Course Description

Title: Advanced Communication System **Code:**

L-T-P scheme: 3-0-0 **Credits: 3**

Prerequisite: Students must have already studied courses, "Analog and Digital communication and "signals and systems".

Objective:

1. Develop problem solving ability using Communication Systems, develop ability to express solutions to problems clearly and precisely.
2. Develop ability to design and analyze probability of errors. Develop fundamental and conceptual learning on basic and advanced Digital communication systems.

Learning Outcomes:

The students shall acquire the generic skills to study & design various applications of the systems and solve the problems.

Course Outcome	Description
CO1	Baseband Modulation techniques Source Coding: Formatting data, Noise effect
CO2	Study and characteristics of Bandpass Modulation Techniques
CO3	Probability of error analysis of baseband and bandpass modulation techniques
CO4	Signal analysis techniques and their response in Signal space
CO5	Design and analysis on Error detecting and correcting scheme
CO6	Study on advanced multi carrier communication systems

Course Contents:

Unit-1: Introduction: Elements of a communication system, Different types of signals, PSD, Random process, Ergodicity, Noise.

Unit-2: Source Coding: Formatting data, Quantization, Dithering, Source coding, Baseband modulation & Correlative coding: Pulse modulation, Correlative coding, PCM generation and detection, quantization, quantization error, non uniform quantization, companding, differential PCM, Delta modulation, Adaptive delta modulation.

Unit-3: Analog Communication systems (A.M.): Different types of AM & FM systems, Transmitters, Receivers and Antenna systems, Phase Locked Loop: Theory and applications, Capture range, Lock range, order of Low pass filter, Loop dynamics.

Unit-4: Probability of error analysis – Optimum filter, Matched filter. Coherent & Non-Coherent Reception. Probability of error for FSK, PSK, DPSK, M-ary PSK, Minimum Shift Keying (MSK). Introduction to bit Vs symbol error probability & Bandwidth. Communication Link Analysis: Link Budget Analysis, Sources of signal loss & noise, Path loss, Link margin, System trade-off, Base band modulation

& demodulation/detection

Unit-5: Base band modulation, Demodulation, Detection of binary signal in Gaussian noise, Band pass modulation & demodulation: Line codes. Binary & M-ary modulation techniques: FSK, PSK, DPSK, M-ary PSK, Minimum Phase Shift Keying (MSK) and Quadrature Amplitude Modulation. Coherent detection, non coherent detection, error performance for M- ray systems.

Unit-6: Signal Space Analysis: Signal Space, Signals and Vectors, The Gram Schmidt Procedure, optimum Signal Detection, Correlator. Multicarrier Modulation: Multicarrier modulation with overlapping sub channels, OFDM, Challenges in Multicarrier system, Spread Spectrum Communication: DSSS, Cellular system, FHSS, CDMA, Wireless sensor networks, Cognitive Radio, Wavelets and their applications.

Teaching Methodology:

1. Lectures would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.
2. Tutorials will have conceptual and numerical questions that would aid in strengthening the data structures principles.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15	Based on Unit-1 & Unit-2
Test-2	25	Based on Unit-2, Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35	Based on Unit-4, Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Tutorials	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Quiz	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Attendance	5	Based on attendance in the theory classes
Total	100	

Text Books:

[1] Modern Digital and Analog Communications Systems - B P Lathi Third Edition Oxford university press.

[2] Communication Systems , S Haykins, John Wiley and Sons

[3] Principles of communication, Taub & Schilling Latest Edition Tata Mc Graw Hill Publication

Reference Books:

[1] Communication Systems by A B Carlson, Tata Mc Graw Hill, 2000

Web References:

[1] www.w3.com
[2] https://www.tutorialspoint.com/e_commerce/index.htm

Journals References:

[1] ACM Transactions on the communication
[2] ACM Transactions on the Information and communication Systems

Title: VLSI Circuit and System Design **Code:**

L-T-P Scheme: 3-0-0 **Credits: 3**

Prerequisite: Students must have already Knowledge of VLSI, CMOS process flow, Combinational MOS logic circuits and HDL based design.

Objective:

1. To learn and be able to implement the concept of MOS transistor and CMOS process flow.

Learning Outcomes:

Course Outcome	Description
CO1	Get familiar with overview of VLSI design complexities and simulation.
CO2	Have a good grounding of VLSI Application and terminologies, VLSI tools and MOS theory.
CO3	Basic step for design of n-well and P-well CMOS
CO4	Having an understanding of the characteristics of CMOS circuit
CO5	Be able to design static CMOS combinational and sequential logic at the transistor level, including mask layout
CO6	Work as a team on a VLSI project using HDL Language

Course Contents:

Unit-1: Building blocks of VLSI: Overview of VLSI, Complexities and Design, VLSI Simulation Steps and Tools.

