GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171004
Semester – VII
Subject Name: Wireless   Communication

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,Zig bee, UWB Radio and Wireless Adhoc Networks.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
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.	2
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	12

	splitting, Cell sectorization, Repeaters, Micro cell zone concept, Channel antenna system design considerations.	
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 models for multipath fading channels and diversity techniques in brief.	07
4.	**Multiple Access Techniques:** Introduction, Comparisons of multiple Access Strategies TDMA,CDMA, FDMA, OFDM , CSMA Protocols., NOMA	04
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
6	**Recent Trends:** Introduction to Wi-Fi, WiMAX, ZigBee Networks, NIMO Software Defined Radio, UWB Radio, Wireless Adhoc Network and Mobile Portability, Security issues and challenges in 5 G abd above Wireless networks	08

Suggested Specification table with Marks (Theory): (For PDDC only)

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: -

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 completion of this course students will be able to…

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the basic concepts of radio propagation and various aspects of cellular system design.	20
CO-2	Understand the emerging trends in Wireless communication like WiFi, WiMAX, Software Defined Radio (SDR) and related issues and challenges.	10
CO-3	Compare the mobile radio standards i.e. GSM, CDMA, GPRS etc. for wireless systems.	25
CO-4	Explore and select the mobile radio propagation model for system design	20
CO-5	Analyze various multiple access techniques i.e. TDMA, FDMA, CDMA towards effective radio resource management.	25

List of Experiments:-

Experiments and Problems will be based on Concept of GSM, Cellular System Design Concepts, Wi-Fi,Wi-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.

Write a 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-CDMA 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

Major Equipments: GSM Trainer Kit,CDMA Trainer Kit, Spectrum Analyser, SDR kit,UWB kit, GPS Trainer kit, Mobile Communication Trainer Kits, ,SCILAB , CRO,Power Supply,Function Generator etc.

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)

List of Open Source Software/learning website:-

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