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

DEPARTMENT: Electrical and Telecommunications Engineering Technology

SUBJECT CODE AND TITLE: TCET 3102/TC500
Analog and Digital Communications I

COURSE DESCRIPTION: The course introduces basic concepts in analog and digital communications. Topics covered include spectral analysis of electrical signals, Fourier series, Fourier transform, signal and noise filtering, and amplification. Amplitude, frequency, and phase modulation techniques are covered.

PREREQUISITES: EET 2140/ET313, EET 2141/ET313, MAT 1475/MA475

TEXTBOOK:
1. Electronic Communications, 4th Ed. By Dennis Roddy and John Coolen , Prentice-Hall, 1995
2. Laboratory Manual:
   a. Part I developed by Prof. Mynbaev
   b. Part II from Emona Technologies, LLC (TIMS)
3. Reference:
   a. Introduction to MATLAB 7 for Engineers By William J. Palm III McGraw-Hill Higher Education, 2005
   b. Introduction to Telecommunications, 2nd Ed. By Marion Cole Prentice-Hall, 2002
   c. Telecommunications, 4th Ed. By Warren Hioki Prentice-Hall, 2001

COURSE OBJECTIVES/ COURSE OUTCOMES:
Upon completion of this course students will posses the ability to:

1. Describe the general architecture of the telephone network and describe future trends in telecommunications. (ABET Criteria 2a, 2b, 2e, 2g, 2j, 2k)
2. Perform spectral analysis of periodic and aperiodic signals. (ABET Criteria 2a, 2b, 2k, 2q)
3. The student will be able to use CAD software in the design and analysis of filters. (ABET Criteria 2a, 2d, 2l, 2q)
4. The student will be able to apply the concept of a transfer function to transmission channels and be capable of describing the noise in a system quantitatively and calculate signal-to-noise ratios. (ABET Criteria 2a, 2b, 2k, 2l, 2m)
5. The student will be able to describe the need for modulation and quantitatively analyze amplitude modulated and angle modulated signal. (ABET Criteria 2a, 2b, 2k)
6. Develop hands-on experience by analyzing and implementing amplitude modulated and angle modulated systems through hardware experiments. (ABET Criteria 2a, 2b, 2e, 2f, 2g, 2h, 2l, 2n)

TOPICS: Topics include the history and future trends of communications systems, the use of CAD software such as MATLAB in the design and analysis of filters, understanding and practical uses of SSB, VSB, DSBSC, standard AM, and angle modulation techniques as well as the necessity to have accurate synchronization of signals with local oscillators.

CLASS HOURS: 3
LAB HOURS: 3
CREDITS: 4

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Descriptive details for laboratory course work:
Laboratory exercises include using MATLAB to analyze periodic signals by obtaining their frequency spectrums, designing elliptic and Butterworth filters and analyzing their digital counterparts. Hardware experiments include implementation and analysis of DSBSC signals, standard AM signals, envelope recovery of standard AM signals, phase division multiplexing (PDM), generation of FM signals using a VCO, and FM demodulation with a phase-locked loop (PLL).

GRADING POLICY: TC500

Homework	10%
Quizzes	5%
Midterm Exams	20%
Laboratory Reports	20%
Term Paper	15%
Final Exam	30%

Letter Grade	Numerical Grade Ranges	Quality
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: In addition, each assessment technique incorporates one or more of the following ABET Criterion 2 outcomes (2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2i, 2j, 2k, 2l, 2m, 2n, 2q)	
Course Objectives	**Assessment**
1. Describe the general architecture of the telephone network and describe future trends in telecommunications.	1.1 Distinguish between local, regional, and long-distance networks. 1.2 Use technical characteristics of cables to determine the length and applicability of a local loop. 1.3 Submit a written report describing the motivations for the need for higher bandwidth systems for digital communications. 1.4 Give an oral presentation on the subject of a modern or emerging technology in communications.
2. Perform spectral analysis on periodic and aperiodic.	2.1 Understand and apply the Fourier series and Fourier Transform to different signals. 2.2 Using CAD tools to obtain the spectrum of signals. 2.3 Using CAD tools to design and analyze filters.
3. Ability to use CAD software in the design and analysis of filters.	3.1 Understanding the difference between various filter types such as the band-pass, high-pass, low-pass, elliptic, and Butterworth filters. 3.2 Understanding how the various parameters in the design of filters affect their performance. 3.3 Ability to use MATLAB in designing filters.
4. Applying the concept of a transfer function to transmission channels and be capable of describing the noise in a system quantitatively and calculate signal-to-noise ratios.	4.1 Being able to use filter transfer functions to calculate signal-to-noise ratios for a given system. 4.2 Understanding how transfer function relates output signals to input signals.

