Q.2 a. Discuss the significance of any FOUR of the following terms in optical fibers:- **(8)**
(i) Snell's law
(ii) Acceptance angle
(iii) Numerical Aperture
(iv) Mode theory
(v) Skew rays

Answer: **(i) Refer section 2.2 of Text Book-I**
(ii) Refer section 2.3.4 of Text Book-I
(iii) Refer section 2.3.5 of Text Book-I
(iv) Refer section 2.4 of Text Book-I
(v) Refer section 2.3.4 of Text Book-I

b. A typical relative refractive index difference for an optical fiber designed for long distance transmission is 1% and its core index is 1.46, then
(i) Estimate its Numerical Aperture
(ii) Calculate the Critical Angle at the core-cladding interface within the fiber. **(8)**

Answer:

$NA = n_1(2\Delta)^{1/2} = 1.46(0.02)^{1/2} = 0.21$

$\Delta = \frac{n_1 - n_2}{n_1} = 1 - \frac{n_2}{n_1}$

Hence $\frac{n_2}{n_1} = 1 - \Delta = 1 - .01 = .99$

The critical angle at core-cladding interface is

$\phi_c = \sin^{-1}\frac{n_2}{n_1} = \sin^{-1} 0.99 = 81.9^\circ$

Q.3 a. What is dispersion? How does it play an important role in determining information capacity of a waveguide? Classify the different types of dispersions. **(8)**

Answer: **Refer section 3.2 of Text Book-I**

b. Discuss the design-optimization characteristics of single-mode fibers with suitable diagrams. **(8)**

Answer: **Refer section 3.5.1 of Text Book-I**

Q.4 a. A double hetrojunction lnGaAsp LED emitting at peak wavelength of 1310nm has radiative and nonradiative recombination times of 30ns and 100ns respectively. The drive current is 40 mA. Find (i) the bulk recombination lifetime and (ii) internal quantum efficiency. **(8)**

Answer:

$$\tau = \frac{\tau_r \tau_{nr}}{\tau_r + \tau_{nr}} = \frac{30 \times 100}{30 + 100} ns = 23.1 ns$$

$$\eta_{int} = \frac{\tau}{\tau_r} = \frac{23.1}{30} = 0.77$$

b. Discuss the basic architecture of a vertical-cavity surface emitting single mode laser with the help of a suitable diagram. **(8)**

Answer: **Refer section 4.3 of Text Book-I**

Q.5 a. A GaAs optical source with a refractive index of 3.6 is coupled to a silica fiber that has a refractive index of 1.48. If the fiber end and the source are in close physical contact. Then find (i) the Fresnel reflection at the interface, and (ii) the power loss **(8)**

Answer: **Refer section 5.3 of Text Book-I**

b. With the help of diagrams, explain the various lensing schemes for coupling improvement. **(8)**

Answer: **Refer section 5.2 of Text Book-I**

Q.6 a. Explain any **TWO** the following terms with reference to optical receivers:
(i) Intersymbole interference
(ii) Bit error rate
(iii) Quantum Limit
(iv) Extinction Ratio **(8)**

Answer: **(i) Refer section 7(7.1.2) of Text Book-I**
(ii) Refer section 7.2.1 of Text Book-I
(iii) Refer section 7.2.2 of Text Book-I
(iv) Refer section 7.3.5 of Text Book-I

b. Draw and explain the circuit of High Impedance pre-amplifier using FET. **(8)**

Answer: **Refer section 7.4.1 of Text Book-I**

Q.7 a. Explain the basic concept of Sub Carrier Multiplexing with a neat diagram. **(8)**

Answer: **Refer section 9.3.3 & Figure 9.12 of Text Book-I**

b. What is RIN? What are the reflection effects on RIN? **(8)**

Answer: Refer sections 9.2.3 & 9.2.4 of Text Book-I

Q.8 a. What are the key system requirements needed for analyzing a transmission link in optical fiber technology? **(8)**

Answer: Refer section 8.1 of Text Book-I

b. What is Rise Time Budget? How is it useful in determining dispersion limitation of an optical fiber link? **(8)**

Answer: Refer section 8.1.3 of Text Book-I

Q.9 a. Explain Semiconductor optical Amplifier with a neat diagram and compare it with EDFA. **(8)**

Answer: Refer section 11.2 of Text Book-I

b. Consider an lnGaAsP SOA with w = 5μm and d = 0.5μm. Given that $\upsilon_g = 2\times10^8 \text{m/s}$, if a 1.0μW optical signal at 1550nm enters the device. Then;
(i) What is the photon density?
(ii) What is the steady state gain per unit length? **(8)**

Answer: Refer section 11.1 of Text Book-I

TEXT BOOK

Optical Fiber Communications, Gerd Keiser, 3rd Edition, McGraw Hill Publications, 2000