

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

**DEPARTMENT:** Electrical and Telecommunications Engineering Technology

**SUBJECT CODE** TCET 2202/TC 420  
**AND TITLE:** Data Communications and Systems

**COURSE DESCRIPTION:** Introduction to analog and digital communications systems, synchronous transmission of information and binary transmission. Multiplexing and various binary codes used in communication systems are explored. Distortion, noise and test equipment are discussed. Modems are analyzed. The RS232 interface, protocols, and line testing (loopback, analog, and digital) are covered. Laboratory exercises emphasize fault isolation and systems troubleshooting techniques. The protocol analyzer used for monitoring, troubleshooting and emulation.

**PREREQUISITES:** TCET2102/TC320

**PRE-OR COREQUISITES:** TCET2242/TC430 OR EET2261ET482

**TEXTBOOKS:** 1. Warren Hioki, *Telecommunications*, 4<sup>th</sup> edition, Pearson Prentice Hall Publishers, ISBN 0-13-020031-X.

**COURSE OBJECTIVES/  
COURSE OUTCOMES:**

Upon completion of the course the students should be able to:

1. Describe how modern digital communications systems are currently evolving and implemented. (ABET Criteria 2a, 2b, 2k, 2l)
2. Explain how various communications codes are used with modems and what is an ASCII code and how it's used in DTE/DCE equipment. (ABET Criteria 2a, 2b, 2f, 2k, 2l)
3. Demonstrate operation of an RS232 interface and what role it plays in the ISO-OSI layer protocol. (ABET Criteria 2a, 2b, 2c, 2k, 2l)
4. Discuss modems operations in the M-ary modes and the meaning of constellation diagrams. (ABET Criteria 2a, 2b, 2c, 2f, 2k)
5. Analyze TDM/PCM systems and error detection and correction techniques. (ABET Criteria 2a, 2b, 2c, 2k, 2l)

**TOPICS** Course topics include noise and its measurements, the dB and dBm, character and transmission codes, RS-232 interface, TDM, modulation, error detection and correction, synchronous protocol, switching, data networks, and DSL and other data transmission systems.

**CLASS HOURS** 3

**LAB HOURS** 3

**CREDITS** 4

**PREPARED BY** Professor Sheldon Rosenberg, Fall 2006.  
Revised by Professor Djafar Mynbaev, Fall 2006.

**COURSE**

**COORDINATOR** Professor Misza Kalechman, email: [mkalechman@citytech.cuny.edu](mailto:mkalechman@citytech.cuny.edu)

**DESCRIPTIVE DETAILS FOR LABORATORY COURSEWORK:**

The laboratory exercises essentially follow the course curriculum and include measuring a serial digital bit streams affected by system filtering; measuring a rise time of an individual pulses, experimenting with a Null Modem, studying ASCII character generation and recognition, working with the 2341 Codex Modem to observe constellation patterns, working with terminals, interfaces, and modems, analyzing BYSINC protocol, and experimenting with end-to-end communications.

**GRADING POLICY:**

Laboratory part	25%
Quizzes	25%
Final Exam	50%

**SCORE AND GRADES:**

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

**Assessment**

The following assessment techniques are correlated to the course objectives as follows: Each assessment classification incorporates one or more of the following ABET Criteria 2 outcomes (2a, b, c, d, f, and k).

