

EECE 598

Optical Communications

Note 00

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Office : OCNL 309



Schedule

- Lecture :
 - Tu/Th 3:30 – 5:20PM
 - OCNL 119
- Office Hours
 - TBD
 - By appointment (email me)



Course Flow

- Prerequisites :
 - EECE 211, EECE 311, EECE Senior Standing
- Relations to other courses :
 - Provide background knowledge for communication systems and devices, optical components
 - Provide technical documents preparation skills, technical presentation skills



Class Materials

- Text :
 - Optical Fiber Communications (4th Ed) by G.Keiser, McGraw-Hill, 2011
- Reference
 - Fiber-optic communication systems (4th Ed) by G.P.Agrawal, Wiley, 2010 (available via online CSU Chico library)
 - Optical fiber telecommunications. VIA, Components and subsystems by Ivan P. Kaminow, Tingye Li, Alan E. Willner, Elsevier, 2013 (available via online CSU Chico Library)
 - Optical fiber telecommunications. VIB, Systems and networks by Ivan P. Kaminow, Tingye Li, Alan E. Willner, Elsevier, 2013 (available via online CSU Chico Library)
 - Design of Integrated Circuits for Optical Communications, 2nd Ed, Wiley, 2012
 - Advanced Optical Wireless Communication systems, Cambridge Univ. Press, 2012



Class Materials

- Lecture Notes :
 - Syllabus, major electronic notes, assignments, and announcements will be posted on Vista (<http://portal.csuchico.edu>)



Grading

- Presentations (30%)
- Midterm exam 1 (20%)
 - TBD, Late September
 - In class, Closed book
- Midterm exam 2 (20%)
 - TBD, Early November
 - In class, Closed book
- Final exam (30%)
 - Date will be announced
 - Closed book, No calculators



Side Notes

- Dropping and Adding

- You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. found <http://www.csuchico.edu/catalog/>
You should be aware of the new deadlines and penalties for adding and dropping classes.

- Academic integrity

- Students are expected to be familiar with the University's Academic Integrity Policy. Your own commitment to learning, as evidenced by your enrollment at California State University, Chico, and the University's Academic Integrity Policy requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the Office of Student Judicial Affairs. The policy on academic integrity and other resources related to student conduct can be found at: <http://www.csuchico.edu/sjd/integrity.shtml>

- Other details

- Refer to syllabus provided



Lectures

- Presentation 1
 - Topics will be determined
 - 15 – 20 min presentation
 - 5 min Q&A from the audiences
- Presentation 2
 - Topics will be determined
 - 15 – 20 min presentation
 - 5 min Q&A from the audiences
- Lecture
 - Summary



Presentations

- Each students will have 3 ~ 4 presentations
 - Provide Presentation Slides
 - 15 -20 min worth
 - Be sure to practice and “time” the presentation
 - Audiences are asked to provide the summary (Audience Report) as the homework



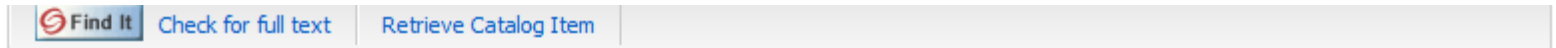
Online Resources



How to access online texts

- Online **Text 1**

- Goto <http://www.csuchico.edu/library/>
- Type in the search word “**fiber optic communication**”
- Click “**Online Access**”



3.



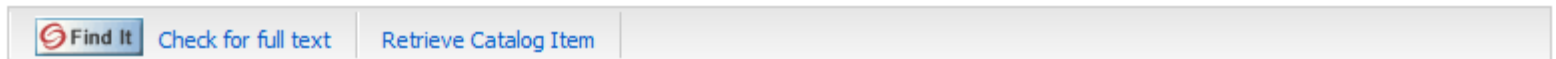
[Fiber-optic communication systems \[electronic resource\] / Govind P. Agrawal.](#)

By: Agrawal, G. P.. Hoboken, N.J. : Wiley, c2010. 01/01/2010 1 online resource. Language: English

[Online Access](#)

Subjects: Optical communications; Fiber optics

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How to access online texts


- Online **Text 2**


- Goto <http://www.csuchico.edu/library/>
- Type in the search word “**fiber optic communication**”
- Click “**Online Access**”

10. Optical **fiber** telecommunications. VIA, Components and subsystems [electronic resource] / [edited by] Ivan P. Kaminow, Tingye Li, Alan E. Willner.