	4.3 Being aware of the various sources of noise that exists in electronic circuits and how they affect communications systems. 4.4 Ability to calculate the signal to noise ratio of an input signal as it passes through a system.
5. Describe necessity for modulation and analyze amplitude modulated and angle modulated signals.	5.1 Understand the advantages of modulation for purposes of effective transmission. 5.2 Ability to quantitatively and experimentally analyze various AM systems. 5.3 Ability to quantitatively and experimentally analyze FM systems. 5.4 An understanding of the use of the VCO, LPF, and amplifier in the various stages of a modulation system. 5.5 Explain the concepts of multiplexing and its application to modern and future telecommunication systems.
6. Perform various lab experiments providing hands on experience with communication systems.	6.1 Work together as a member of a group. 6.2 Achieve familiarity with equipment used in professional laboratories. 6.3 Know how to apply knowledge to real world problems. 6.4 Understand how to implement various modulation techniques in a practical setting.

Week	**Topic**	**Reading Assignments**	**Homework Problems**
1.	- Overview of the class, rules, and policies - History of the Telephone Network - General architecture of telephone network - How to breakdown and understand a typical 10-digit telephone number - LATA architecture - Analog and digital transmission	Text Book (TB): pp. 643-652, 656-658	Pr. 17.11
2.	- Define Bandwidth and its importance - Voice Characteristics - The Biology of the Telephone - The Local Loop Twisted Pair - Broadband: DSL, cable, wireless, Fiber optic – The Last Mile	TB: 628-631, 637-643	Pr. 17.1 – 17.7
3.	- Time and Frequency Domains (Sine and Cosine) - Sums of Sines and Cosines - Power signals - Real Frequency & Complex Frequency - Introduce some Mathematics (integrals) - Fourier Series - Filtering	TB: 57-72	Pr. 2.1 – 2.9
4.	- Non-Periodic Signals - Energy Signals - Spectrum and Power Signals - Fourier Transforms ▪ Triangle ▪ Square	TB: 74-87	Pr. 2.14, 2.15, 2.23 – 2.29, 2..32, 2.33, 2.35, 2.38, 2.48 – 2.54, 2.58
5.	- Transfer Functions - Convolution - Introduction to Noise	Lecture Notes	Handout # 1
6.	Exam 1		
7.	- Noise: ▪ What is noise? ▪ Why do we care? ▪ What is the source of noise?	TB: 118 – 148	Pr. 4.1 – 4.10, 4.17, 4.18, 4.26, 4.29
8.	- Signals and Modulation ▪ Why do we modulate? ▪ How do we Modulate: • Analog Modulation • Digital Modulation	Lecture Notes	Handout #2

9.	- Amplitude Modulation: ▪ DSBSC ▪ SSB ▪ DSBAM - Modulation Methods - Mention VSB on passing and its use in Television - FDM	TB: 252 – 266, 297 – 299, 302 – 309	Pr. 8.1, 8.3 – 8.5, 8.10, 8.11, 8.14, 8.18,
10.	- Amplitude Demodulation ▪ Synchronous detection – DSBSC, SSB, DSBAM and phase error ▪ Envelope Detection – DSBAM	TB: 272 – 273, 307 – 309.	Handout #3
11.	- Angle Modulation ▪ Phase Modulation ▪ Frequency Modulation - Modulation Methods ▪ Armstrong ▪ VCO	TB: 321 – 337 Lecture Notes	PR. 10.1 – 10.11
12.	Exam 2		
13.	- Angle Demodulation ▪ Phase Demodulation ▪ Frequency Demodulation - Frequency discriminator - PLL	Lecture Notes	Handout #4
14.	- Project Presentations		
15.	Review for Final Exam		

Weekly Schedule for TC 500 Experiments

Week #	**Experiment**
1-2	- Review Matlab - Introduce and use of the Demo and Help file system in Matlab - Functions: ▪ Colon (:) operator ▪ Semicolon operator ▪ Plot, title, label - Matlab Review: ▪ Matrix ▪ Matrix Arithmetic
3	Analysis and synthesis of a square wave using MATLAB.
4-5	Characterization of an Elliptic Filter using MATLAB.
6	Transfer Function of a Butterworth Filter using MATLAB.
7	Modeling an Equation (using TIMS)
8	DSBSC Generation (using TIMS)
9	Amplitude Modulation (using TIMS)
10	Envelope Recovery (using TIMS)
11	Phase Division Multiplex (using TIMS)
12	Introduction to FM using a VCO (using TIMS)
13	FM demodulation with the PLL
14	Lab Exam