<b>COURSE OBJECTIVES</b> Upon completion of the course the student should be able to:	<b>ASSESSMENT</b> Evaluation methods and criteria: Students will be assessed based on their ability to:
1. Describe how modern digital communications systems are currently evolving (ABET criteria 2i and 2o) and implemented.	1. Analyze main features of digital communications systems, such as noise, BER, channel capacity, modulation, multiplexing, and coding.
2. Explain how various communications codes are used with modems and what is an ASCII code and how it's used in DTE/DCE equipment.	2. Distinguish between character and transmission codes and identifies ASCII and EBCDIC codes along with NRZ, RZ, Manchester and other line codes.
3. Demonstrate operation of an RS232 interface and what role it plays in the ISO-OSI layer protocol.	3. Distinguish between mechanical and electrical specifications of the RS-232, explain its operation and its role in ISO_OSI protocol.
4. Discuss modems operations in the M-ary modes and the meaning of constellation diagrams.	4. Distinguish between binary and M-ary coding systems, explain PSK, DPSK, QPSK and other types of modulation, analyze constellation diagrams and their applications in modern modem technology.
5. Analyze TDM/PCM systems and error detection and correction techniques.	5. Demonstrate knowledge of TDM operation and its application in T system and show the use of parity, CRC, Check Sums and other error detection and correction techniques.

Weekly course outline

WEEKS	TOPIC	READING ASSIGNMENTS
1	<b>Introduction to Data transmission systems, Noise, S/N, BER, dB, Channel capacity. Modulation and Multiplexing. Fourier series, Fourier transforms. (Rectangular &amp; pulsed waveforms)</b> Spectrums: Power, and Energy. Phase and magnitude plots.	<b>See note at the end of this Syllabus.</b> Chapter 1 & 2 Reference Young: Chapter 3 Pages 91-94
2	Nyquist Theorem and Nyquist rate. Pulse modulation: PAM PPM, PWM, PCM (Quantizing and coding) delta modulation	<b>Chapter #5</b> Pages 79-94
3	<b>Character Codes:</b> Numbering Systems, Decimal, binary, octal, hexadecimal, conversions, BCD Excess 3-code, Morse code Gray code Lab-FSK, Baudot, EBCDIC, BAR codes, ASCII codes. ASCII Control characters, ASII waveform <b>Encoding Techniques: (Line codes):</b> - Unipolar vs. Bipolar - NRZ - NRZ invert - RZ - Self clocking (Manchester) Differential Manchester, Miller	Chapter 5 Pages 94-97 <b>Chapter 6</b> Pages 105-130  Chapter 8. Sections 8.4.3 Fig. 8-9
4	<b>Serial Interfaces RS-232.</b> Mechanical specs/electrical specs. DTE/DCE handshake. Null Modem, RS449, 422, 423 Balanced vs. Unbalanced Common Mode Rejection Noise Margin.	<b>Chapter 8</b> Pages 175-211
5	Exam # 1	Chapter #12 Pages 324-332
6	<b>Time-division multiplexing, TDM. Bell's T1, Digital Channel Banks. T system Hierarchy. T1 Carrier, AMI, B8ZS</b> Digital Communication Concepts (Baseband) Information, Transfer Rate, Baud Rate, Capacity, Bandwidth, Power for T1.	<b>Reference book Young:</b> <b>Chapter # 12</b> Pages 472-486 Thru Section 12-6
7	Digital Communications using Modulation: Shannon Information Capacity, Modulation Techniques (Generation, Reception, Bandwidth, Constellations) for: FSK, PSK, BPSK, M-ary, QPSK, 8-QAM, DPSK. Bit/Baud B.W. efficiency, BER.	<b>Ref. Electronic Comm. Sys.</b> Chap. 12
8	Modems: Transmission Modes Bell family of Modems Half and full duplex types, ITU-TS Recommendations Cable, ADSL, Testing Scrambling, Protocols, Throughput, compression.	<b>Chapter # 13</b> Pages 335-371
9	Error detection and correction: Parity, VRC/LRC, CRC, Check Sums Error correction (Hamming Code),	<b>Chapter # 17</b> Pages 520-535 Reference: Young: Chapter #13

