

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (WIRELESS COMMUNICATION SYSTEMS & NETWORKS) (27)

SMART ANTENNAS FOR WIRELESS COMMUNICATION

SUBJECT CODE: 2732701

ME Semester: III

Type of course: Major Elective-IV

Prerequisite: Basic concepts of antennas, cellular concepts, Smart antennas: Introduction, applications and techniques.

Rationale: PG Students of Wireless Communication System and Networks needs to possess good understanding of the smart antennas for wireless communication. They should understand the basic concepts of cellular mobile systems, smart antennas used for wireless communication. This subject aims to teach Propagation and modeling, spatial processing, techniques for CDMA system and RF positioning for the smart antennas.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	ESE (V)		PA (I)			
					ESE	OEP	PA	RP		
4	0	2#	5	70	30	20	10	10	10	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Fundamental Parameters of Antenna and cellular concepts: Radio communication link with transmission and receiving antenna, radiation patterns, antenna equivalent circuits, reciprocity theorem, beam area, beam width, directivity, gain, antenna apertures, effective height, field zones, radiation resistance, radiation efficiency, antenna polarization. Potential functions and the electromagnetic fields, oscillating electric dipole-derivations for E and H field components in spherical co-ordinate systems, power radiated by a current element, Principal operation of a cellular mobile system, analogue and digital cellular mobile radio systems.	05	10%
2	Mobile antennas and mobile Radio Propagation and Modelling: Introduction and basics of mobile radio propagation, free-space propagation model, link budget design, propagation models, types of small-scale fading, statistical models for multipath propagation. Antennas for Mobile Communication: Mean effective gain, Human body interactions and specific absorption rate, mobile satellite antennas, Macrocell antennas, microcell antennas, Picocell antennas, femtocell antennas, space diversity antennas.	05	10%
3.	Introduction to Smart Antennas:	04	13%

	Need for smart antennas, standards for smart antennas, types of smart antennas, features and benefits ,architecture, advantages and disadvantages of smart antennas, introduction to orthogonal signals, signal propagation: multipath and co-channel Interference.		
4	Introduction to Smart Antennas: Spatial Processing for Wireless Systems : The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming networks, Switched Beam Systems.	09	14%
5	Adaptive Antenna Systems: Wideband Smart Antennas, Spatial Diversity, Diversity Combining, and Sectoring, Transmission Beam forming, Array Calculation.	09	14%
6	Smart Antennas Techniques for CDMA: Non-Coherent CDMA Spatial Processors, Coherent CDMA Spatial Processors and the Spatial Processing Rake Receiver, Multi-User Spatial Processing, multi-carrier communication, Dynamic Re-sectoring Using Smart Antennas, Downlink Beam-forming for CDMA.	08	13%
7	CDMA System Range and Capacity Improvement Using Spatial Filtering: Range Extension in CDMA, Reverse Channel Performance of Multi-cell Systems with Spatial Filtering at the Base Station, Range and Capacity Analysis Using Smart Antennas – A Vector Based Approach	07	13%
8	RF Position Locating Systems: Direction finding PL systems, True ranging PL Systems, Elliptical PL Systems, Hyperbolic PL Systems, Hyperbolic Vs DF PL Systems, TDOA Estimation Techniques: General Model for TDOA Estimation, Measures of Position Location Accuracy: Circular Error Probability and Geometric Dilution of Precision.	09	13%

Reference Books:

1. Antennas for all applications, 3rd edition, by J.D. Krauss, TMH.
2. Antenna & Wave Propagation, K.D. Prasad, Satyaprakash publications.
3. Mobile cellular communication, Gottapu Sashibhushana Rao, Pearson Publications
4. Wireless Communications: Principles and practice, 2nd edition, Theodore S. Rappaport, PHI.
5. Joseph C. Liberti and Theodore S. Rappaport, Smart Antennas for Wireless Communications IS 95 and Third Generation CDMA Applications, Prentice Hall PTR
6. Balanis C A, Antenna Theory: design and applications, Wiley
7. Frank Gross, Smart Antennas for Wireless Communications-Mc Graw Hill
8. Ahmed El-Zooghby, Smart Antenna Engineering, Artech House Publishers
9. Constantine Balanis, Introduction to Smart Antennas, Morgan and Claypool Publisher.

Course Outcomes:

After learning the course the students should be able to:

1. Understand the fundamental parameters of antenna and use of cellular concepts.
2. Understand the basic architecture, features and benefits of smart antennas.
3. Able to integrate smart antenna technology with overall communication system design, principle and its performance.
4. Understand fundamental, characteristics, problem, architectures and consequences of all wireless communication system.
5. Understand the beam forming techniques and adaptive array techniques.

6. Understand the implementation of smart antennas for Direct sequence CDMA systems and examine some of the challenges involved in applying smart antennas to CDMA.
7. Understand the performance of CDMA cellular radio systems which use spatial filtering, as well as to determine practical limits on the number of simultaneous active users that can be supported in these systems.

List of Experiments:

1. To setup base-band digital communication link using raised cosine spectrum pulses with the chosen roll-off factor, to study the characteristics of the RC pulse, to explore the behavior of the timing acquisition algorithm and to understand clock slip control in the tracking algorithm using matlab.
2. To observe the BER performance of DS-CDMA using mixed codes in multipath channel using RAKE receiver for single user case.
3. To understand the basic aspects of DS-CDMA in single user case and two user case.
4. To determine the free space loss and the power received using MATLAB program.
5. To perform and study the reciprocity theorem of antennas.
6. To perform and study the microstrip antenna showing its radiation characteristics, beam width and bandwidth.
7. To plot 2-D and 3-D radiation pattern of directional antenna using MATLAB.
8. To design and simulate the linear array using antenna designing software.
9. To design and simulate the microstrip antenna using antenna designing software.
10. To design and simulate the mobile antenna using antenna designing software.

Design based Problems (DP)/Open Ended Problem:

1. Miniaturized antenna elements design
2. Antenna arrays constructions
3. Adaptive beam steering
4. Signal searching techniques
5. Smart phone applications.

Major Equipment:

MATLAB, antenna designing software such as HFSS, IE3D, CST, Wireless communication kits, antenna trainer kits.

List of Open Source Software/learning website:

http://ids.nic.in/technical_letter/TNL_JCES_JUL_2013/Smart%20Ant%20Technology%20.pdf

http://117.218.52.222:8080/quality/TelecomBasics%5Csmart_ant.pdf

http://sfhmy.ntua.gr/2007/papers/Smart%20Antennas_NTUA_07_Balanis_Final.pdf

[http://www.srmuniv.ac.in/sites/default/files/files/TE0421%20-%20Manual_Final\[1\].pdf](http://www.srmuniv.ac.in/sites/default/files/files/TE0421%20-%20Manual_Final[1].pdf)

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.