NEW YORK CITY COLLEGE OF TECHNOLOGY
The City University of New York

DEPARTMENT: Electrical and Telecommunications Engineering Technology

SUBJECT CODE AND TITLE: TCET3202 Analog and digital Communications II

COURSE DESCRIPTION:

Required Course

Theory and practice of transmission and filtering of analog and digital signals are covered. Fundamental parameters of digital communication systems, various modulation techniques such as Pulse Code Modulation (PCM) and Delta Modulation (DM) and their performance in terms of bandwidth efficiency and signal to noise ratio (SNR), line coding and pulse shaping are analyzed. Introduction to information theory and error correcting codes such as block coding and convolutional coding. Emerging technologies. Software simulation and hard wired experiments dealing with PCM, DM, and line coding are parts of laboratory exercises.

PREREQUISITES: TCET3102, TCET3122

TEXTBOOK:

1. Modern Digital and Analog Communications Systems
   B.P.Lathi and Zhi Ding, 5th Ed. 2018. Oxford University Press
2. Laboratory Manual: Part I developed by Prof. M. Kouar
   Part II from Emona Technologies, LLC (TIMS)
3. Reference: Digital and Analog Communication Systems
   Leon W. Couch, Prentice Hall, 8th Ed. 2012.

COURSE OBJECTIVES/ COURSE OUTCOMES: (ETAC/ABET Criteria 3, Program Criteria)

Upon completion of this course students will posses the ability to:

1. Apply Fourier analysis to study analog communications systems.(ETAC/ABET Criteria 3a, 3b, PC d)
2. Describe and analyze the mathematical techniques of analog modulation and demodulation.(ETAC/ABET Criteria 3a, 3b, PC d)
3. Convert analog signals to digital format using sampling and quantization techniques.(ETAC/ABET Criteria 3a, 3b)
4. Define and evaluate the performance of digital communications systems.(ETAC/ABET Criteria 3c, 3f)
5. Describe digital signaling schemes and determine their properties.(ETAC/ABET Criteria 3a, 3b)
6. Explain the basic types of digital carrier systems (ASK, FSK, PSK) and evaluate their effective bandwidths. (ETAC/ABET Criteria 3a, 3b)
7. Design source coding schemes based on the Huffman/Shannon-Fano and Lempel-Ziv algorithms. (ETAC/ABET Criteria 3a, 3b, 3d)
8. Understand, analyze and develop error correcting codes using the latest techniques in communications. (ETAC/ABET Criteria 3a, 3b, 3f)
9. Develop hands-on experience by analyzing, and

implementing PCM and DM systems using CAD and hardware experiments.(ETAC/ABET Criteria 3a, 3b, 3c, 3e, PC a)

10. Describe and discuss the emerging digital communications technologies and demonstrate awareness of professional, ethical and social responsibilities.(ETAC/ABET Criteria 3g, 3h, 3i, 3k)
11. Develop good communications skills by working in teams and writing laboratory reports (ETAC/ABET Criteria 3e, 3g, 3i, 3k).

TOPICS:

_Fourier Transform, Energy Spectral Density, Power Spectral Density
_Analog Modulation/Demodulation revisited.
_Sampling Theorem, Aliasing, Quantization.
_PCM, DPCM, DM, ADM.
_Line Coding, Pulse Shaping.
_Information Theory, Source Encoding.
_Error Detection and Correction Codes.

CLASS HOURS: 3
LAB HOURS: 3
CREDITS: 4

Prepared by: Professor M. Kouar
Fall 2019

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Descriptive details for laboratory coursework:
Laboratory exercises include using MATLAB to process sine and sound signals, producing echo effects, simulating and analyzing quantization for uniform case and μ-law, using predictive coding on a sampled signal. Hardware experiments cover implementation of natural sampling and sample-and-hold, pulse code modulation (PCM) linear and non-linear, delta modulation (DM) and demodulation, adaptive delta modulation (ADM). Line coding and amplitude shift keying (ASK) complete the hands-on exercises which efficiently support the theory part.

Contribution of course to meeting the requirements of Criteria 5:
TCET 3202 meets criterion 5 by providing students with a strong foundation of theoretical principles and practical laboratory skills needed to analyze and design analog and digital communication systems with the ability to utilize statistics/probability and transforms methods. Academic benchmarks, course outcomes, and assessment requirements have been established to ascertain student comprehension of concepts and proper usage of test equipment. By also fostering critical thinking, communications, and team work, students develop the skills needed to solve problems in a classroom and laboratory environment which will later serve them in the work place.