WEEK	TOPIC	READING ASSIGNMENTS
10	Exam #2	<b>Chapter 14</b>
11	Synchronous Protocols Open System Interconnect (ISO-OSI) Bit oriented/byte oriented BISYN. Point to point BISYNC Multipoint Poll/select (modes) - TCP-IP (System network architecture) - SNA - X-25 - HDLC - Frame, Flag zero bit insertion. <b>Stuffing Codes</b> <b>Error correction and detection</b>	<b>Chapter #14</b> Pages 377-387 <b>Chapter #14</b> Pages 394-404 <b>Chapter #17</b> Pages 520-535  <b>Chapter #13</b> Pages 368-370 <b>Chapter # 14</b> Pages 394-404
12-13	Switching: - Switching facilities - Circuit Switching - Message Switching - Packet Switching LANS: - Topologies: Star, Ring, Mesh - Channel Access: Polling, Contention, CSMA/CD Token Ring - Baseband vs. Broadband - Ethernet: 10Base5, 10Base2, 10BaseT, Connections Transceiver Controller, Frame Structure, Encoding	<b>Chapter # 14</b> Pages 390-394          <b>Chapter # 15</b> Pages 407-423          Pages 438-451
14	ISDN, BRI/PRI, 2 B1Q DSL Functional diagram Other Emerging Technologies Cellular Technologies TDMA, CDMA Spread Spectrum	<b>Chapter # 16</b> Pages 503-508 Pages 511-516 <b>Chapter 19</b> Pages 583-588 Pages 600-605
15	Final Exam	

**Note:** The student should become familiar with the Glossary of terms used throughout the textbook. The Glossary begins on page 609 of the textbook.

<b>TC 420 – DESCRIPTION OF LABORATORY EXPERIMENTS</b>		
<b>WEEK NUMBER</b>	<b>TOPIC AND DESCRIPTION</b>	<b>ASSIGNMENT AND READING MATERIAL</b>
1	Introduction to Digital & Data Communications <ul style="list-style-type: none"> <li>• Discussion of Dumb Terminals.</li> <li>• Work Stations, and Network Computers.</li> <li>• Modes of Communication.</li> </ul>	Read Experiment No. 1 from the Lab Manual Read Text Chapter 7
2 - 3	Introduction to Data Communications Equipment <ul style="list-style-type: none"> <li>• (Eqpt. used): Analog Patch Panel, 66 Block, RJ21X, VOM, VF Monitor, Telephone Handset</li> <li>• Terminal, VT220 Terminal.</li> <li>• Perform Experiment No. 1, Run 1.</li> </ul>	Student <u>must read</u> Experiment No. 1 Laboratory assignment.
4 - 5	DTE to DTE Communications <ul style="list-style-type: none"> <li>• Experiment No. 1, Run II.</li> <li>• Setup of VT220 Terminal.</li> <li>• Using DTE and ITS.</li> </ul>	Student <u>must read</u> : Lab Manual & Prepare a Lab Report
6 - 8	Setting up and Monitoring/Studying an ASCII Line. <ul style="list-style-type: none"> <li>• Use of Protocol Analyzer.</li> <li>• Study Control and Data characters of ASCII code.</li> <li>• Use of VT100 as Transmitter/Receiver of ASCII code.</li> <li>• Mid-term on Week No. 7.</li> </ul>	Student <u>must read</u> Lab Manual & Prepare a Lab Report.
9 - 10	Analysis of BISYNC Protocol <ul style="list-style-type: none"> <li>• Use of Protocol Analyzer, understand handshake, ACK/NACK, etc.</li> </ul>	Student <u>must read</u> Lab Manual, Textbook, and Prepare a Lab Report.
11 - 12	Become familiar with Modem operations: <ul style="list-style-type: none"> <li>• Modem Theory review.</li> <li>• Learn usage of Codex Modem</li> </ul>	Student <u>must read</u> Lab Manual and Prepare a Lab Report.

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	and oscilloscope.	
13 - 14	Testing End to End Communications Link using a Test Sequence: <ul style="list-style-type: none"><li>• Use Codex Modem, oscilloscope, and EIA Breakout Box.</li></ul>	Student <u>must read</u> Lab Manual and Prepare a Lab Report.
15	Laboratory Final Exam	