

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

DEPARTMENT:	Electrical and Telecommunications Engineering Technology
SUBJECT CODE: AND TITLE	TCET4232/TC830 Optical networks
COURSE DESCRIPTION:	This course is concentrated at optical networks. The main focus of this course is the current status and the future trends in the developing optical networks, which provides the adequate preparation of the students to their future work.
PREREQUISITES:	TCET4152/TC730, TCET4162/TC 760
TEXTBOOKS :	1. Rajiv Ramaswami and Kumar Sivarajan, <i>Optical Networks – A Practical Perspectives</i> , 2nd edition, Morgan Kaufmann Publishers, 2002, ISBN: 1-55860-655-6. 2. Djafar K. Mynbaev and Lowell L. Scheiner, <i>Fiber-Optic Communications Technology</i> , Prentice Hall, 2001, ISBN 0-13-962069-9.
COURSE OBJECTIVES:	Upon the completion of the course, the student should be able to: <ol style="list-style-type: none">1. Understand the evolution and classification of optical networks. (ABET criteria 2i and 2o.)2. Describe the main types of architectures, protocols and standards governing modern optical networks. (ABET criteria 2o and 2p.)3. Analyze the need and methods of switching and routing in optical networks. (ABET criteria 2c, 2o and 2q.)4. Understand main issues in design and management of optical networks. (ABET criteria 2b, 2d, 2f, 2i, 2n, and 2p.)5. Acquire knowledge of technical documentation and develop hands-on experience in working with optical-network equipment. (ABET criteria 2a, 2c, 2d and 2e.)

TOPICS: The topics include evolution and classification of optical networks; architecture, protocols and standards; switching and routing in optical networks; design issues in optical networks; management of optical networks; and access optical networks.

CLASS HOURS: 2
LAB HOURS: 3
CREDITS: 3

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DESCRIPTIVE DETAILS FOR LABORATORY COURSEWORK:

Laboratory exercises comprise the experimental study of operation and measurement of main performance parameters of wavelength-division multiplexing (WDM) optical networks and their systems. These exercises include experimental study of wavelength assignments and routing, including wavelength conversion and measurements transmission and performance parameters, such as eye diagram and bit-error rate (BER). The students will also study the practical approaches to restoration of optical networks.

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, 2f, 2k).

<p style="text-align: center;">COURSE OBJECTIVES</p> <p style="text-align: center;">Upon the completion of the course, the student should be able to</p>	<p style="text-align: center;">ASSESSMENT</p> <p style="text-align: center;">Evaluation methods and criteria Students will be assessed based on their ability to</p>
<p>1. Understand the main steps in evolution of optical networks and their classification, including ability to explain types of modern optical networks from both scale and functional standpoints..</p>	<p>1. Analyze three generations of optical networks and associated technology and protocols, including ability to distinguish between core and edge networks from functional standpoints and analyze main features of long-distance, metro and access networks..</p>
<p>2. Describe the main types of architectures, protocols and standards governing modern optical networks, including understanding the current status and future trends in developing access optical networks, such as fiber-to-the-premises (FTTP) networks.</p>	<p>2. Distinguish between physical and logical topologies of WDM optical networks. Distinguish among architectures of optical access networks. Analyze the main types passive optical networks (PONs). Analyze the current and emerging access-network technologies. Analyze main optical networks protocols and standards developed by the world leading standards bodies (ITU-T, IEEE, IETF, etc.)</p>
<p>3. Understand the need and trends in switching and routing in optical networks, including:</p>	<p>3. Analyze the need and trends in modern approaches to switching and routing in optical networks based on understanding the Internet operation, including ability to:</p> <ul style="list-style-type: none"> a. Analyze the difference between circuit and packet switching and demonstrate comprehension of circuit switching, including wavelength routing, in optical networks. b. Distinguish between burst and packet switching/routing. c. Distinguish between data and control planes in optical networks and analyze the new paradigm in the Internet packet routing-label switching. Demonstrate comprehension of GMPLS in

<p>4. Understand main issues in design and management of optical networks, including:</p>	<p>optical networks.</p> <p>4. Analyze main issues in design and management of optical networks, including ability to:</p> <ul style="list-style-type: none"> a. Describe and perform such designing steps in optical networks as calculations of power and time budgets and realization of these budgets in practical applications and implement the built-in monitoring network capacity and bandwidth-on-demand requirements. b. Analyze the main functions of the optical-network management; exhibit the knowledge of the main issues in the network resilience and illustrate skills in building reliable and survival optical networks.
<p>5. Acquire knowledge of technical documentation and develop hands-on experience in working with optical-network equipment.</p>	<p>5. Analyze the industry technical documentation, comprehend the operational principles supporting this documentation and use these documents for practical applications. Conduct, analyze and interpret experiments and apply experimental results to improve performance of optical networks.</p>

Course outline

(Homework assignments will be given by an instructor at every session.)