Unit-2: MOS Transistor Theory: A review of MOS structure and operation, MOS I-V characteristics, MOSFET model for Circuit Simulation, Scaling and Small Geometry effects.

Unit-3: CMOS Process Flow: Basic steps, CMOS n-well process, Twin-Tub process, layout design rules.

Unit-4: MOS Inverter: Static and Dynamic Characteristic, Performance Estimation.

Unit-5: Combinational MOS logic circuits: Transmission gate, Dynamic logic, Timing issues in CMOS Digital Circuits, Semiconductor Memories, SRAM, DRAM, ROM analysis and design.

Unit-6: HDL based design: Language Fundamentals, Behavioral and RTL style of modeling, Data Flow style of description, Structural style, Test-Bench, Hazards and Fault Analysis.

Teaching Methodology:

This course is introduced to help students' basic theories and techniques of digital VLSI design in CMOS technology. In this course, we will study the fundamental concepts and structures of designing digital VLSI systems include CMOS devices and circuits, standard CMOS fabrication processes, CMOS design rules, static and dynamic logic structures interconnect analysis, CMOS chip layout, simulation and

testing, low power techniques, design tools and methodologies, VLSI architecture. The course is designed to give the student an understanding of the different design steps required to carry out a complete digital VLSI (Very-Large-Scale Integration) design in silicon.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on VLSI Circuit and System Design Course (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:
1. S. M. Kang, Y. Leblebici, CMOS Digital Integrated Circuits: AnalysisandDesign,3rd Edition Tata McGraw-Hill Publication, 2003.
2. J. M. Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuit:Adesignperspective,2nd Edition Pearson Education, 2005.

ReferenceBooks:

1. S. Sjoholm, L. Lindh,VHDL for Designers, Pearson Education Ltd., England,1997.
2. N. Weste, David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 3rdEdition Addison Wesley, 2004.

Web References:
[1] https://www3.nd.edu/~kogge/courses/cse40462-VLSI-fa18/www/links.html
[2] https://www.tutorialspoint.com/vlsi_design/index.htm

Journals References:
[1] IEEE Transactions on Very Large Scale Integration
[2] Integration, the VLSI Journal
[3] International Journal of VLSI Design & Communication Systems

Title: ECE Design and Simulation Lab **Code:**

L-T-P scheme: 0-0-4 **Credit: 2**

Prerequisite: None

Objective:

1. To learn the fundamental & simulation of analog and digital circuits.
2. To develop an ability of designing analog and digital circuits as per the specified requirements.

Learning Outcomes:

Course Outcome	Description
CO1	Outline based on introduction to various analog and digital elements with their representation.
CO2	Describe operation and characteristics of semiconductor elements such as BJT, FET, MOSFET, etc.
CO3	Develop an ability to simulate the behaviour of analog and digital circuit components.
CO4	Identify the application of operational amplifier and multi-vibrator circuit.
CO5	Apply the design techniques to implement active filter and oscillator circuits.
CO6	Demonstrate the operation of digital circuits.

List of Experiments: -

Unit 1: Lab exercise based on characteristics of semiconductor elements such as PN junction diode, Zener diode, NPN transistor, etc.

Unit 2: Lab exercise based on transfer characteristics, DC biasing, and frequency response of JFET.

Unit 3: Lab exercise based on implementation of transistor based amplifier circuits and analysis of their frequency response.

Unit 4: Lab exercise based on simulation of operational amplifier (OP-AMP) and implementation of OP-AMP based filter and oscillator circuits.

Unit 5: Lab exercise based on design and simulation of multi-vibrator and amplitude modulation

Unit 6: Lab exercise based on implementation of digital logic circuits (NOT, AND, OR, NAND, NOR, XOR, XNOR) and simulation of various combinational circuits.

Teaching Methodology:

This course is introduced to help the students to design various analog and digital circuits. In this course, the mixed technique of interactive discussion, regular assignments will be used. In the discussion the fundamental theoretical concepts will be introduced and demonstrated through examples. Discussion will be implemented in laboratory by using Circuit-Maker.

Evaluation Scheme:

Exams	Marks		Coverage
P-1	**15 Marks**		**Based on Lab Exercises: 1-7**
P-2	**15 Marks**		**Based on Lab Exercises: 8-14**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:
Study material of ECE Design and Simulation Lab-I (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

[1] J. Milliman and C. C. Halkias: Integrated Electronics, Mc Graw Hill
[2] Bolleystead, Electronic Devices and Circuits
[3] Ramakant A. Gayakwad: Op-Amps and Linear Integrated Circuits, P.H.I.
[4] D.S. Chauhan & D.C. Kulshreshtha, 'Electronics Engineering', New Age, 2e, 2009.
[5] D.C. Kulshreshtha, 'Electronic Devices and Circuits', New Age, 2e, 2006.
[6] M. Morris Mano, "Digital Design," Pearson Education, 3rd edition.
[7] Taub and Schilling, Digital Integrated Electronics, McGraw Hill, Int. Ed.

