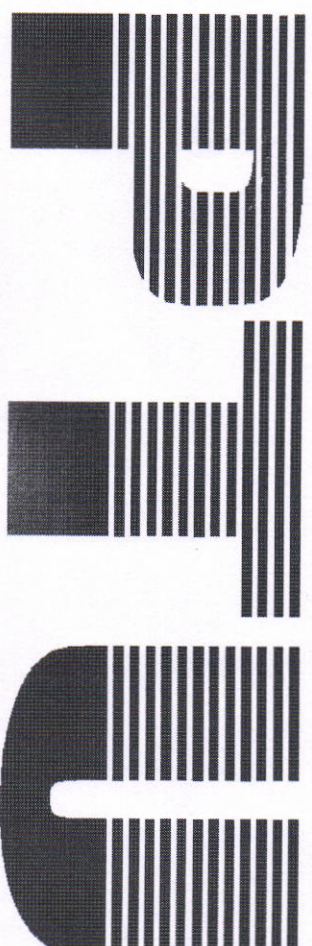


**Scheme and Syllabus**  
**of**  
**M. Tech.**  
**Electronics and Communication Engineering**  
**(Wireless Communication)**

**BATCH-2011**

**Punjab Institute of Technology, Kapurthala**  
*(A constituent college of Punjab Technical University)*



  
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Main Campus, Kapurthala (Punjab)-146003

# First Semester

Course Code	Course Title	Load Allocation				Marks Distribution			Credits
		L	T	P	Hours/Week	Internal	External	Total	
ECL-101	Research Methodology	3	1	-	4	40	60	100	4
ECE-(1XX)	Elective – I	3	1	-	4	40	60	100	4
ECL-102	Information Theory & Coding	3	1	-	4	40	60	100	4
ECL-103	Wireless Communication	3	1	-	4	40	60	100	4
ECE-(1XX)	Elective – II	3	1	-	4	40	60	100	4
Total		15	5	-	20	200	300	500	20

# Second Semester

Course Code	Course Title	Load Allocation				Marks Distribution			Credits
		L	T	P	Hours/Week	Internal	External	Total	
ECL-201	Advanced Wireless Communication	3	1	-	4	40	60	100	4
ECL-202	Simulation Of Wireless Communication Systems	3	1	-	4	40	60	100	4
ECL-203	Soft Computing Techniques	3	1	-	4	40	60	100	4
ECE-(1XX)	Elective –III	3	1	-	4	40	60	100	4
ECE-(1XX)	Elective –IV	3	1	-	4	40	60	100	4
ECP-101	Wireless Simulation Laboratory	-	-	4	4	60	40	100	2
Total		15	5	3	20	260	340	600	22

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### Third Semester

Course Code	Course Title	Load Allocation				Marks Distribution			Credits
		L	T	P	Hours/Week	Internal	External	Total	
ECE-(1XX)	Elective – V	3	1	-	4	40	60	100	4
ECE-(1XX)	Elective – VI	3	1	-	4	40	60	100	4
ECS-101	Seminar	-	-	2	2	100	-	100	2
ECD-101	Dissertation (Part – I)	-	-	8	8	60*	40	100	8
Total		6	2	10	18	260	140	400	18

### Fourth Semester

Course Code	Course Title	Load Allocation	Marks Distribution			Credits
			Internal	External	Total	
ECD-101	Dissertation (Part - II)	24Hours per week	60*	40**	100	20

\*To be evaluated by department research committee.

\*\*To be evaluated by student research committee along-with external examiner.

Elective – I, II, III, IV, V and VI is to be chosen from the set list of electives.

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### List of Electives\*

1. ECE-101 Advanced Digital Signal Processing
2. ECE-102 Advanced Communication Systems
3. ECE-103 Smart Antennas
4. ECE-104 RF MEMS For Wireless Communications
5. ECE-105 CDMA Technology
6. ECE-106 Wireless Sensor Networks
7. ECE-107 Software Defined Radio
8. ECE-108 Bluetooth Technology
9. ECE-109 Soft Computing Techniques
10. ECE-110 Emerging Technologies in wireless communications
11. ECE-111 Advanced Antenna Systems
12. ECE-112 Space Time Wireless Communication
13. ECE-113 Wireless Protocols and Architecture
14. ECE-114 Microwave and RF Design
15. ECE-115 Audio and Video Signal Processing
16. ECE-116 Detection and Estimation Theory
17. ECE-117 Mobile Ad hoc Networks
18. ECE-118 Wireless LAN and PAN
19. ECE-119 Wireless Security
20. ECE-120 Advanced Wireless Networks

