fiber modes? Explain mode theory for optical fiber in detail? **(16)**
2. Compare SM fiber and Graded index fiber. Explain the requirements for fiber materials? **(16)**
3. Discuss the theory of GI fiber. Derive the expression for the numerical aperture of GI fiber? **(16)**
4. Derive an expression for number of modes propagating in GI fiber from the first principle . **(16)**
5. i) Mention the advantages of optical communication systems? **(8)**
   ii) Draw the elements of an optical communication systems? **(8)**

6. i) Discuss the propagation modes in SM fiber **(8)**
   ii)Briefly explain the evolution of fiber optic systems? **(8)**
6. i)Compare the configurations of different types of fibers? **(8)**
   ii) Discuss the modes in Step index fiber? **(8)**
7. i)Derive the wave equations for step index fiber and explain? **(8)**
   ii)Sketch and explain the electric field distributions of low order guided modes in symmetrical slab waveguide? **(8)**
8. A fiber has normalized frequency is 26.6 and wavelength is 1300nm.If the radius of core is 25μm.Compute numerical aperture? **(16)**
9. a) A multimode step index fiber with core diameter of 80μm and index difference of 1.5% at wavelength of 0.85μm.If the refractive is 1.48,find normalized frequency and no of modes? **(8)**
   b) Derive the expression for power flow in step index fiber? **(8)**
10. a)Explain Linearly polarized modes? **(8)**
    b)The relative index difference in graded index fiber is 0.7% ,core refractive is 1.45.Find numerical aperture when index profile is triangular. **(8)**

11 a).Derive modal equation. **(8)**
   b) Compare single and multimode fiber. **(8)**

UNIT II

SIGNAL DEGRADATION OPTICAL FBERS

PART- A (2 marks)

1. An optical signal has lost 55% of its power after traversing 3.5 km of fiber. What is the loss in dB/km of this fiber?
2. Define mode-field diameter.
3. What are the causes of absorption?
4. Define normalized propagation constant.
5. List the basic attenuation mechanisms in an optical fiber.
6. What is meant be mode coupling ? What causes it ?
7. Mention the two causes of intramodal dispersion.
8. Define fiber loss.

9. What do you mean be polarization mode dispersion?
10. Commonly available single mode fibers have beat lengths in the range 10cm <Lp <2m. What range of refractive index differences does this correspond to?
11. Find the coupling loss for two fibers having core refractive index profiles α_E =2.0 and α_R =1.5
12. Define Raleigh Scattering loss.
13. Define Mie Scattering loss.
14. When the mean optical power launched into an 8 km length of fiber is 120 µw. Determine the overall signal attenuation or loss in decibels.
15. How are micro bending losses reduced?
16. Distinguish intrinsic and extrinsic absorption.
17. Distinguish dispersion shifted and dispersion flattened fibers.

PART-B

1. What is meant by waveguide dispersion ? Derive the expression for the same. **(16)**
2. What is meant be material dispersion ? Derive the expression for the pulse broadening due to material dispersion. **(16)**
3. Discuss the signal distortion in single mode fibers. **(16)**
4. Sketch the fundamental mode field in a curved optical wave guide and explain how bending losses occur**.** **(16)**
5. Explain with suitable diagrams the different mechanisms that contribute to attenuation in optical fibers. **(16)**
6. When the mean optical power launched into an 8km length of fiber is 120 µW, the mean optical power at the fiber output is 3µ W.

   Determine

   (1) Overall signal attenuation in dB/km and **(8)**

   (2) The overall signal attenuation for a 10km intervals, each giving an attenuation of 1dB. **(8)**
7. Explain in detail mode coupling and design optimization of single mode fibers. **(16)**
8. Discuss in detail intermodal dispersion of multimode step index fiber with relevant expression and diagrams**.** **(16)**
9. What is mode coupling ? Discuss pulse broadening in GI fibers**.** **(16)**

10. Discuss various kinds of losses that an optical signal might suffer while propagating through fiber. Which is most important one? What is the effect of these losses on light power and pulse shape? **(16)**
11. A 6 km optical link consists of multimode step index with a core refractive index of 1.5 and a relative refractive index difference of 1%. Estimate the delay difference between the slowest and fastest modes at the fiber output and the rms broadening due to intermodal dispersion on the link. Also derive the expression involved in it. **(16)**

UNIT III

FIBER OPTCAL SOURCES AND COUPLING

PART- A (2 marks)

1. Define radiance.
2. What is meant by " population inversion"?
3. what is meant by heterojunction?
4. What is meant by indirect band gap semiconductor material?
5. Draw the three key transition processes involved in laser action.
6. Give examples for direct and indirect semiconductor materials.
7. Define internal quantum efficiency of an LED.
8. Name few splicing methods in fiber optics.
9. Compare LED and LASER.
10. What so you mean by heterojunction ? Mention its advantages.
    a. List the different types of mechanical misalignments that can occur between two joined fibers.
    b. Calculate the ratio of stimulated emission rata to the spontaneous emission rate for a lamp operating at a temperature of 1000 K. Assume average operating wavelength is 0.5μm.
11. Define lambertian pattern .
12. Define FWHM.
13. Define Modal or speckle noise.

