332: 559 Optical Computer/Communication Networks — Spring 2001
Potential Questions for Exam II
Exam II, Monday, April 30, SEC 212, 6:10–7:30

Up to Section 8.5

CN = Class Notes; RS = Ramaswami and Sivarajan Textbook

1. Explain the modulation technique used in optical networks. (CN, p. 78–79; RS, p. 177–179).
2. Explain the demodulation process using an ideal photo detector and define its bit-error-rate (BER), (CN, p. 80–81; RS, p. 180–181).
3. Explain the procedure of deriving BER for a realistic (practical) receiver (CN, p. 82–84; RS, p. 186–188).
4. Define the power penalty (PP) due to practical optical network impairments and present the practical PP table including the given values (CN, p. 86; RS, p. 205–206).
5. Derive the power penalty formula for the transmitter (CN, p. 87; RS, p. 207–208).
6. Discuss imperfections (limitations) of EDFA (CN, p. 88–90; RS, p. 209–212).
7. Explain how do we coupe with the power transient and gain saturation in EDFA (CN, p. 90–92; RS, p. 213–216).
8. Derive power penalties due to intracross talk and intercross talk and present the corresponding graphs: PP vs crosstalk in [dB]. How the graphs look like in the case of an optical network with many nodes. (CN, p. 93–95; RS, p. 218–223).
9. Present the graph: dispersion vs wavelength for SMF, NDF, and DSF single mode fibers (CN, p. 96; RS, p. 229).
10. Present the graph: bit rate vs modal, chromatic, and polarization mode dispersions (CN, p. 97; RS, p. 234).
11. Derive the expression for the effective length in optical systems with amplifiers and present the graph: PL_e vs amplifier spacing (CN, p. 98–99; RS, p. 235–237).
12. Explain the stimulated Brillouin scattering nonlinear phenomenon (CN, p. 100–101; RS, p. 238–240).
13. Explain the stimulated Raman scattering nonlinear phenomenon (CN, p. 101–102; RS, p. 240–243).
14. Present the star topology and discuss its loss (no need to go through derivations). CN, p. 107–108; RS, p. 292–294.
15. Present the bus topology and discuss its loss (no need to go through derivations). CN, p. 108–19, RS, p. 293–294.
16. Discuss the synchronization procedure for the star coupler. CN. p. 110–111; RS, p. 298–300.
17. Explain the SA/SA basic and modified protocols. CN, p. 111–113; RS, p. 300–303.
18. Derive the throughput formula for the basic SA/SA protocol and draw graphs throughput vs expected number of data packets for both the basic and modified SA/SA protocols. CN, p. 113–114; RS, p. 303–306.
19. Discuss the DT-WDMA protocol. CN, p. 115–117; RS, p. 307–309.
20. Present the throughput analysis of the DT-WDMA protocol and comment on the impact of scheduling. Present the delay vs load graph. CN, p. 117–118; RS, p. 309–310, 313.
21. Present the main features of the optical layer. CN, p. 122.; RS, p. 334, 336.
22. Draw a diagram for an all-optical WXC (wavelength crossconnector) with no wavelength conversion. CN. p. 125; RS, p. 342.
23. Draw a diagram for an all-optical WXC (wavelength crossconnector) with wavelength conversion. CN. p. 126; RS, p. 342.
24. Draw an arbitrary static WXC, write its connectivity matrix, and draw the corresponding graph. CN, 130–131; RS, p. 353–355.
25. Explain how the graph coloring problem can be related to the wavelength assignment prblem (CN, p. 135; RS, p. 368–369).
26. Difine the wavelength assignment problem for line and ring networks and give simple examples (CN, p. 136; RS, p. 371–372).
27. Present linear lightwave networks (CN, p. 138–139; CN, p. 384–388).
28. Define OTDM using bit interleaving and packet interleaving techniques (CN, p. 140–141; RS, p. 516–518).
29. Present the multiplexing technique via bit interleaving used in OTDM. (CN, p. 142–143; RS, p. 519–520).
30. Present the demultiplexing technique via bit interleaving used in OTDM. (CN, p. 143–144; RS, p. 520–521).
31. Present the multiplexing technique via packet interleaving used in OTDM. (CN, p. 144–145; RS, p. 521–522).

32. Present the demultiplexing technique via packet interleaving used in OTDM. (CN, p. 146; RS, p. 523–524).
33. *** (Problem 4.5). Show that BER for an OOK direct detection receiver is given by

$$BER = Q\left(\frac{I_1 - I_0}{\sigma_1 + \sigma_0}\right)$$

34. *** (Problem 4.6). Show that the threshold current in OOK direct detection receiver is given by

$$I_{th} = \frac{\sigma_0 I_1 + \sigma_1 I_0}{\sigma_0 + \sigma_1}$$

35. *** (Problem 5.17). Neglecting the depletion of the pump wave solve

$$\frac{dI_s}{dz} = -g_B I_p I_s + \alpha I_s, \quad \frac{dI_p}{dz} = -g_B I_p I_s - \alpha I_p, \quad P_s(L),\ P_p(0) \text{ given}$$

36. *** (Problem 7.1). Staring with the electric field formula of a 2×2 directional coupler, that is

$$\begin{bmatrix} E_{01}(f) \\ E_{02}(f) \end{bmatrix} = e^{-i\beta l} \begin{bmatrix} \cos(kl) & i\sin(kl) \\ i\sin(kl) & \cos(kl) \end{bmatrix} \begin{bmatrix} E_{i1}(f) \\ E_{i2}(f) \end{bmatrix}$$

derive the corresponding formula for optical powers, that is

$$\begin{bmatrix} P_{01}(f) \\ P_{02}(f) \end{bmatrix} = (1-\gamma) \begin{bmatrix} 1-\alpha & \alpha \\ \alpha & 1-\alpha \end{bmatrix} \begin{bmatrix} P_{i1}(f) \\ P_{i2}(f) \end{bmatrix}$$

37. *** (Problem 7.3). Derive the loss formula $L_{loss}^{opt} \approx 8.7 + 20\log_{10}(n) - (2n-1)\log_{10}(\gamma)$ for the bus topology.
38. *** (Problem 7.7). prove that in the modified SA/SA protocol the probability that no data packet is transmitted on a given data slot is $1 - Ge^{-G}/W$, where G is the arrival rate of control packets in each control slot. Assume the traffic is uniform.
39. *** (Problem 7.8). Prove that for all values of $W, L,$ and G, the modified SA/SA protocol has a throughput at least as high as that of the basic SA/SA protocol.
40. *** (Problem 7.9). For fixed W and L, what is the value of G that minimizes the throughput of the basic SA/SA protocol? Repeat for the modified SA/SA protocol.
41. *** (Problem 7.10). For fixed W and G, what is the value of L that minimizes the throughput of the basic SA/SA protocol? Repeat for the modified SA/SA protocol.
42. *** (Problem 8.14). Prove Theorem 8.2 that states that $W = (n!)^{1/2n}$ is the necessary number of wavelengths for permutation routing in a static network with n users.
43. *** (Problem 14.1).
44. *** (Problem 14.2).