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# Syllabus Already covered in 1<sup>st</sup> Sem

## Research Methodology

### Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial, response surfaces (8)

### Methods of Data Collection

Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. (4)

### Sampling Methods

Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling. Sampling distributions. (8)

### Processing and analysis of Data

Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests. (8)

### Multivariate Analysis

Multiple Regression, Factor Analysis, Discriminant Analysis, Cluster Analysis, multidimensional scaling (6)

### Reliability and Validity

Test-retest reliability, alternative-form reliability, internal-comparison reliability, and scorer reliability.

Content validity, criterion-related validity, and construct validity. (3)

### Essential of Report writing (3)

Note: Application and use of various software for case studies should be essential

#### Reference Books

- Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.  
Malhotra, N.K., Marketing Research An Applied Orientation, 4th Edition Pearson Education: New Delhi.  
Zikmund, W.G., Business Research Methods, 7th Edition, Thomson South-Western.  
Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.  
Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition

## ADVANCED COMMUNICATION SYSTEMS

### • INTRODUCTION

Introduction to communications systems, analog and digital communication systems, Applications of communication systems.

### • DIGITAL COMMUNICATION

Introduction, Digital Modulation techniques, BPSK, QPSK, PCM, DPCM, Delta Modulation, Digital Transmission and Transmission Impairments.

### • OPTICAL NETWORKS

WDM, TDM, Telecommunication Infrastructure, Switching, 3G systems, SONET, SDH, Architecture of Optical Transport Network, Link Management Protocols, Solutions.

### • SATELLITE COMMUNICATION

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### **Uplink and Downlink AWGN channel :**

Capacity via successive interference cancellation, Comparison with conventional CDMA, Comparison with orthogonal multiple access, General K-user uplink capacity, Symmetric case: two capacity achieving schemes, General case: superposition coding achieves capacity

### **Uplink and Downlink fading channel :**

Slow fading channel, Fast fading channel, Full channel side information, Channel side information at receiver only, Full channel side information, Frequency-selective fading channels

### **Multuser diversity :**

Multuser diversity gain, Multuser versus classical diversity, Fair scheduling and multuser diversity, Channel prediction and feedback, Opportunistic beam forming using dumb antennas, Multuser diversity in multicell systems

### **Physical modeling of MIMO channels :**

Line-of-sight SIMO channel, Line-of-sight MISO channel, Antenna arrays with only a line-of-sight path, Geographically separated antennas, Line-of-sight plus one reflected path, MIMO multipath channel, Angular domain representation of signals, Angular domain representation of MIMO channels, Statistical modeling in the angular domain, Degrees of freedom and diversity, Dependency on antenna spacing

1. Andrea Goldsmith, "Wireless Communications" Cambridge University Press, 2005

2. David Tse, Pramod Viswanath "Fundamentals of Wireless Communications" Cambridge University Press 2005

## **ADVANCED DIGITAL SIGNAL PROCESSING**

### **Review :**

Fourier Transforms, Z-Transforms, Discrete Fourier Transform, Fast Fourier Transform, Convolution And Correlation.

### **Design of digital filters:**

Introduction to filter design, types of digital filters, choosing between, fir and iir filters, filter design steps, effect of finite register length in filter design, realization of iir digital filters and fir digital filter, design of iir filters from continuous time filters, design of fir filters by windowing.

### **Digital signal processors:**

General and special purpose digital signal processors, computer architecture for signal processing, selecting digital signal processors, architecture and programming of ADSP 2181 processor.

### **Spectrum estimation:**

non-parametric methods correlation method, co-variance estimator, performance analysis of estimators, consistent estimators, ar, ma, ARMA signal modeling, parameter estimation using Yule-walker method.

### **Linear estimation and predication:**

Maximum likelihood criterion efficiency of estimator, least mean squared error criterion, recursive estimators, and linear predications.

### **Multirate digital signal processing:**

Mathematical description of change of sampling rate, interpolation and decimation, continuous time model, direct digital domain approach, interpolation and decimation by an integer factor, single and multistage realization, applications of sub band coding.