14. Define " Kinks".
15. Define Mode partition noise.
16. Define Lensing Schemes.
17. Define Splicing ? What are types of Splicing.?
18. What are the Characteristics of Light Source .

PART - B

1. Draw the two basic LED configurations and discuss the principle. **(16)**
2. Discuss the principle of optical feedback and LASER oscillation. **(16)**
3. Derive the threshold condition for LASER oscillation. **(16)**
4. Explain various fiber splicing techniques. **(16)**
5. Write technical notes on optical fiber connectors. **(16)**
6. Discuss the laser diode structures and radiation patterns.(16)
7. Draw the structures of edge – emitting LED and surface emitting LED and explain the operation. **(16)**
8. Discuss the LASER diode principle , modes and threshold conditions. **(16)**
9. Explain various types of fiber splicing techniques and fiber connectors. **(16)**
10. Derive the threshold condition for LASER **(16)**
11. Explain the laser action with neat diagrams. **(16)**
12. a) A GaAs laser operating at 850 nm has a 500 μm length and a refractive index n = 3.7. What are the frequency and wavelength spacings? **(6)**
    b) With neat diagram explain the construction and working of high radiance surface Emitting LED. **(10)**
13. Discuss about modulation of laser diodes. Why thermoelectric coolers are used in laser diodes. **(16)**
14. Discuss in detail fiber splicing and connectors. Explain the operation principles of WDM. **(16)**
15. Draw and explain the LED structures based double hetero structure configuration. **(16)**
16. Discuss the principles of operation of laser diodes. What are the effects of temperature on the performance of a laser diode? **(16)**
17. Explain in different lensing schemes available to improve the power coupling efficiency. **(16)**

18. Explain the fiber splicing techniques with necessary diagrams. **(16)**

UNIT - IV

FIBER OPTICAL RECEIVERS

PART- A (2 marks)

1. Define diffusion length.
2. Define avalanche effect .
3. Define responsivity.
4. Define Quantum efficiency of photo detector.
5. Write the noise sources in the receiver section.
6. Define Quantum limit.
7. What are the desired features of photo detector.
8. A photo diode is constructed of GaAs which has a bandgap energy of 1.43Ev at 300k. What is meant by long wavelength cutoff?
9. What are the benefits of trans impedance amplifier.
10. Define long wave length cutoff related photo diode.
11. What is meant by bulk dark current?
12. A photo diode has a capacitance of 6pf.Calculate the max load resistance which allows an 8MHz post defection BW.
13. What is meant by impact ionization. In APD?
14. What is transit time of photo carriers?
15. What is meant by ionization rate?
16. Define avalanche multiplication?
17. Define S/N ratio of an optical receiver?What are the conditions are required to achieve high S/N?
18. Define BER?
19. Define Extinction ratio?

20. Define photo current?
21. What is p+ πpn+ reach through structure?
22.Define excess noise factor?
23. What is meant by Pre amplifier? What are the advantages of pre amplifier?
24.Whar are the draw backs of high impedance amplifier?

PART - B

1. Describe the working principle of PIN photo detector and explain the characteristics of pin diode. **(16)**
2. Explain with neat diagram, construction and working of APD. Compare photo detectors. **(16)**
3. Discuss the different noise sources and disturbances in the optical pulse detection mechanism and derive the expression of S/N ratio. **(16)**
4. a) Explain the fundamental receiver operation in optical communication. **(6)**
   b)Derive an expression for the bit error rate of an optical receiver. **(10)**
5. Discuss the source of errors in optical receivers **(16)**
6. The Quantum efficency of a RAPD is 80% for thr detection of radiation at 0.9µm, when incident optical power is 0.5µw.The output current from the device(after avalance gain) is 11 µA. Determine avalanche multiplication factor? **(16)**

UNIT - V

DIGITAL TRANSMISSION SYSTEM

PART- A (2 marks)

1. List out the requirements that are to be considered in analyzing a link
2. Differentiate link power budget and rise time budget.
3. What is SONET? How does it differ from SDH?
4. What are solitons?
5. What is meant by 'modal noise'?

PART-B

1. Write notes on LINK POWER BUDGET. **(16)**
2. Write notes on RISE TIME BUDGET. **(16)**
3. Write notes on SONET. **(16)**
4. List out the WDM components. Explain them briefly. **(16)**
5. Discuss the principles, requirements and applications of WDM. **(16)**

*** ALL THE BEST ***