GRADING POLICY:	**EXAMS (2)**	**35%**
	LAB REPORTS	**25%**
	FINAL	**40%**

Letter Grade	Numerical Grade Range	Quality Points
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

ATTENDANCE REQUIREMENT:

- A student is allowed to be absent not more than twice during the semester.
- A student is late if he/she appears after attendance is taken. Three latencies are equal to one absence.

HELPFUL SUGGESTIONS:

- **READ** the assigned sections (or chapters) before coming to class.
- **TRY** to do your homework as soon as possible after you leave the classroom (while your memory is still fresh and you do not want too much work to accumulate).
- **DO NOT** hesitate to ask questions if something is not clear to you.
- **TRUST** yourself in any work you do and learn how to be self-dependent (An important quality that hiring institutions look for).

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 ETAC/ABET Criterion 3 outcomes (3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i, 3k, PCa, PCd).	
Course Objectives	**Assessment**
	Students will exhibit skills in class, labs, and all homework assignments, laboratory reports, quizzes, and exams. Students will be able to:
1. Apply Fourier analysis to study analog communications systems.	1.1 Use Fourier Transform to determine spectra of common communications signals. 1.2 Compute correlation integral for signal comparison 1.3 Perform convolution operation to determine system output.
2. Describe and analyze the mathematical techniques of analog modulation and demodulation	2.1 Describe and analyze the block diagram of different types of analog communications systems. 2.2 Calculate the required bandwidth for each type.
3. Convert analog signals to digital format using sampling and quantization techniques	3.1 Determine the minimum sampling frequency (Nyquist frequency) for a given analog signal. 3.2 Apply pulse code modulation (PCM) and delta modulation (DM) to produce a digital signal.
4. Define and evaluate the performance of digital communications systems.	4.1 Calculate the signal to noise ratio (SNR) for PCM and DM. 4.2 Determine the required number of bits for achieving a given SNR in PCM. 4.3 Compute the maximum voice signal amplitude for no slope overload in DM.
5. Describe digital signaling schemes and determine their properties.	5.1 Analyze a line code spectrum to determine some desirable properties (DC null, not excessive bandwidth, etc…). 5.2 Apply various transmission codes to a digital data.

	5.3 Explain the use of pulse shaping to eliminate inter symbol interference (ISI).
6. Explain the basic types of digital carrier systems (ASK, FSK, PSK) and evaluate their effective bandwidths.	6.1 Define and describe amplitude shift keying (ASK), phase shift keying (PSK), and frequency shift keying (FSK). 6.2 Explain the multiplexing scheme of North American Digital Hierarchy.
7. Design source coding schemes based on the Huffman/Shannon-Fano and Lempel-Ziv algorithms.	7.1 Determine the optimum entropy source code using Huffman and Shannon-Fano methods. 7.2 Apply Lempel-Ziv algorithm for data compression. 7.3 Evaluate code performance quantities such as efficiency.
8. Understand, analyze and develop error correcting codes using the latest techniques in communications.	8.1 Explain block and convolutional codes. 8.2 Compute Hamming distance. 8.3 Design a systematic block code by generating parity check bits. 8.4 Demonstrate error detection and correction using the syndrome vector. 8.5 Construct convolutional codes. 8.6 Apply Viterbi's algorithm.
9. Develop hands-on experience by analyzing, and implementing PCM and DM systems using CAD and hardware experiments.	9.1 Develop the ability to compare and contrast the strengths and weaknesses of communications systems. 9.2 Use MATLAB to quantize a sampled signal using Uniform and μ-law. 9.3 Use predictive coding on the sampled signal of DM and ADM. 9.4 Implement PCM encoding and Decoding. 9.5 Practice with line coding and amplitude shift keying (ASK) modulation and demodulation.
10. Describe and discuss the emerging digital communications technologies and demonstrate awareness of professional, ethical and social responsibilities.	10.1 Discuss the recent developments in communications technologies. 10.2 Comment on some case studies dealing with ethics such as the Challenger etc… 10.3 Define and Comprehend IEEE code of ethics.
11. Develop good communications skills by working in teams and writing laboratory reports.	11.1 Prepare and Perform experiments in teams using MATLAB and Hardware. 11.2 Write a laboratory report for each experiment