 Oxford, UK ; Waltham, MA : Elsevier, 2013. 01/01/2013 1 online resource (1 v.) : ill. Language: English, Database: Meriam Library Catalog

Subjects: Optical **fiber** communication; Optical communications; Fiber optics

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How to access online texts

- Online **Text 3**

- Goto <http://www.csuchico.edu/library/>
- Type in the search word “**fiber optic communication**”
- Click “**Online Access**”

8. Optical **fiber** telecommunications: VIB, Systems and networks [electronic resource] / [edited by] Ivan P. Kaminow, Tingye Li, Alan E. Willner.



eBook

Oxford, UK ; Waltham, MA : Academic, 2013. 01/01/2013 1 online resource (1 v.) : ill. Language: English, Database: Meriam Library Catalog

Subjects: Optical **fiber** communication; Optical **fiber** communication -- Equipment and supplies; **Fiber optics**; Telecommunication systems -- Management



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A page from
your text

in PC usage. To handle the ever-increasing demand for high-bandwidth services ranging from home-based PC users to large businesses and research organizations, telecommunication companies worldwide greatly enhanced the capacity of fiber lines. This was accomplished by adding more independent signal-carrying wavelengths on individual fibers and increasing the transmission speed of information being carried by each wavelength.

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1.1.2 Advantages of Optical Fibers

The advantages of optical fibers compared to copper wires include the following:

Long Distance Transmission Optical fibers have lower transmission losses compared to copper wires. Consequently data can be sent over longer distances, thereby reducing the number of intermediate repeaters needed to boost and restore signals in long spans. This reduction in equipment and components decreases system cost and complexity.

Large Information Capacity Optical fibers have wider bandwidths than copper wires, so that more information can be sent over a single physical line. This property decreases the number of physical lines needed for sending a given amount of information.

Small Size and Low Weight The low weight and the small dimensions of fibers offer a distinct advantage over heavy, bulky wire cables in crowded underground city ducts or in ceiling-mounted cable trays. This feature also is of importance in aircraft, satellites, and ships where small, low-weight cables are advantageous, and in tactical military applications where large amounts of cable must be unreeled and retrieved rapidly.³⁴

Immunity to Electrical Interference An especially important feature of an optical fiber relates to the fact that it is a dielectric material, which makes it immune to electrical interference. This makes optical fibers immune to the electromagnetic interference that affects copper wires, such as

Reference 34



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Optical Fiber Communications

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Goto reference
at the back of
each chapters

- (b) Convert the following decibel power gains to absolute power gains: -30 dB, 0 dB, 13 dB, 30 dB, 10n dB.
- 1.8 (a) Convert the following absolute power levels to dBm values: 1 pW, 1 nW, 1 mW, 10 mW, 50 mW.
- (b) Convert the following dBm values to power levels in units of mW: -13 dBm, -6 dBm, 6 dBm, 17 dBm.
- 1.9 A signal travels from point A to point B.
- (a) If the signal power is 1.0 mW at point A and 0.125 mW at point B, what is the attenuation in dB?
- (b) What is the signal power at point B if the attenuation is 15 dB?
- 1.10 A signal passes through three cascaded amplifiers, each of which has a 5-dB gain. What is the total gain in dB? By what numerical factor is the signal amplified?
- 1.11 A 50-km long optical fiber has a total attenuation of 24 dB. If 500 μ W of optical power get launched into the fiber, what is the output optical power level in μ W?
- 1.12 Based on the Shannon theorem, the maximum data rate R of a channel with a bandwidth B is $R = B \log_2(1+S/N)$, where S/N is the signal-to-noise ratio. Suppose a transmission line has a bandwidth of 2 MHz. If the signal-to-noise ratio at the receiving end is 20 dB, what is the maximum data rate that this line can support?
- 1.13 (a) At the lowest TDM level of the digital service scheme, 24 channels of 64 kb/s each are multiplexed into a 1.544-Mb/s DS1 channel. How much is the overhead that is added?
- (b) The next higher multiplexed level, the DS2 rate, is 6.312 Mb/s. How many DS1 channels can be accommodated in the DS2 rate, and what is the overhead?
- (c) If the DS3 rate that is sent over a T3 line is 44.376 Mb/s, how many DS2 channels can be accommodated on a T3 line, and what is the overhead?
- (d) Using the above results, find how many DS1 channels can be accommodated over a T3 line, and what is the overhead?

