

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

DEPARTMENT: Electrical and Telecommunications Engineering Technology

SUBJECT CODE AND TITLE: TCET4132/TC720 Wireless Communications

COURSE DESCRIPTION: The course covers concepts of wireless systems; propagation effects, including loss, dispersion, fading, transmission, and reception; mobile systems, including analysis and design principles of base units and mobile units; micro cells and pico cells; cell division, including frequency use and reuse; concepts of FDMA, TDMA, and CDMA; error rates and outage probability. Computer simulations and hard wired experiments dealing RF spectrum, outdoor and indoor propagation, cellular concept, DSSS, IEEE 802.11 WLAN, and CDMA are parts of laboratory exercises.

PREREQUISITES: MAT1372/MA372 or MAT1572/MA572 , MAT1575/MA575, TCET3102/TC500

TEXTBOOK: INTRODUCTION TO WIRELESS SYSTEMS
P. M. Shankar, Wiley, 2002

REFERENCES :

- 1) An Introduction to Wireless Technology
G.S. Rogers , J. Edwards, Prentice Hall, 2003
- 2) Wireless Communications
Principles and Practice,
T. S. Rappaport, Prentice Hall, 2002 2nd Ed.
- 3) Wireless Communications and Networks,
W. Stallings, Prentice Hall, 2005, 2nd Ed

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

1. Understand key wireless communications terms and concepts.(ABET Criteria 2a, 2b, 2k)
2. Understand the basic operations of wireless equipment as they relate to the communications industry.(ABET Criteria 2a, 2b, 2e, 2h, 2k, 2l, 2m)
3. Characterize the tradeoffs among frequency reuse, signal-to-interference ratio, capacity, and spectral efficiency. (ABET Criteria 2a, 2b, 2f, 2k)
4. Characterize large-scale, small-scale propagation models and their corresponding path losses.(ABET Criteria 2a, 2b, 2f, 2k)
5. Describe different types of diversity and how they improve performance for mobile radio channels.(ABET Criteria 2a, 2b, 2f, 2k)
6. Characterize TDMA, FDMA and CDMA(ABET Criteria 2a, 2b, 2k)
7. Understand the basic principles and practices of installing and maintaining wireless communication equipment and wireless networks. (ABET Criteria 2a, 2b, 2c, 2k, 2l, 2m, 2q)
8. Study, analyze, and critically evaluate the major product offerings of current vendors, their costs, and applications.

(ABET Criteria 2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2k)

- TOPICS:**
- _ Indoor /outdoor propagation, Fading.
 - _ Modems for wireless communications.
 - _ Co-channel interference (CCI), adjacent channel interference.
 - _ Cellular concepts.
 - _ Traffic capacity and trunking.
 - _ Forms of diversity
 - _ FDMA, TDMA, CDMA
 - _ Bluetooth

CLASS HOURS: 2

LAB HOURS: 3

CREDITS: 3

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Descriptive details for laboratory coursework:

The students are first introduced to **RF measurement** equipment. They then explore the **radio spectrum** to examine spectrum utilization and its compliance with the FCC frequency allocation plan. Characteristics of **outdoor and indoor radio propagation** are examined in the next experiments followed by cellular concept experiment allowing students to study co-channel and adjacent channel interference. **Pseudo-Noise sequence, Direct Sequence Spread Spectrum, and CDMA** are implemented using TMS equipment. Study of **IEEE 802.11 Wireless LAN** completes the set of laboratory exercises.

GRADING POLICY:

Homework Problems, Participation and Presentations	10%
Exams (2)	30%
Lab Performance and Lab Reports	30%
Term Paper with Presentation	10%
Final Exam	20%

<u>Letter Grade</u>	<u>Numerical Grade Range</u>	<u>Quality Points</u>
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