### **Adaptive Filters:**

Applications Of Adaptive Filters, Adaptive Direct Form FIR Filters: The LMS Algorithm, Adaptive Lattice Ladder Filters, Recursive Least Squares Lattice Ladder Algorithms.

### **BOOKS/REFERENCE**

- Monson H.Hayes, " Statistical Digital Signal Processing and Modeling ", John Wiley and Sons, Inc., New York, 1996
- Emmanuel C.Ifeachor Barrie W.Jervis, "Digital Signal Processing", Pearson Education Asia
- Proakes Manolakis, " Digital Signal Processing principles, algorithms, and applications", Prentice Hall India
- ADSP 2181 manuals
- Keshab K. Parhi, " VLSI DSP Systems; Design & implementation", Wiley InterScience Publishers
- Moonen, Ian k. Proudler, " Algorithms for statistic

## **INFORMATION THEORY & CODING**

### **UNIT I INFORMATION THEORY**

Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memoryless channels – ~~BSC~~ <sup>BEC</sup> – Channel capacity, Shannon limit.

### **UNIT II SOURCE CODING: TEXT, AUDIO AND SPEECH**

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Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MPEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

### **UNIT III SOURCE CODING: IMAGE AND VIDEO**

Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I,B,P frames, Motion estimation, Motion compensation, H.261, MPEG standard

### **UNIT IV ERROR CONTROL CODING: BLOCK CODES**

Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder - CRC

### **UNIT V ERROR CONTROL CODING: CONVOLUTIONAL CODES**

Convolutional codes – code tree, trellis, state diagram - Encoding – Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding

### **TEXT BOOKS:**

1. R Bose, "Information Theory, Coding and Cryptography", TMH 2007
2. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", Pearson Education Asia, 2002

### **REFERENCES:**

1. K Sayood, "Introduction to Data Compression" 3/e, Elsevier 2006
2. S Gravano, "Introduction to Error Control Codes", Oxford University Press 2007
3. Amitabha Bhattacharya, "Digital Communication", TMH 2006

## **Proposed core subjects syllabi for 2<sup>nd</sup> Sem**

## SIMULATION OF WIRELESS COMMUNICATION SYSTEMS

### UNIT-I: Introduction to simulation approach

Methods of performance evaluation-simulation approach- Advantages and limitations. System model steps and its types involved in simulation study. Error sources in simulation. Role of simulation in communication system and random process. Introduction to random variables - univariate models (discrete and continuous) and multi-variate models.

### UNIT-II: Review of Stochastic process and parameter estimation

**Stochastic process:** Definitions, properties – stationarity, time averaging and ergodicity, random process models

**Parameter estimation:** Quality of an estimator, estimating average power probability density function, estimation of power spectral density of a process, delay and phase. SNR estimation and importance sampling.

**UNIT-III, Numerical methods for wireless Communication Systems:** numerical differentiation, integration, differential equation.

**Monte Carlo simulation:** concepts and integration, Application in wireless Communication Systems.

### UNIT-III: Modeling of Communication systems

, properties, generation and techniques for generating random numbers and processes.

Introduction to modeling of communication systems - Information sources, source coding, base band modulation, channel coding, RF and optical modulation, filtering, multiplexing, detection/demodulation- carrier and timing recovery for BPSK and QPSK. Modeling considerations for PLL.

### UNIT-IV: Communication channel models

Statistical characterization of multipath channels and time-varying channels with Doppler effects, models for multipath fading channels. Finite state channel models – channels with and without memory. Methodology for simulating communication systems operating over fading channels.

### TEXT BOOKS:

1. M.C. Jerruchim, Philip Balaban & K.Sam shammugam. "Simulation of communication systems", Plenum press, New York, 1992
2. M.Law & W.David Kelton, "Simulation Modelling and analysis", McGraw Hill, New York, 1999.
3. K.Hayes, "Modelling and Analysis of computer communication networks", Plenum press, New York, 1984.
4. Banks, J.S.Carson, Nelson and D.M.Nicol, "Discrete –Event system simulation", Prentice Hall of India, 4th Edition, 2005.
5. Z.Peebles, "Probability, Random Variable and Random Signal Principles", Tata McGraw Hill, 4th edition 2002.