List of References

REFERENCES

1. J. Hecht, *City of Light*, Oxford University Press, New York, revised expanded ed., 2004. This book gives a comprehensive account of the history behind the development of optical fiber communication systems.
2. E. Snitzer, "Cylindrical dielectric waveguide modes," *J. Opt. Soc. Amer.*, vol. 51, pp. 491-498, May 1961.
3. A. E. Willner, ed., *Optical Fiber Telecommunications-I*, vols. A and B, Academic, New York, 1983.
4. I. P. Kaminow and T. L. Koch, eds., *Optical Fiber Telecommunications-III*, vols. A and B, Academic, New York, 1997.
5. I. P. Kaminow and T. Li, eds., *Optical Fiber Telecommunications-IV*, vols. A and B, Academic, New York, 2002.
6. I. P. Kaminow, T. Li, and A. E. Willner, eds., *Optical Fiber Telecommunications-V*, vols. A and B, Academic, New York, 2008.

Look for
reference 34



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- List of References**
10. R. L. Freeman, *Fiber-Optic Systems for Telecommunications*, Wiley, Hoboken, NJ, 2002.
 11. G. P. Agrawal, *Fiber Optic Communication Systems*, Wiley, Hoboken, NJ, 3rd ed., 2002.
 12. E. Desurvire, *Erbium-Doped Fiber Amplifiers*, Wiley, Hoboken, NJ, 2002.
 13. E. Desurvire, D. Bayart, B. Desthieux, and S. Bigo, *Erbium-Doped Fiber Amplifiers: Devices and System Developments*, Wiley, New York, 2002.
 14. B. Razavi, *Design of Integrated Circuits for Optical Communi.*, New York, 2003.
 15. J. A. Buck, *Fundamen*, Wiley, New York, 2004.
 16. K. P. Ho, *Phase-Modulated Optical Communication Systems*, Springer, New York, 2005.
 17. G. Keiser, *Optical Communications Essentials*, McGraw-Hill, New York, 2003.
 18. G. Keiser, *FTTX Concepts and Applications*, Wiley, Hoboken, NJ, 2006.
 19. A. Yariv and P. Yeh, *Photonics: Optical Electronics in Modern Communications*, Oxford University Press USA, New York, 6th ed., 2006.
 20. B.E.A. Saleh and M. C. Teich, *Fundamentals of Photonics*, Wiley, Hoboken, NJ, 2nd ed., 2007.
 21. *Optical Fiber Communications (OFC) Conf.* is cosponsored annually by the Optical Society of America (OSA), Washington, DC, and the Institute of Electrical and Electronic Engineers (IEEE), New York, NY.
 22. *European Conference on Optical Fibre Communications (ECOC)* is held annually in Fitrone: sponsored by various European
 26. J. Proakis and M. Salehi, *Digital Communications*, McGraw-Hill, Burr Ridge, IL, 5th ed., 2008.
 27. A. B. Carlson and P. B. Crilly, *Communication Systems*, McGraw-Hill, Burr Ridge, IL, 5th ed., 2009.
 28. L. W. Couch II, *Digital and Analog Communication Systems*, Prentice Hall, Upper Saddle River, NJ, 7th ed., 2007.
 29. F. P. Kapron, D. B. Keck, and R. D. Maurer, "Radiation losses in glass optical waveguides," *Appl. Phys. Lett.*, vol. 17, pp. 423–425,
 - the rise and rise of optical *Topics Quantum Electron.*, vol. 6, no. 6, pp. 1084–1093 Nov./Dec. 2000.
 31. B. St. Arnaud, J. Wu, and B. Kalali, "Customer-controlled and -managed optical networks," *J. Lightwave Technology*, vol. 21, pp. 2804–2810, Nov. 2003.
 32. D. Simeonidou, R. Nejabati, G. Zervas, D. Klonidis, A. Tzanakaki, M. J. O'Mahony, "Dynamic optical-network architectures and technologies for existing and emerging grid services," *J. Lightwave Technology*, vol. 23, pp. 3347–3357, Oct. 2005.
 33. N. Taesombut, F. Uyeda, A. A. Chien, L. Smarr, T. A. DeFanti, P. Papadopoulos, J. Leigh, M. Ellisman, and J. Orcutt, "The OptiPuter: High-performance, QoS-guaranteed network service for emerging e-science applications," *IEEE Commun. Mag.*, vol. 44, pp. 38–45, May 2006.
 34. D. H. Rice and G. Keiser, "Applications of fiber optics to tactical communication systems," *IEEE Commun. Mag.*, vol. 23, pp. 46–57, May 1985.
 35. ITU-T Recommendation G.650.3, *Optical*

