

NEW YORK CITY COLLEGE of TECHNOLOGY
THE CITY UNIVERSITY OF NEW YORK

DEPARTMENT: Electrical and Telecommunications Engineering Technology

COURSE CODE: TCET 4102/TC 700

COURSE TITLE: Fiber-optic communications

COURSE DESCRIPTION: This course is devoted to all aspects of fiber-optic communication technologies. Optical fibers, LEDs, laser diodes, photodiodes, passive components, optical amplifiers, and all basic units of a fiber-optic communications system are discussed. Transmission aspects of optical networks are also studied. The laboratory familiarizes students with main components, measuring and troubleshooting tools and techniques for optical communications applications.

PREREQUISITE: TCET 3202/TC 620

TEXTBOOK and other material: 1. Djafar K. Mynbaev and Lowell L. Scheiner, *Fiber-Optic Communications Technology*, Prentice Hall, 2001, ISBN 0-13-962069-9.
2. Course notes prepared by Professor Djafar Mynbaev, New York City College of Technology, Spring 2006.

COURSE OBJECTIVES: Upon the completion of this course, the students should be able to:

1. Understand the principle of fiber-optic communications. (ABET criteria 2b, 2c, and 2p.)
2. Describe the main types of components for fiber-optic communication systems. (ABET criteria 2d, 2f and 2m.)
3. Describe the main types of architectures, protocols and standards governing modern optical networks. (ABET criteria 2o and 2p.)
4. Develop hands-on experience in working with fiber-optic communications equipment. (ABET criteria 2c, 2d and 2e.)

TOPICS: The topics include components of fiber-optic communication systems, such as optical fiber, transmitters, receivers, passive and active components and subsystems; topology, architecture, protocols and standards governing optical networks; and specific types of optical networks, such as WDM and FTTP.

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CLASS HOURS: 2
LAB HOURS: 3
CREDITS: 3

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Descriptive details for laboratory coursework:

Laboratory exercises include measurement of power losses in multimode optical fibers and computer simulations of attenuation and dispersion in both multimode and singlemode fibers. The students will also measure input-output and spectral characteristics of various LEDs, a VCSEL and a photodiode. Measuring losses of a splitter and a MEMS optical switch is also included. Computer simulation of fiber-optic communications network, both single-wavelength and WDM, conclude the series of experiments.

GRADING POLICY:

Laboratory part	30%
Quizzes	30%
Research paper	10%
Final Exam	30%

Score and grades:

Quality Points	Numerical	Letter equivalent grade
4.0	100-93	A
3.7	90-92.9	A-
3.3	87-89.9	B+
3.0	83-86.9	B
2.7	80-82.9	B-
2.3	77-79.9	C+
2.0	70-76.9	C
1.0	60-69.9	D
0.0	59.9 and below	F

Assessment

The following assessment techniques are correlated to the course objectives as follows. In addition, each assessment technique incorporates one or more of the following ABET Criterion 2 outcomes (2a, 2b, 2c, 2d, 2e, 2f, 2k, 2l, 2m, 2n, 2o, 2p, and 2q.).

<p align="center">COURSE OBJECTIVES</p> <p>Upon the completion of the course, the student should be able to</p>	<p align="center">ASSESSMENT</p> <p align="center">Evaluation methods and criteria</p> <p>Students will be assessed based on their ability to</p>
<p>1. Understand the principle of fiber-optic communications.</p>	<p>1. Analyze the function of an optical fiber, a transmitter and receiver and describe the means of delivering information in a fiber-optic communication system.</p>
<p>2. Describe the main types of components for fiber-optic communication systems.</p>	<p>2. Distinguish between multimode and singlemode fibers from operational and functional standpoints and analyze main areas of applications of each type of fiber. Distinguish between LED and laser diode as light sources in transmitters. Analyze the role and characteristics of a photodiodes and receivers. Analyze the difference between passive and active components. Analyze the function and operation of optical switches and optical amplifiers and techniques for measuring their main characteristics.</p>
<p>3. Describe the main types of architectures, protocols and standards governing modern optical networks.</p>	<p>3. Distinguish between an optical point-to-point link and network. Analyze the main features of optical communication networks; distinguish between physical and logical topology; describe SONET, ATM, IP and other protocols; and demonstrate knowledge of main standards in optical networking.</p>
<p>4. Develop hands-on experience in working with fiber-optic communications equipment.</p>	<p>4. Demonstrate the ability to conduct, analyze and interpret both hands-on and computer-simulation experiments with components and systems in fiber-optic communications.</p>

Weekly course outline

WEEK NO.	TOPICS	READING ASSIGNMENT	HOMEWORK PROBLEMS/ LABORATORIES
1	Intro: Course outline and grading policy. Block diagram of a fiber-optic communi-	Pp. 1-13, 18-25,	Pr. 1.1-1.10, 1.12-1.20, 2.1-2.11.