Reference Books:

1. R.C. Bhatia- Business Communication (Ane Books Pvt. Ltd.)
2. P.D. Chaturvedi – Business Communication (Pearson Education, 1st Edition 2006).
3. Lesikar RV & Pettit Jr. JD – Basic Business Communication: Theory & Application (Tata Mc Graw Hill, 10thEdition)
4. Wren & Martin, High School English Grammar & Composition – S. Chand & Co. Delhi.
5. Raman Meenakshi & Sharma Sangeeta, Technical Communication-Principles & Practice –O.U.P. New Delhi. 2007.
6. Mitra Barum K., Effective Technical Communication – O.U.P. New Delhi. 2006.
7. Better Your English- a Workbook for 1st year Students- Macmillan India, New Delhi.
8. Raymond Murphy,' Essential English Grammar', Cambridge University Press.

Web References

[1] https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-101-introductory-analog-electronics-laboratory-spring-2007/study-materials/
[2] https://nptel.ac.in/courses/117/106/117106086/

Journal References

[1] Analog Integrated Circuits and Signal Processing International Journal, Springer
[2] Digital logic circuits, IEEE publisher

Title: Advanced Digital Signal Processing **Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "*Digital signal processing"* and *Signals and Systems*".

Objective:

1. To develop to understand the concept of digital signal processing and designing of filters.

Learning outcomes:

1. At the end of the course the students will have knowledge of digital signal processing, multirate signal processing and spectral analysis.

Course Outcome	Description
CO1	Review of Digital Signal Processing
CO2	Transforms and their applications in signal processing, Design and implement of FIR and IIR Filter Design.
CO3	Digital Filter Design
CO4	Concept and Applications of Multi-rate Digital Signal Processing
CO5	Design and development of Adaptive Filters
CO6	Spectral Analysis and Power Spectrum Estimation

Course Contents:

Unit-1: Review of Digital Signal Processing: Review of discrete–time sequences and systems, Linear Shift Invariant (LSI) systems. Causality and Stability Criterion, FIR & IIR representations, Z-Transform, Digital structures, Fast Fourier Transform, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms using decimation in time and decimation in frequency techniques, Chirp Z- Transform, Hilbert Transform and applications.

Unit -2: Digital Filter design: FIR filters design. IIR filter design from analog filters, digital filter design based on least square method.

Unit-3: Multirate Digital Signal Processing: Decimation & Interpolation, Sampling rate conversion, Filter design and implementation for sampling rate conversion, applications of multirate signal processing.

Unit-4: Adaptive Filters: Introduction. Application of adaptive filters, Adaptive Direct-form FIR filters Adaptive Lattice-Ladder filters.

Unit-5: Spectral Analysis and Power Spectrum Estimation: Spectral Analysis of Sinusoidal Signals, Spectral Analysis of Non stationary signals, Nonparametric and parametric methods of power spectrum estimation, Eigen analysis algorithms for spectral estimation.

Teaching Methodology:

1. Lectures would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.

2. Practice sheets will have conceptual and numerical questions that would aid in strengthening the numerical ability of students.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15	Based on Unit-1 & Unit-2
Test-2	25	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35	Based on Unit-3, Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Tutorials	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Quiz	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Attendance	5	Based on attendance in the theory classes
Total	100	

Text Books:

[1] J. G. Proakis & D.G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", PHI.

[2] John G. Proakis, Charles M. Rader, Fuyun Ling, Chrysostomos L. Nikias, Mark Moonen and Ian K. Proudler, Algorithms for Statistical Signal Processing, Pearson Education Inc., 2002.

Reference Books:

[1] P. P. Vaidyanathan, "Multirate Systems and Filter Banks", PHI

Web References:

[1] https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

[2] https://www.tutorialspoint.com/e_commerce/index.htm

Journals References:

[1] Journal of Digital Signal Processing, Elsevier

[2] IEEE Signal Processing Magazine

[3] Journal of Signal Processing Systems, Springer

Title: Seminar **Code:**

L-T-P scheme: 0-0-4 **Credit: 2**

Prerequisite: Students must have already studied the courses, "*ECE Design and Simulation Lab-I*" and "*ECE Design and Simulation Lab –II*".

Objective:

Students will be able to understand the identification of different areas and new technologies related to electronics and communications.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the seminar topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of electronics
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of basic block diagram/algorithm steps of the methods.

Course Content:

Unit 1: Motivation about Seminar Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem identification

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the method.

Unit 7: Block Diagram/Algorithm Steps of the method.

Teaching Methodology:

This course is introduced to help students the basic fundamental areas of electronics and communications. It also introduces knowledge of new technologies to grow in this field.

