

GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: Electronics Engineering / Electronics & Communication
Engineering / Electronics & Telecommunication Engineering
SUBJECT NAME: Wireless Communication
SUBJECT CODE: 2171004
B.E. 7th SEMESTER**

Type of course:-

The course addresses the fundamentals of wireless communications and provides an overview of existing and emerging wireless communication Technology and networks. It covers radio propagation and fading models, fundamentals of cellular communications, multiple access technologies, and various wireless systems like GSM, CDMA etc., including past and future generation wireless networks.

Prerequisite: - It is desirable that student is familiar with following domains: Digital and analog Communication, Signals & Systems, Electromagnetic Theory, Probability & Random Processes.

Rationale: - The course will provide fundamental about many theoretical & practical concepts that form the basis for wireless communication systems and Networks. Also the emphasis is given for creating foundation of cellular concepts which will be useful for understanding the fundamentals of cellular mobile communication systems design. The students will learn Mobile Radio Propagation models and various wireless channel effects. Student will understand Multiple Access techniques. Students will also be exposed to recent emerging trends in wireless communication like Software Defined Radio as well. The course also covers overview of recent trends like wireless communication like Wi-Fi, Wi-MAX, bee, UWB Radio and Wireless Adhoc Networks.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction to Wireless Communication System: Evolution of mobile communications, Mobile Radio System around the world, Types of Wireless communication System, Comparison of Common wireless system, Trend in Cellular radio and personal communication. Second generation Cellular Networks, Third Generation (3G) Wireless Networks , Wireless Local Loop(WLL),Wireless Local Area network(WLAN), Bluetooth and Personal Area Networks.	3	10

2	The Cellular Concept- System Design Fundamentals: Cellular system, Hexagonal geometry cell and concept of frequency reuse, Channel Assignment Strategies Distance to frequency reuse ratio, Channel & co-channel interference reduction factor, S/I ratio consideration and calculation for Minimum Co-channel and adjacent interference, Handoff Strategies, Umbrella Cell Concept, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular System-cell splitting, Cell sectorization, Repeaters, Micro cell zone concept, Channel antenna system design considerations.	12	20
3	Mobile Radio Propagation Model, Small Scale Fading and diversity: Large scale path loss:-Free Space Propagation loss equation, Path-loss of NLOS and LOS systems, Reflection, Ray ground reflection model, Diffraction, Scattering, Link budget design, Max. Distance Coverage formula, Empirical formula for path loss, Indoor and outdoor propagation models, Small scale multipath propagation, Impulse model for multipath channel, Delay spread, Feher's delay spread, upper bound Small scale, Multipath Measurement parameters of multipath channels, Types of small scale Fading, Rayleigh and rician distribution, Statistical for models multipath fading channels and diversity techniques in brief.	09	20
4	Multiple Access Techniques: Introduction, Comparisons of multiple Access Strategies TDMA, CDMA, FDMA, OFDM, CSMA Protocols.	07	15
5	Wireless Systems: GSM system architecture, Radio interface, Protocols, Localization and calling, Handover, Authentication and security in GSM, GSM speech coding, Concept of spread spectrum, Architecture of IS-95 CDMA system, Air interface, CDMA forward channels, CDMA reverse channels, Soft handoff, CDMA features, Power control in CDMA, Performance of CDMA System, RAKE Receiver, CDMA2000 cellular technology, GPRS system architecture.	12	20
6	Recent Trends: Introduction to Wi-Fi, WiMAX, ZigBee Networks, Software Defined Radio, UWB Radio, Wireless Adhoc Network and Mobile Portability, Security issues and challenges in a Wireless network.	09	15
Total		52	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	10	15	10	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

Text Book:

- 1 Wireless Communication, Theodore S. Rappaport, Prentice hall
- 2 Wireless Communications and Networking, Vijay Garg, Elsevier
- 3 Wireless digital communication, Kamilo Feher, PHI
- 4 Mobile Communications Engineering, William C. Y. Lee, Mc Graw Hill Publications
- 5 Mobile and personal Communication system and services by Rajpandya, IEEE press (PHI).
- 6 Wireless Communications-T.L.Singh-TMH
- 7 Adhoc Mobile Wireless network, C.K.Toh Pearson.

Course Outcome:

After learning the course the students should be able to:

- 1 Understand the basics of propagation of radio signals
- 2 Understand the basic concepts of basic Cellular System and the design requirements
- 3 Have an understanding of the basic principles behind radio resource management techniques such as power control, channel allocation and handoffs.
- 4 Gain insights into various mobile radio propagation models and how the diversity can be exploited to improve performance
- 5 Gain knowledge and awareness of the technologies for how to effectively share spectrum through multiple access techniques i.e. TDMA, CDMA, FDMA etc.
- 6 Have in-depth understanding of the design consideration and architecture for different Wireless Systems like GSM, CDMA, GPRS etc
- 7 Understanding of the emerging trends in Wireless communication like WiFi, WiMAX, Software Defined Radio (SDR) and related issues and challenges.

List of Experiments:

Experiments and Problems will be based on Concept of GSM, Cellular System Design Concepts, Wi-Fi, -MAX, Zig bee standard , Multipath propagation Environment and its parameter and loss measurement, Adhoc N/Ws & Protocols , Software Defined Radio, UWB Radio, GPRS etc.

Following are the examples of Experiments from the various part of syllabus topic. Same or similar Experiments may be given to the students based on availability of resources in wireless laboratory of the institute.

➤ **Experiments based on MATLAB OR SCILAB**

Write a MATLAB/ SCILAB Program/s based on

- 1 Free space Propagation Model & Frequency Selective Fading Model
- 2 Ground Reflection (Two-ray) Model
- 3 Diffraction (Knife-Edge) Model
- 4 Large-scale Empirical models
- 5 Small-scale Empirical models
- 6 Cellular Systems
- 7 Wireless LANs

➤ **Experiments based on GSM (Using Wireless Communication Trainer)**

- Study the implementation of –GMSK modulation, OQPSK detection.
 - Observe phase response of Tx and Rx and Spectrum of Tx and Rx.
 - Measure the BER value
 - GSM AT Commands

➤ **Experiments based on CDMA (Using Wireless Communication Trainer)**

- Study the performance of DS-SS-SSB system under multi-path condition for single user case
 - Using RAKE receiver with MRC method and EGC method
 - Observation of SNR vs BER curve for two different combining techniques.

➤ **Experiments based on OFDM (Using Wireless Communication Trainer)**

- Study OFDM system synchronization requirement
 - Observe the performance of Schmidl-Cox algorithm used for timing acquisition and fractional freq offset estimation
 - Integer Frequency offset estimation

Design based Problems (DP)/Open Ended Problem:-

1. Design of Any Arbitrary Modulation Scheme
 - 8PSK, QAM (16, 64 etc), EDGE, WCDMA*, WiFi*, WiMAX*
 - Compare at base-band, IF and RF
2. Design of Discrete Multi-tone modem, FM Radio Reception.
3. Design/implement the different Channel Coder/Decoder
 - Turbo decoder
 - LDPC coder / decoder
4. Project based on Reception of local GSM broadcast channel
5. Project based on Frequency Hopping Spread Spectrum (FHSS)

Major Equipment: -

DSO, CRO, Signal Generators, Spectrum Analyzers, GSM, GPRS, GPS, CDMA Trainer Kits, Mobile Communication & Wireless Communication Trainer Kits etc.

List of Open Source Software/learning website:-

Students may use SCILAB, MATLAB, NETSIM, NS2 and NPTL Videos, MIT open course website, Virtual Labs (Source:[http://vlab .co.in](http://vlab.co.in)).

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.