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	cations system, technology and networks. Physics of light: quantum view, wave view and ray view. Total internal reflection and optical fiber.	28-41	Demo - Total internal reflection; optical fiber and cable. Computer demo - fiber-optic communications system, fabrication of optical fiber.
2	Light propagation in an optical fiber. Attenuation: absorption, scattering, bending losses. <i>Self study: Launching light into optical fiber, numerical aperture.</i>	Pp. 42-56	Pr. 3.1-3.26. Lab 1: Measuring attenuation in plastic optical fibers. Lab manual: pp.7 and 25.
3	Modes in optical fibers. Multimode fiber (MMF) Attenuation in MMF.	Pp. 57-69. Course Notes (CN) 1.	Pr. 3.27-3.44. Discussion of lab reports. Demo: MMF.
	Quiz #1 – Light and fiber.		
4	MMF: Modal dispersion. Multimode singlemode fibers. Chromatic dispersion. CN1.	Pp. 57-69. pp.2-10.	Lab 2: Measuring attenuation and in silica fibers: hands-on experiment. Lab manual: pp. 8 and 26-29.
	Next week: Bring a diskette or thumb drive to save the results of Lab 3.		
5	Bandwidth and bit rate. Reading the data sheets of MM optical fibers. <i>Self study: Reading specs of singlemode fiber.</i>	Pp. 71-77, 195-204. CN 1, Pp. 2-10.	Pr. 3.45-3.51, 6.16, 6.17, 6.19. Lab 3: Signal distortion in silica MM and SM fibers: computer simulation. Lab manual: pp. 9-10 and 56-59.
6	Fiber-optic cables. Splicing: procedure and losses. Connectors and adapters. Quiz # 2 – Optical fiber	Pp. 220-244. 248-270.	Pr. 7.6-7.8, 7.12. 8.1-8.16. Demo: Fiber-optic cables. Demo: Fusion splicer. Lab 4: Connection losses. Lab manual: pp. 11, 30-31, and 30-31.
7	Light sources for communications: LED -- principle of action, basic characteristics, and data sheets.	Pp. 313-332.	Pr. 9.1-9.23. Lab 5: Input-output characteristic of LEDs. (Session 1.) Lab manual: pp. 12-13 and 32-38.
8	Light sources for communications:	Pp. 332-359.	Pr. 9.25-9.51

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	Laser diodes -- principle of action, basic characteristics and data sheets.		Lab 5: Input-output characteristic of a VCSEL diode. (Session 2.) Lab manual: pp. 12-13 and 41-43.
9	Photodetectors: principle of action and characteristics. Minimum sensitivity. Reading a receiver data sheet.	Pp. 434-459.	Pr. 11.1-11.45, 11.91. Lab 6: Spectral characteristic of a photodiode. Lab manual: pp. 8 and 39-
40.	Quiz # 3 – Light sources		
10	Optical networks: point-to-point link and network. Physical and intelligent levels. Components: splitters and switches, repeaters and amplifiers.	Pp. 586-603, 637-642. CN 2.	Pr. 13.1-13.8, 13.35-13.36. Lab 7: Fiber-optic switch and splitter. Lab manual: pp. 15 and 44.
11	WDM optical networks. Definition, and main characteristics. DWDM and CWDM. ITU-T grid.	Pp. 499-511, CN 3. Pp. 503-506, 603-614.	Pr. 12.1-12.18, 12.19-12-28. Pr. 12.13- 12.18, 12.26. 13.12-13.19. Lab 11: Computer
	Quiz # 4 – PD, splitters, switches, repeaters, and optical		simulation amplifiers.
		Lab manual: pp. 21-22 and 60-61.	of fiber-optic link.
12.	Transmission in WDM networks: Power budget.	Pp. 506-523. pp. 283-288.	Pr.12.1-12.3, 12.1.2-12.18. Lab 12: Computer simulation of WDM system: Lab manual: pp. 23-24. Pr. 8.21-8.24.
13.	Optical access networks: FTTP/FTTH and PON: architecture, operation and components.	CN 2.	Instructor assignment. Lab 13: Computer simulation of power budget measurements. Lab manual: p. 24. Demo: OTDR.
14	Topic by students' request or General architecture of optical networks: Control plane and data plane, GMPLS. Review for the final examination.	CN 3.	Instructor assignment. Laboratory make-up session.

15 Final examination.

Legend: CN – course notes.

ASSIGNMENTS:

1. Answer the questions and solve the homework problems as listed in the course outline.
2. Be prepared to the lab experiments. Write lab reports.
A report is due by the next laboratory session. Late submission penalty: Every week of lateness will result in 10 points of penalty with the maximum accumulated penalty equaling to 50 points.
3. Submit a term paper devoted to the future trends in fiber-optic communications.
Choose a specific topic for your term paper. Consult your instructor when choosing a topic. A term paper is due by Week 14, i.e., one week before the final examination.