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(Ref 34) D.H.Rice and G.Keiser, "Applications of fiber optics to tactical communication systems," *IEEE Commun. Mag.*, vol.23, pp46-57, May 1985



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1.



Periodical

[IEEE Xplore \[electronic resource\]](#).

New York, N.Y. : IEEE 01/01/2000 Language: English



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Subjects: Electrical engineering -- Congresses; Electrical engineering -- Periodicals; Electrical engineering -- Standards; Computer science -- Congresses; Computer science -- Periodicals; Computer science -- Standards



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The screenshot displays the IEEE Xplore Digital Library interface. At the top, a navigation bar includes links to IEEE.org, IEEE Xplore Digital Library, IEEE Standards, IEEE Spectrum, and More Sites. On the right, it shows 'Cart(0)', 'Create Account', and 'Sign In'. The main header features the IEEE Xplore logo and a message: 'Access provided by: California State University - Chico Sign Out'. Below this is a 'BROWSE' menu with categories like Books & eBooks, Conference Publications, Education & Learning, Journals & Magazines, and Standards. A 'QUICK LINKS' section on the left lists 'Manage Alerts', 'Training & Tools', and 'IEEE Xplore Mobile'. The central search area shows 'Search 3,243,147 items' with a search bar and a 'SEARCH' button. Below the search bar are links for 'Advanced Search', 'Preferences', 'Search Tips', and 'More Search Options'. At the bottom, there are tabs for 'Highlights', 'What's Popular', and 'Most Recent', followed by a 'MORE HIGHLIGHTS' section with a list of items (1-5) and a preview of 'Now in IEEE Xplore TMS 2012 conference papers'.