TCET 3202 OUTLINE			
WEEK	**TOPIC**	**READING ASSIGNMENT**	**HOMEWORK PROBLEMS**
1	Overview of course contents. Review of Fourier series. Energy and power signals. Useful signal operations. Unit impulse function. Correlation.	Chapter 2 pages14-60	2.1-1, 2.1-8, 2.4-1, 2.4-2, 2.6-1
2	Fourier transform revisited. Properties of Fourier transform.	Chapter 3 pages 71-101	3.3-10, 3.4-1, 3.3-6
3	Signal transmission through a linear system. Convolution. Ideal and practical filters.	Chapter 3 pages 101-110	3.2-1, 3.8-4
4	Analog modulation revisited: AM, DSB, SSB, VSB, FM, PM.	Chapter 4 pages 151-188 , Chapter 5 pages 208-228	4.2-1, 4.2-4, 4.2-8, 4.2-9, 4.3-1, 4.5-1, 4.5-5, 5.2-1, 5.2-2, 5.2-3
5-6	Sampling theorem. Antialiasing filter. Maximum information rate. Pulse code modulation (PCM).Quantizing. Compander. Transmission bandwidth and Output signal to noise ratio. EXAM # 1	Chapter 6 pages 251-281	6.1-1, 6.1-2, 6.1-4, 6.2-2
7	Delta Modulation (DM). Threshold of coding and overloading. Adaptive delta modulation (ADM). Signal to noise ratio (SNR).	Chapter 6 pages 281-288	6.2-3, 6.2-5, 6.2-9, 6.4-1
8	Digital data transmission: Line coding, pulse shaping, regenerative repeaters. Digital carrier systems. Digital multiplexing.	Chapter 7 pages 294-329, 337-348	7.3-1, 7.3-3, 7.9-1, 7.9-2. 7.9-3.
9	Introduction to information theory. Memoryless source. Entropy of a source. Source Encoding. Compact codes. Classification of codes.	Chapter15 pages 679-685	15.1-1, 15.1-2, 15.1-3.
10	Entropy coding. Huffman coding. Shannon-Fano coding. Code efficiency. Redundancy. Lempel-Ziv coding. Channel capacity.	Chapter 15 pages 686-693	15.2-1, 15.2-2, 15.2-3, 15.2-4, 15.2-5.

11	Introduction to error correcting codes. Code efficiency. Hamming codes. Hamming distance. Binary symmetric channel. Linear block codes. Systematic codes. Parity check bits. Syndrome. Generator matrix.	Chapter 16 pages 728-737	16.2-2, 16.2-3, 16.2-4, 16.2-6, 16.2-9

	TCET 3202 OUTLINE (continued)		
WEEK		**READING ASSIGNMENT**	**HOMEWORK PROBLEMS**
12-13	Cyclic codes. BCH codes. Burst-error detecting and correcting codes. Convolutional coding. Code tree. Viterbi's decoding. EXAM # 2	Chapter 16 pages 737-755	16.2-11, 16.3-1, 16.6.-1, 16.6-2
14	Emerging digital communications technologies. Define Engineering ethics Professional and codes of ethics Workplace responsibilities Class discussion of IEEE code of Ethics.	Chapter 8 pages 354-400 Handouts	8.1-2, 8.1-3, 8.1-5
15	Review and Final Exam		

Weekly Schedule for TCET 3202 Experiments

Week #	EXPERIMENT
1-2	VOICE AND AUDIO SAMPLIND, PROCESSING, AND PLAYBACK
3-4	SPEECH AND AUDIO SIGNAL COMPRESSION
5	THE SAMPLING THEOREM
6	SAMPLING WITH SAMPLE & HOLD
7	PCM ENCODING
8	PCM DECODING

9	DELTA MODULATION
10	DELTA DEMODULATION
11	LINE CODING
12	AMPLITUDE SHIFT KEYING
13-14	SPEECH MODELING, PREDICTION, AND SYNTHESIS
15	DIGITAL SONAR FOR LOCALIZATION AND SIGNALING

New York City College of Technology Policy on Academic Integrity

Students and all others who work with information, ideas, texts, images, music, inventions, and other intellectual property owe their audience and sources accuracy and honest in using, crediting, and citing sources. As a community of intellectual and professional workers, the College recognizes its responsibility for providing instruction in information literacy and academic integrity, offering models of good practice, and responding vigilantly and appropriately to infractions of academic integrity. Accordingly, academic dishonesty is prohibited in The City University of New York and at New York City College of Technology and is punishable by penalties, including failing grades, suspension, and expulsion. The complete text of the College Policy on Academic Integrity may be found in the catalog.