**Tutorial Problems**

**Q1.** In the optical fiber, the core has a refractive index equal to 1.7 and a cladding of refractive index of 1.2.

a) What is the speed of light inside the core?

Ans: refractive index of the core is defined as n1 = C/V (C- speed of light, and V- velocity of light in core), V = C/n1 = 1.76х108 m/sec.

b) What is the critical angle at the core-cladding interface?

θc =arcsin (1.2/1.7) = 44.9ᵒ (note: at critical angle θ in cladding will be 90ᵒ)

c) What is the maximum angle θ that the rays leaving the source of light should make with the axis of the fiber so that total internal reflections takes place at the core cladding interface?

θ < 90 – θc = 45.1ᵒ.

**Q2**. Ten signals, each requires 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? (a) without guard band, and (b) with guard bands are of 400 Hz wide.

Ans: a) 40KHz, and (b) 43.6 KHz

**Q3**. four channels , two with a bit rate of 200kbps and two with a bit rate 150 kbps are to be multiplexed using multiple slots TDM with no synchronization bits. Answer the following questions: assume 4 bits are sent from each of the first 2 sources and 3 bits from each of the second 2 sources.

i. What is the size of a frame in bits?

ii. What is the frame rate?

iii. What is the duration of a frame?

iv. What is the date rate?

Sol:

i. The frame carries 4 bits from each of the first two sources and 3 bits from each of the second two sources. Frame size = 4 × 2 + 3 × 2 = 14 bits.

ii. Each frame carries 4 bit from each 200-kbps source or 3 bits from each 150 kbps. Frame rate = 200,000 / 4 = 150,000 /3 = 50,000 frames/s.

iii. Frame duration = 1 /(frame rate) = 1 /50,000 = 20 μs.

iv. Output data rate = (50,000 frames/s) × (14 bits/frame) = 700 kbps. We can also calculate the output data rate as the sum of input data rates because there are no synchronization bits. Output data rate = 2 × 200 + 2 × 150 = 700 kbps.