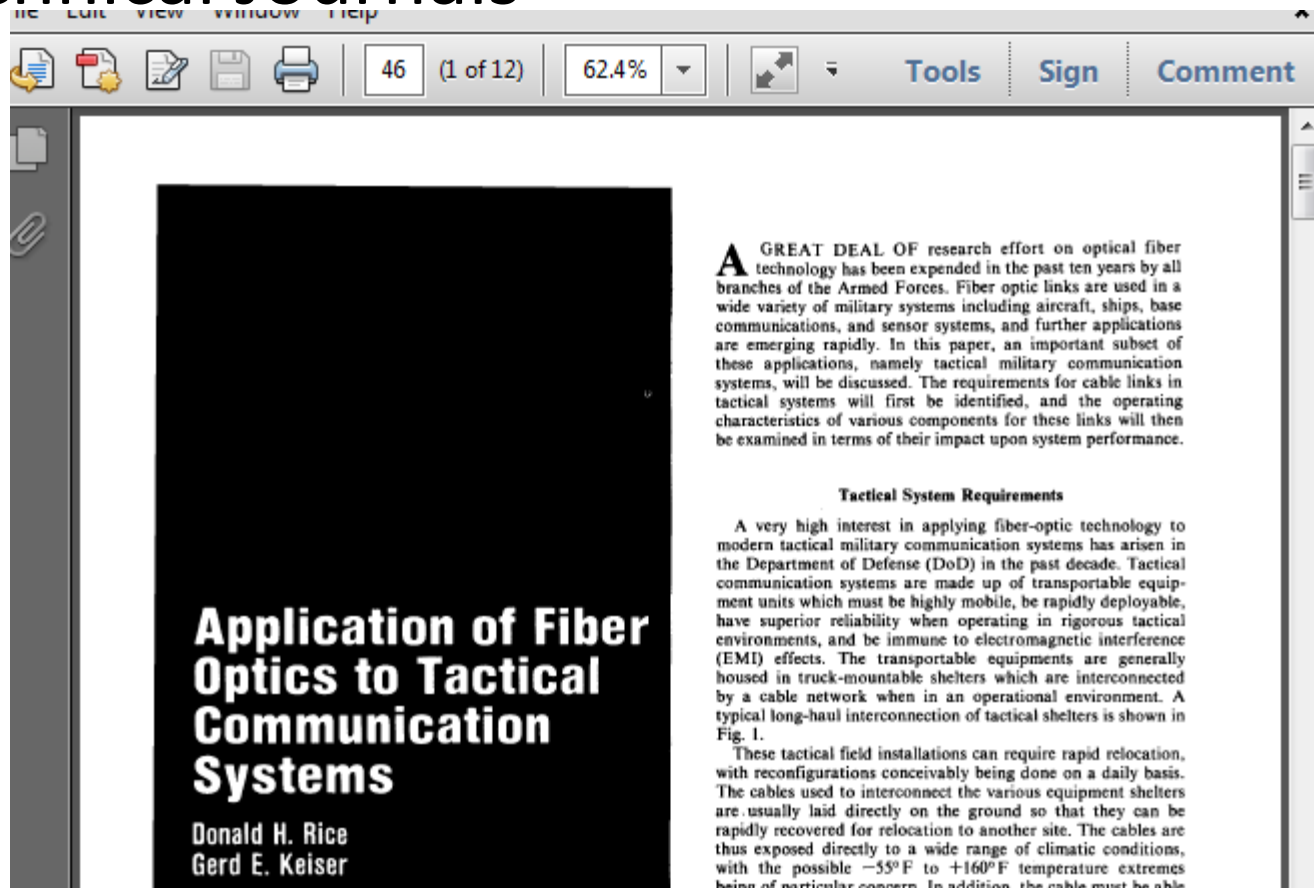
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The screenshot shows the IEEE Xplore search results page. At the top, there is a search bar with the text "SEARCH" and a dropdown menu for "Advanced Search | Preferences | Search Tips | More Search Options". Below the search bar, the search results are displayed. On the left, there is a "FILTER THESE RESULTS" sidebar with options for "Search within results:", "Only show full text results included in my subscription", "CONTENT TYPE" (Conference Publications (14), Journals & Magazines (8)), "PUBLICATION YEAR" (Single Year, Range, 1978 to 2012), and "AUTHOR". The main search results area shows "You searched for: applications fiber optics tactical communication systems" and "22 Results returned". The results are sorted by "Relevance". The first result is "Application of fiber optics to tactical communication systems" by Rice, D.; Keiser, G., published in "Communications Magazine, IEEE", Volume: 23, Issue: 5, Digital Object Identifier: 10.1109/MCOM.1985.1092579, Publication Year: 1985, Page(s): 46 - 57. The result is marked as "INCLUDED WITH YOUR SUBSCRIPTION". Below the title, there are links for "Quick Abstract" and "PDF (3752 KB)". The second result is "Army Fiber Optic Program: An Update" by Dworkin, L.; Christian, J., published in "Communications, IEEE Transactions on".

How to access tech journals

- Technical Journals



Slide Format



Slide Format

- No restrictions on the format.
 - Make slides for you to use during 15 - 20 min talk.
 - Do not exceed 20 min, or too short.
 - Use figures, tables, etc., if necessary.
 - Some key words on the slides will help.
- Refer to one of my lecture notes (especially for introduction session) for your reference.