Week	Topic	Reading assignment	Laboratory Exercises
1	Evolution of optical networks: From point-to-point (PTP) link to WDM optical network, from ring to mesh topology, network models.	[1] Chapter 1; [2] 14.1. Lecture notes.	Demo: WDM link and its components.
2	Optical network classification. Scale criterion: long-haul, metro, and local networks; functional criterion: core (backbone), edge, access networks. Main features of long-haul, metro and access networks. Quiz # 1 - _PTP link and network.	[1] Chapter 1; [2], Chapter 1, 14.1. Lecture notes.	Demo: Architecture and performance of long-haul network.
3	Architectures, protocols, and standards—logical layers: Four-layer architecture and future trends, protocols ruling access, transport, signaling, protection and restoration. Specific protocols: IP, ASON, OTN, GMPLS, RPR, others.	[1] 1.4, 1.8, 6.1, 6.3; [2] 14.2. Lecture notes.	Lab 1: WDM MUXs and DEMUXs – operation and characteristics
4	Architectures, protocols, and standards—logical layers (continued): Standardization in optical networks. (What to standardize. Activities of standards organizations: ITU-T, ODSI, OIF, IETF, ISO, and IEC.)	[1] 6.3, Appendix C; [2] 14.2, Appendix D. Lecture notes.	Lab 2: WDM link – operation and characteristics.
5	Routing in optical networks What it is. Circuit switching. (Fiber connections and wavelength switching: operations and protocols. Problems: granularity, bandwidth efficiency, etc. Quiz #2 – Classification and architecture of optical networks	[1] 7.3, 7.4, 8.2; [2] 13.5. Lecture notes.	Lab 3: WDM network – optical cross-connect for path routing.
6	Routing in optical networks (continued): Packet switching: What it is. Problems and solutions, current status. Protocols supporting packet switching → preparing packet-switching optical networks. Burst switching: What it is. Reservation schemes. Technology and control plane.	[1] 12.1 - 12.5; [2] 14.3. Lecture notes.	Lab 4: WDM network – wavelength routing (Session I).

	General protocols → preparing burst-switching networks.		
7	Routing in optical networks (continued): Label switching (GMPLS). (Label switching in electronic and optical domain: MPLS and GMPLS. Advantages: QoS, traffic prioritization, traffic engineering, others. Problems. GMPLS as a means to simplification of network architecture.)	[1] 6.3, 8.2; [2] 14.3. Lecture notes.	Lab 4 (cont'd): WDM network – wavelength routing (Session II).
8	Design issues: Design criteria. (Power and dispersion: Power margin and power penalty. BER and Q factor. Performance characteristics.) Quiz # 3 – Routing in optical networks.	[1] 8.1, 9.5; [2] 8.4. Lecture notes.	Lab 5: Measuring BER in WDM network.
9	Design issues: WDM network design – general. (Choosing fiber, OAs, and channel density; placement OAs, DCs, and OXCs; choosing type of OXCs and OADMs; OTDM and DWDM.)	[1] 5.1 – 5.5; [2] 12.2, 12.4. Lecture notes.	Lab 6: Wavelength conversion in WDM network.
10	Design issues (cont'd): Transmission problems. Improving performance characteristics of optical networks. (Overcoming transmission impairments, increasing network capacity, achieving all-optical transmission; specific improvements: reduction of FWM effect, cancellation of Raman crosstalk, etc.) Quiz # 4 – Design issues in optical networks.	[1] 5.6— 5.12; [2] 6.3, 6.4. Lecture notes.	Lab 7: Transmission evaluation using eye diagram.
11	Optical network management: Introduction. – Optical network management is and its main functions. Survivability. (What it is; protection and restoration; dedicated and share protection; restoration time; MPLS restoration; survivability design. Standardization.	[1] 9.1 – 9.4, 10.2, 10.6; [2] 14.3. Lecture notes.	Lab 8: Restoration in an optical network: study the operation and measuring parameters.
12	Network monitoring, measuring, and testing: Why and what to monitor. (The need; the	[1] 9.5, 13.1; [2] 8.5.	Lab 9: Measuring the performance parameters of

	<p>lack of agreements and standards, the state of the issue.) Performance monitoring. (What network parameters to monitor and how; monitoring systems.)</p> <p>Quiz # 5 – Management of optical networks.</p>	Lecture notes.	optical network (Session I).
13	<p>Network monitoring, measuring, and testing (cont'd):</p> <p>Power monitoring and fiber protection. (Monitoring devices and systems; fuse for fiber protection.)</p> <p>Testing and measuring. (Testing specific elements and networks, multi-layer testing; testing devices and systems.)</p>	[1] 9.6, 9.7, 13.2; [2] 14.3. Lecture notes.	Lab 9: Measuring the performance parameters of optical network (Session II).
14	<p>Optical access networks:</p> <p>What they are, passive and active networks.</p> <p>Passive optical networks (PONs). (Architectures, protocols, standards, technology, state of deployment.)</p> <p>FTTP. (Architecture, protocols, and technology. Request for proposal (RFP) by BellSouth, SBC, and Verizon.)</p> <p>Active optical access networks. (Architectures, protocols, standards, technology, state of deployment.)</p> <p>Components for optical access networks.</p>	[1] Chapter 11; [2] 9.4. Lecture notes.	Make-up laboratory session.
15	Final examination		