

Course Title: Wireless Networks
Course No: CSIT.424.3
Nature of the Course: Theory+Lab
Year: Fourth, Semester: Eighth
Level: B. Sc. CSIT

Credit: 3
Number of period per week: 3+3
Total hours: 45+45

1. Course Introduction

The course addresses the fundamentals of wireless communications and provides an overview of existing and emerging wireless communications networks. It covers radio propagation and fading models, fundamentals of cellular communications, multiple access technologies, and various wireless networks, including past and future generation networks. Simulation of wireless systems under different channel environments will be integral part of this course.

2. Objectives

The course aims at providing basic knowledge about problems and design approaches in wireless communication systems. This includes engineering models in radio propagation and the application of antennas to wireless communication. An introduction to spectrum resource management issues is also given in the course. Upon completion of the course, the student will be able to:

- Characterize fading multi-path radio channels in terms of Doppler spectrum, coherence time, power delay profile, and coherence bandwidth.
- Distinguish the difference between large-scale fading and small-scale fading.
- Describe and explain the effects of fading multi-path channels on the link performance of wireless communication systems.
- Provide possible solutions to the problem of signal fading in wireless communication links. Describe different types of diversity and how they improve performance for mobile radio channels.
- Apply propagation models and design basic radio communication links with respect to signal-tonoise ratio and outage probabilities. Special emphasis is given to propagation models for mobile and portable wireless communication.
- Plan and analyse simple wireless networks in terms of coverage and capacity.
- Understand about multiple access techniques and slandered
- Describe and explain mobility management strategies and traffic calculation.
- Describe and understand about concept of mobile IP, protocols and routing in ad-hoc network.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Understands basics of wireless	Unit I: Overview of wireless communications and systems(2 Hrs) 1.1. Introduction to Wireless Communications

<p>communication, challenges, its history</p> <ul style="list-style-type: none"> • Understand the different standard of wireless communication 	<p>1.2. Challenges in wireless communication networks 1.3. Cellular systems from 1G to 3G 1.4. Wireless 4G systems</p>
<ul style="list-style-type: none"> • Understand effects of fading in multipath environment, fading models and channel modeling • Distinguish the difference between large-scale fading and small-scale fading. • Able to calculate the receive power in different fading model 	<p>Unit II: Wireless Channel Characterization(7 Hrs)</p> <p>2.1. Multipath Propagation Environment 2.2. Small Scale Fading 2.2.1 Fading Effects due to Multipath Time Delay Spread 2.2.2 Fading Effects due to Doppler Spread</p> <p>2.3. Channel Models 2.4. Fading models: 2.4.1 Rayleigh Fading Distribution 2.4.2 Ricean Fading Distribution</p> <p>2.5 Large Scale Path-loss and Shadowing 2.5.1 Free-space Path loss Model 2.5.2 Propagation Over Reflecting Surface (smoothing plane) 2.5.3 Long Distance Path loss with Shadowing: 2.5.4 Okumura-Hara Path Loss Model</p>
<ul style="list-style-type: none"> • Understand the pulse shaping as well as requirement of modulation and selection of modulation scheme • .Design of transmitter and receiver for different digital modulation schemes 	<p>Unit III: Band Pass Transmission Technique for Mobile Radio (9 Hrs)</p> <p>3.1. An overview of Digital Communication 3.2. Pulse Shaping Technique 3.2.1 Nyquist Pulse Shaping 3.2.2 Raised Cosine Roll-off Filter</p> <p>3.3. Modulation Techniques For Mobile Radio 3.3.1 Analog and Digital Modulation – An overview 3.3.2 Criteria of Choosing Modulation Schemes 3.3.3 Geometric Representation of Modulated signal 3.3.4 Power Spectral Density 3.3.5 Probability of Error</p> <p>3.4 Digital Modulation Techniques 3.4.1 Digital Linear Modulation (BPSK, DPSK, QPSK) 3.4.2 Minimum Shift Keying (MSK) 3.4.3 Gaussian Minimum Shift Keying (GMSK) 3.4.4 M-array (MPSK, MFSK, QAM and OFDM) Modulation and Demodulation</p>
<ul style="list-style-type: none"> • Understand the basic concept of equalization and diversity 	<p>Unit IV: Equalization, Diversity and Channel Coding(4 Hrs)</p> <p>4.1 Basics of equalization. Equalization in communications</p>

