ECE425S Optical Communication Systems

FINAL EXAM

April 27, 1998
9:30 am - 12 noon

ATTEMPT ALL 7 PROBLEMS

1. A single mode fibre has a core with a refractive index of 1.45 and an index step of 0.005. Calculate the core radius if the fibre has a cutoff wavelength for the second order mode of $\lambda = 1$ μm. Estimate the fraction of modal power in the core for a mode of wavelength $\lambda = 1.5$ μm.

2. A network designer is considering using either a star or a linear network topology for a network connecting **N** stations. Assume the star has a connector loss of 2 dB for each coupling into and out of the star, and an excess loss (over the power splitting loss) of 10 dB. The couplers for the linear network tap off 10% of the incident light and have a total insertion loss of 1 dB. Assuming that the fibre losses are negligible, show in detail how the choice of a network topology to optimize the power budget would depend on **N**.

3. Assume that both the star and linear systems described in problem 2 utilize stations with a transmitter that sends +6 dBm of optical power into the fibre, and a receiver that requires an input of -30 dBm to achieve the required signal-to-noise ratio. If the system is to be designed with a system margin of 6 dB, what would be the maximum **N** possible for each topology?

4. Describe in as much detail as possible how the optical output power of a semiconductor laser diode varies as the drive current is varied from 0 to high above threshold. Describe also how the spectrum of the optical signal will vary with drive current.

5. A p-i-n detector is used with a load resistor **R** to detect digital signals with an average optical power **P**. Assuming an equal number of "1"s and "0"s; a detector quantum efficiency of $\eta = 0.7$ with no dark current or surface leakage current, and a receiver bandwidth **B**, develop an expression (as a function of **P**) for the value of load resistance **R** necessary for the signal-to-noise ratio of the receiver to be shot noise limited.

6. For the receiver described in problem 5, calculate the incident optical power required to achieve a bit-error-rate (BER) of 10^{-11} if the receiver is shot noise limited with bandwidth **B** = 100 MHz, and the wavelength of light is $\lambda = 1.5$ μm.

7. A wide area network (WAN) is being designed to carry a large amount of data, and also telecommunications signals. Discuss the limits on the number of wavelengths that could be used in a wavelength-division multiplexed (WDM) system for this kind of application.