## DESIGN AND SIMULATION OF WIRELESS LABORATORY

1. Generation of Voice, Data and Video traffic.
2. Simulation of the Radio Channel.
3. Simulation of Hand off mechanisms.
4. Simulation of CDMA Transmitter and Receiver.
5. Coding Techniques for Wireless Communication.
6. Link Budget.33
7. Simulation of Security Algorithms.
8. Study of Glomosisim and NS2.

### Soft Computing Techniques

#### Artificial Neural Network

Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model, Properties of neural network, Typical architectures: single layer, multilayer, competitive layer, Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent N.N; Application of N.N; Neuron.

Pattern Recognition

Pattern Classification, Pattern Association, Clustering, Simple Clustering algorithm, k-means & k-medoid based algorithm.

Models Of Neural Network

Architecture, Algorithm & Application of -- McCulloch-Pitts, Hebb Net, Perceptron ( with limitations & Perceptron learning rule Convergence theorem), Backpropagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet, Kohonen Self Organizing Maps, ART1, ART2.

#### Fuzzy Sets & Logic

Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic—Laws of propositional logic, Inference; Predicate logic—Interpretations, Inference; Fuzzy logic—Quantifiers, Inference; Fuzzy Rule based system; Defuzzification methods; FAM;

#### Genetic Algorithm

Basic concept, role of GA in optimization, Fitness function, Selection of initial population, Cross over(different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation; Genetic Programming; Schema theorem; Multiobjective & Multimodal optimization in GA; Application—Travelling Salesman Problem

#### Hybrid soft computing Techniques

GA based BPNN(Weight determination, Application); Neuro Fuzzy Systems—Fuzzy BPNN—fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled G.A;

Books:

1. Principles of Soft Computing –S. N. Sivanandam, S.N. Deepa; Wiley India
2. Neural Networks- A Comprehensive foundation, Simon Haykin, 2nd Ed; Pearson
3. Neural Networks, Fuzzy Logic & Genetic Algorithms – Synthesis & applications, T.S. Rajasekaran & G.A. Vijaylaxshmi Pai, PHI
4. Genetic Algorithm & fuzzy Logic Systems - Sanchez, Takanori, Zadeh; World Scientific
5. Genetic Algorithm, Goldberg David E.; Pearson
6. Fuzzy Set Theory & Its Applications - Zimmermann H. J.; Allied Publishers

### ADVANCED WIRELESS COMMUNICATION

UNIT-I: REVIEW OF FUNDAMENTALS OF WIRELESS COMMUNICATION: MULTIPATH FADING, MULTIPATH CHANNEL MODELS, CAPACITY OF WIRELESS CHANNELS.

UNIT-II: PERFORMANCES OF DIGITAL MODULATION OVER WIRELESS CHANNELS: AGWN CHANNELS SIGNAL TO NOISE POWER RATIO AND BIT/SYMBOL ENERGY, ERROR PROBABILITY FOR BPSK, QPSK, MPSK, MPAM, MQAM- THEIR COMPARISON.

UNIT-III: MULTICARRIER MODULATION: DATA TRANSMISSION USING MULTIPLE CARRIERS, MULTICARRIER MODULATION WITH OVERLAPPING SUBCHANNELS, MITIGATION OF SUBCARRIER FADING, DISCRETE IMPLEMENTATION OF MULTICARRIER MODULATION, CHALLENGES IN MULTICARRIER SYSTEMS.

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UNIT-IV: INTRODUCTION TO WIRELESS OFDM: OFDM PRINCIPLES, SYSTEM MODEL, GENERATION OF SUB CARRIER USING IFFT, GUARD TIME, CYCLIC EXTENSION, WINDOWING, OFDM PARAMETERS, OFDM SIGNAL PROCESSING, COHERENT AND DIFFERENTIAL DETECTION

UNIT-V: OFDMA: FREQUENCY HOPPING IN OFDMA, DIFFERENCE BETWEEN OFDMA AND MC-CDMA, OFDMA SYSTEM DESCRIPTION-CHANNEL CODING, FREQUENCY SYNCHRONIZATION, INITIAL MODULATION TIMING AND FREQUENCY OFFSET SYNCHRONIZATION ACCURACY, RANDOM FREQUENCY HOPPING OPERATION, APPLICATIONS OF OFDMA.

**Books:**


- A.Goldsmith, "Wireless Communications, Cambridge Univ. Press, 2005.
- R.Vannee and R.Prasad, "OFDM for Wireless Multimedia Communication, Artech House, 2000.
- M.Engels, Wireless OFDM systems, Klumer Academic Publishers, 2002.