<p>Techniques</p> <ul style="list-style-type: none"> • Represent the knowledge about diversity in different paradigm • Design of RAKE receiver 	<p>receivers, linear equalizers</p> <p>4.2 Non-linear equalization, decision feedback and maximum likelihood sequence estimation equalizations</p> <p>4.3 Adaptive equalization algorithms, zero forcing, least mean square, recursive least squares algorithms, fractionally spaced equalizers</p> <p>4.4 Diversity methods, advantages of diversity, basic definitions</p> <p>4.5 Space diversity, reception methods (selection, feedback, maximum ratio and equal gain diversity)</p> <p>4.6 Polarization, frequency and time diversity</p> <p>4.7 RAKE receivers and interleaving</p>
<ul style="list-style-type: none"> • Understand fundamental concept of cellular network. • Plan and analyse simple wireless networks in terms of coverage and capacity. 	<p>Unit V: Fundamental of Cellular Network (6 Hrs)</p> <p>5.1 Cellular Concept and Operational Channel</p> <p>5.2 Frequency Reuse and Channel Assignment Strategies</p> <p>5.3 Interference and system capacity, co-channel and adjacent channel interference, power control measures</p> <p>5.4 Grade of service, definition, standards</p> <p>5.5 Coverage and capacity enhancement in cellular network, cell splitting, sectoring, repeaters, microcells</p>
<ul style="list-style-type: none"> • Understand the different multiple access techniques used in wireless network • Understand the different slandered used in multiple access techniques 	<p>Unit VI: Multiple Access in Wireless Network(5 Hrs)</p> <p>6.1. Frequency Division Multiple Access (FDMA) Principle and Application</p> <p>6.2. Time Division Multiple Access (TDMA), principles and applications</p> <p>6.3. Spread Spectrum Multiple Access, Frequency Hopped Multiple Access, Code Division Multiple Access, hybrid spread spectrum multiple access techniques</p> <p>6.4. Space Division Multiple Access</p> <p>6.5. Standards for Wireless Local Area Networks</p>
<ul style="list-style-type: none"> • Explore and manage the mobility in wireless network • Able to calculate the traffic in handoff associated network 	<p>Unit VII: Mobility Management in Wireless Network(5 Hrs)</p> <p>7.1. Introduction to Mobility Management</p> <p>7.2. Call Admission Control (CAC)</p> <p>7.3. Handoff Management</p> <p>7.3.1 Handoff Strategies</p> <p>7.3.2 Handoff Types</p> <p>7.4. Location Management For Cellular Network</p> <p>7.5. Location Management For PCS Network</p> <p>7.6. Traffic Calculation</p>
<ul style="list-style-type: none"> • Understand the concept of 	<p>Unit VIII: Wireless / Wireline Internetworking(5 Hrs)</p>

internetworking as well as mobile IP • Learns about the different protocols used in wireless network • Understand about AD-HOC network and its routing	8.1.Introduction to Internetworkingfor Wireless Networks 8.2. Concept of mobile IP, Architecture and Operation 8.3. Tunnelling in mobile IP 8.4.Mobility in IPv6 8.5.Transmission Control Protocol (TCP) 8.6. Wireless Application Protocol (WAP) 8.7. Wireless Markup Language (WML) 8.8.Mobile AD HOC Network (MANET) 8.9.AD HOC Routing Protocols
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Evaluation System

Undergraduate Programs							
External Evaluation	Marks	Internal Evaluation	Weight age	Marks	Practical	Weight age	Mark
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. External Practical Evaluation:

After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	Total questions to be asked	Total questions to be answered	Total marks	Weightage
Group A: multiple choice*	20	20	$20 \times 1 = 20$	60%
Group B: Short answer type questions	7	6	$6 \times 8 = 48$	60%
Group C: Long answer type questions	3	2	$2 \times 16 = 32$	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture
- Field visit

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

Laboratory Work

Student should write programs and prepare lab sheet for most of the units in the syllabus. Majorly, students should practice design and implementation of wireless network. Students are advised to implement the modulator de-modulator, frequency planning, channel assignment as well as routing algorithms used in wireless network. Students are advised to use MATLAB simulator. However, nature of programming can be decided by the instructor. The lab work should be practiced for minimum of 3 lab hours per week. Student are advised to visit the mobile service operators, network service providers, internet service providers and prepare the report including architecture, service, and functioning of the wireless network.

Prescribed Text

1. **Jon W. Mark and Weihua Zhuang**, *Wireless Communication and Networking*, Prentice Hall

References

2. **K. Feher**, *Wireless Digital Communications*, Prentice Hall
3. **T. Rappaport**, *Wireless Communications*, Prentice Hall
4. **J. Schiller**, *Mobile Communications*, Pearson