Audience Report Format



Audience Report Format

- Include following
 - Title, name of presenters,
 - Summary of the talk
 - The slides will be posted on the portal site.
 - Write 1 page summary/presentation.
 - You should make notes during the talk to do this.
 - Presentation Rating
 - Ratings
 - Excellent/Very Good/Good/Needs Improvement.
 - Consider “How well you understood the materials”
 - Consider “How well presenter answered your questions”
 - Provide the reason for the rating.



Grade on Presentations



Grade on Presentations

Date	2012--09--00 (000)							
Presenter	Name							
Title	Presentation Title							
Presentation Grade		Max						
Total	98/100							
Time	10	10						
Slide Prep	28	30						
Presentation	40	40						
Q&A	20	20						
Comments	Keeping good phase with class when presenting. Kept 20 min limit in presentations. Good examples from ext references.							
	Good slide prep, with signal propagation example and detailed calculation (design) method.							
	Some mistakes in abbreviation, DCF (Dispersion Compensating Fiber, not double clad fiber)							
	Good preparation for the Q&A (able to pin point difference between single mode and multi mode sources)							
Audience Report Grade	Percentage							
Excellent	78%							
Very Good	11%							
Good	11%							
Need Improvements	0%							
Comments (from Audience)	He covered the materials very thoroughly with lots of graphs and even some examples							
	He answered most of the questions he was asked and obviously had done his research on the topic.							
	Whe asked questions, he answered them in depth and in a very well through out manner.							
	I liked the examples, but it would be more useful if the equations were introduced earlier so that audience can better follow the ex							



Presentations



Who wants to present first?

- Two students per topic
- Batch A, Week 1
 - Optical Fiber Attenuation
 - Optical Fiber Dispersion



Week 1, Topic 1



Week 1, Topic 1

1. Optical Communication Fiber **Attenuation** (Loss) in Light Signal Propagation.

- Describe the concept of “Fiber Attenuation”.
- Include explanation about “Decibel Units” [dB], [dBm]
- Search for tables and figures which explains “Fiber Attenuation” w.r.t. wavelength.
- Search light signal propagation examples which explains “Fiber Attenuation” from the texts, technical journals, and google.
- Avoid using too many equations and try to include as many examples as possible.

(Ref 1) **Chapter 3.1** in text (Keiser, McGraw Hill, 2011)

(Ref 2) **Chapter 2.5** in text (Agrawal, Wiley, 2010)

(Ref 3) **Chapter 1.3** in text (Keiser, McGraw Hill, 2011 – for “decibel units”)



For Presenters

- Due Dates
 - Presentation Slides
 - MS Office power point or equivalent
 - **One day before presentation date**
 - For Week 1, Topic 1
 - Presentation
 - 09/02/2014 (Tuesday) 3:30pm
 - Presentation Slides due
 - **09/01/2014 (Monday) 5:00pm**



For Audiences

- Due Dates
 - **Audience Reports** (everyone except presenter)
 - MS Office word, pdf, or equivalent
 - **At beginning of next lecture**
 - For Week 1, Topic 1
 - Presentation
 - 09/02/2014 (Tuesday) 3:30pm
 - Audience Report due
 - 09/04/2014 (Thursday) 3:30pm



Week 1, Topic 2

1. Optical Communication Fiber **Dispersion** in Light Signal Propagation.

- Describe the concept of “Fiber Dispersion”.
- Search for tables and figures which explains “Fiber Dispersion” w.r.t. wavelength.
- Search light signal propagation examples which explains “Fiber Dispersion” from the texts, technical journals, and google.
- Describe different types of fibers (SMF, DCF, DSF, NZDSF) and dispersion properties.
- Avoid using too many equations and try to include as many examples as possible.

(Ref 1) **Chapter 3.2** in text (Keiser, McGraw Hill, 2011)

(Ref 2) **Chapter 2.3** in text (Agrawal, Wiley, 2010)

(Ref 3) ITU-T standard on SMF, G.652 (<http://www.itu.int/rec/T-REC-G.652-200911-I/en>)

(Ref 4) ITU-T standard on DSF, G.653 (<http://www.itu.int/rec/T-REC-G.653-201007-I/en>)

(Ref 5) ITU-T standard on NZDSF, G.655 (<http://www.itu.int/rec/T-REC-G.655-200911-I/en>)