**SMART ANTENNAS FOR WIRELESS COMMUNICATIONS**

**Unit-I:**

INTRODUCTION TO SMART ANTENNAS, WHY SMART ANTENNAS, BENEFITS OF SMART ANTENNAS, SPATIAL PROCESSING FOR WIRELESS SYSTEMS, WIDEBAND SMART ANTENNAS, HISTORICAL DEVELOPMENT

**Unit-II:**

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ANTENNA FUNDAMENTALS – ANTENNA FIELD REGIONS, POWER DENSITY, RADIATION INTENSITY, ANTENNA NOMENCLATURE, FRIIS TRANSMISSION FORMULA, LINEAR ANTENNAS, LOOP ANTENNAS.

Unit-III:

ARRAY FUNDAMENTALS – LINEAR ARRAYS, ARRAY WEIGHTING, CIRCULAR ARRAYS, RECTANGULAR ARRAYS, FIXED BEAM AND RETRODIRECTIVE ARRAYS.

Unit-IV:

BEAMFORMING BASICS – MAXIMUM SIGNAL TO INTERFERENCE RATIO, MINIMUM MEAN SQUARE RATIO, MINIMUM VARIANCE, ADAPTIVE BEAMFORMING, DESCRIPTION OF NEW SDMA RECEIVER, SOFTWARE RADIOS FOR SMART ANTENNAS..

Unit-V:

SMART ANTENNA TECHNIQUES FOR CDMA, NON-COHERENT CDMA SPATIAL PROCESSORS, COHERENT CDMA SPATIAL PROCESSORS AND THE SPATIAL PROCESSING RAKE RECEIVER, MULTI-USER SPATIAL PROCESSING, DYNAMIC RE-SECTORING USING SMART ANTENNAS, DOWNLINK BEAMFORMING FOR CDMA.

## BOOKS

- Gross F.B. "Smart Antennas for Wireless Communications with MATLAB", McGraw-Hill, New York, 2005.
- Balanis A., "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 1982
- Joseph C. Liberti, Theodore S. Rappaport - "Smart Antennas for Wireless Communications: IS95 and third generation CDMA Applications", Prentice Hall Communications Engineering and Emerging Technologies Series

- **Wireless Sensor Networks**

- **Unit I**

- Introduction: the vision, Networked wireless sensor devices, Applications, Key design challenges.
- Network deployment: Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.

- **Unit II**

- Localization: issues & approaches, Coarse-grained & Fine-grained node localization, Network-wide localization, Theoretical analysis of localization techniques.

- Synchronization: Issues & Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization.

### Unit III

- Wireless characteristics: Basics, Wireless link quality, Radio energy considerations, SINR capture model for interference.
- Medium-access and sleep scheduling: Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols.
- Sleep-based topology control: Constructing topologies for connectivity, constructing topologies for coverage, Set K-cover algorithms.

### Unit IV

- Routing: Metric-based approaches, Routing with diversity, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing, Routing to mobile sinks.
- Data-centric networking: Data-centric routing, Data-gathering with compression, Querying, Data-centric storage and retrieval, The database perspective on sensor networks.
- Reliability and congestion control: Basic mechanisms and tunable parameters, Reliability guarantees, Congestion Control, Real-time scheduling.

### Books:

1. Wireless Sensor Networks: Technology, Protocols, and Applications: Kazem Sohraby, Daniel Minoli, Taieb Znati, Wiley Inter Science.
2. Wireless Sensor Networks: Architectures and Protocols: Edgar H. Callaway, Jr. Auerbach Publications, CRC Press.
3. Wireless Sensor Networks: Edited by C.S Raghavendra, Krishna M, Sivalingam, Taieb Znati, Springer.
4. Networking Wireless Sensors: Bhaskar Krishnamachari, Cambridge University Press
5. Distributed Sensor Networks: A Multiagent Perspective, Victor Lesser, Charles L. Ortiz, and Milind Tambe, Kluwer Publications.
6. Wireless Sensor Networks: An Information Processing Approach- by Feng Zhao, Leonidas Guibas, Morgan Kaufmann Series in Networking 2004.
7. Waltenegus Dargie And Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks: Theory And Practice". John Wiley & Sons, August 2010.

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