<p style="text-align: center;"><u>Assessment</u></p> <p>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, 2k, 2l, 2m, 2q).</p>	
<p style="text-align: center;"><u>Course Objectives</u></p>	<p style="text-align: center;"><u>Assessment</u></p> <p>Students will exhibit skills in class, labs, and all homework assignments, laboratory reports, quizzes, and exams. Students will be able to:</p>
<p>1. Understand key wireless communications terms and concepts.</p>	<p>1. Demonstrate comprehension of wireless common communications technical terms and principles through lectures, reading material and laboratory experiments.</p>
<p>2. Understand the basic operations of wireless equipment as they relate to the communications industry.</p>	<p>2. Show understanding of the use of wireless equipment through experiments preparation, and their implementation.</p>
<p>3. Characterize the tradeoffs among frequency reuse, signal-to-interference ratio, capacity, and spectral efficiency</p>	<p>3. Demonstrate their analytical skills of solving problems in homework assignments and exams dealing with cellular concepts.</p>
<p>4. Characterize large-scale, small-scale propagation models and their corresponding path losses.</p>	<p>4. Exhibit knowledge of large scale and small scale propagation and how they influence wireless communications systems design.</p>
<p>5. Describe different types of diversity and how they improve performance for mobile radio channels</p>	<p>5. Display skills in analyzing different techniques of diversity such as space, time, or frequency diversity and show their positive effects.</p>
<p>6. Characterize TDMA, FDMA and CDMA</p>	<p>6. Understand and describe common multiple access techniques and trade-offs in using them.</p>
<p>7. Understand the basic principles and practices of installing and maintaining wireless communication equipment and wireless networks.</p>	<p>7. Demonstrate their abilities to install and maintain wireless equipment by performing lab exercises and software simulations.</p>
<p>8. Study, analyze, and critically evaluate the major product offerings of current vendors, their costs, and applications.</p>	<p>8. Display understanding, analytical and decision making skills in working on real life application for their term paper.</p>

MEASURES OF COURSE OBJECTIVES ASSESSMENT

- *Weekly Problems Assignment*- provide practice in, and establish a knowledge base for the solution in wireless communications.(1, 2, 3, 4, 5, 6)
- *Two Exams and Final* - Test students' ability to synthesis information from a variety of sources into a comprehensive understanding of broad classes of problems in wireless communications.(1, 2, 3, 4, 5, 6)
- *Laboratory Exercises* - provide students the opportunity to operate laboratory equipment, to make specified measurements, and to use collected data in subsequent wireless communications calculations. (2, 7)
- *Term Paper* - will give students the opportunity to work on an open-ended, real-life application of wireless communications.(8)

Week	Contents	Assignments
1	Overview North American Cellular Systems Pan-European Cellular Systems Pacific Digital Cellular (PDC) Systems Universal Mobile Telecommunication Systems(UMTS)/International Mobile Telecommunications 2000 (IMT 2000) Components of a Cellular System	Chapter 1 Reading: pages 1-9
2	Attenuation Indoor Propagation Models Fading	Chapter 2 Reading: pages 10-39 Homework Pbs.: 1,2,5
3	Other Fading Models Testing of Fading Models Power Units	Chapter 2 Reading: pages 40-52 HW Pbs.: 9,11,13,22,23
4	Analog Modulation Digital Modulation Modems	Chapter 3 Reading: pages 57-109 HW Pbs.: 1,2,5,13,17
5	General M-ary Modulation Schemes Comparison of Modems for Wireless Communications	Chapter 3 Reading: pages 125-132 HW Pbs.: 20,25,27,33,45
6-7	Geometry of a Hexagonal Cell Co-Channel Interference (CCI) CCI Reduction Techniques EXAM #1	Chapter 4 Reading: pages 138-148 HW Pbs.: 1,2,3,4
8	Cell Splitting Microcells, Picocells, and Fiber optic Mobile Systems Coverage Area Estimation	Chapter 4 Reading: pages 149-155 HW Pbs.: 5,6,7,8
9	Traffic Capacity and Trunking Trunking Efficiency of Omni versus Sectorized Antennae Adjacent Channel Interference	Chapter 4 Reading: pages 156-165 HW Pbs.: 10,11,13,18,24

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10	Effects of Fading and the Concept of Diversity Other Signal Degradation Effects Forms of Diversity Diversity Combining Methods	Chapter 5 Reading: pages 168-190 HW Pbs.: 1,2,6,7
11	Performance Improvement from Diversity in Terms of Reduced Bit Error Rate Macroscopic Diversity Equalization /Frequency-Selective Fading	Chapter 5 Reading: pages 191-204 HW Pbs.: 10,11,21,22
12-13	Frequency Division Multiple Access (FDMA) Time Division Multiple Access (TDMA) Code Division Multiple Access (CDMA) EXAM #2	Chapter 6 Reading: pages 207-223 HW Pbs.: 1,2,3,8
14	Overview of Wireless Systems and Standards North American Digital Cellular Systems Based on CDMA CDMA2000 Other New Developments: Bluetooth Networks	Chapter 6 Reading: pages 224-246 HW Pbs.: 9,10,13,19
15	Review and Final	

Lab Schedule	
Week #	Experiment
1-2	1. Introduction to RF measurement equipment.
3	2. Exploring the Radio Spectrum
4-5	3. Outdoor radio propagation.
6-7	4. Indoor radio propagation
8-9	5. The Cellular Concept.
10	6. Pseudo Noise Sequence Generator(TIMs).
11	7. Direct Sequence Spread Spectrum.(TIMs)
12-13	8. IEEE 802.11 Wireless LAN .
14-15	9. CDMA (TIMs)

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).