Evaluation Scheme:

Exams		Marks	Coverage
Presentation-1		20 Marks	**Unit 1-Unit 3**
Presentation-2		30 Marks	**Unit 4-Unit 7**
Day to Day Work	Attendance and Discipline	15 Marks	**50 Marks**

	Sincerity and Regularity	20 Marks	
	Report	15 Marks	
Total		**100 Marks**	

Learning Resources:

Students with concern to the faculty will develop some new areas in the field of electronics and communications and related information they will acquire from the faculty and internet.

Text Books:

[1] Proceedings of the Multi-Conference, Himanshu B. Soni, Universal Publishers, 2011.

[2] Electronics for you (Monthly Magazine).

Reference Books/Material:

[1] "Electronics project management and design", D. Joseph Stadtmiller, Pearson; 1 edition 2000.

[2] "50 Electronics Projects for Beginners", A. K. Maini, Pustak Mahal; First Edition 2007.

Web References:

[1] https://www.engineersworldonline.com

[2] https://www.seminarsonly.com

Journals References:

[1] Journal of Communications Technology and Electronics

[2] IEEE Transaction on communication

[3] Science direct journal of digital control system

[4] IRE Transactions on Industrial Electronics

Title of Course: Dissertation Part-I **Course Code:**

L-T-P Scheme: 0-0-8 **Credits: 04**

Prerequisite: Students must have already studied the basic courses like, "*Advanced digital signal processing*", "*VLSI design*" etc.

Objective:

To study of literature survey, formulate the research problem and develop necessary methodology related to research problem. A workable design/ algorithm to be developed based on the proposed methodology, algorithm a design to be noted.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the dissertation topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of electronics
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of basic block diagram/algorithm steps of the methods.

Course Content:

Unit 1: Motivation about dissertation Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem formulation.

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the proposed method.

Unit 7: Block Diagram/Algorithm Steps of the proposed method.

Teaching Methodology:

This course is introduced to help students the basic fundamental areas of electronics and communications. Student must spend two hours daily in library to analyze the problem. It is also essential for student to meet supervisor twice in a week to discuss the research problem. After four weeks of registration the first evaluation has been done before committee to revive the literature survey and formulation of the problem. In second the evaluation, the student has to show the progress of work in terms of design level, mathematical model/ algorithm etc. At end of semester, simulation based design has been analyzed by the committee.

Evaluation Scheme:

Exams		Marks	Coverage
Presentation-1		15 Marks	**Unit 1-Unit 3**
Presentation-2		15 Marks	**Unit 4-Unit 5**
Presentation-3		20 Marks	**Unit 6-Unit 7**
Day to day work	Attendance	10 Marks	**50 Marks**
	Sincerity	10 Marks	
	Report	15 Marks	
	Performance	15 Marks	
Total		**100 Marks**	

Learning Resources:

Students with concern to the faculty will develop some new areas in the field of electronics and communications and related information they will acquire from the faculty and internet.

Text Books:

[1] Proceedings of the Multi-Conference, Himanshu B. Soni, Universal Publishers, 2011.

[2] Electronics for you (Monthly Magazine).

Reference Books/Material:

[1] "Electronics project management and design", D. Joseph Stadtmiller, Pearson; 1 edition 2000.

[2] "50 Electronics Projects for Beginners", A. K. Maini, Pustak Mahal; First Edition 2007.

Web References:

[1] https://www.engineersworldonline.com

[2] https://www.seminarsonly.com

Journals References:

[1] Journal of Communications Technology and Electronics

[2] IEEE Transaction on communication

[3] Science direct journal of digital control system

[4] IRE Transactions on Industrial Electronics

Title: Dissertation Part-II **Code:**

L-T-P Scheme: 0-0-30 **Credit: 15**

Prerequisite: Students must have already studied the basic courses like, "*Advanced digital signal processing*", "*VLSI design*" etc.

Objective:

1. To study of literature survey, formulate the research problem and develop necessary methodology related to research problem. A workable design/ algorithm to be developed based on the proposed methodology, algorithm a design to be noted.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the dissertation topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of electronics
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of basic block diagram/algorithm steps of the methods.

Course Content:

Unit 1: Motivation about dissertation Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem formulation.

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the proposed method.

Unit 7: Block Diagram/Algorithm Steps of the proposed method.

Teaching Methodology:

This course is introduced to help students the basic fundamental areas of electronics and communications. Student has to spend two hours daily in library to analyze the problem. It is also essential for student to meet supervisor twice in a week to discuss the research problem. After four weeks of registration the first evaluation has been done before committee to revive the literature survey and formulation of the problem. In second the evaluation, the student has to show the progress of work in terms of design level, mathematical model/ algorithm etc. At end of semester, simulation based design has been analyzed by the committee.

Evaluation Scheme:

Exams		Marks	Coverage
Presentation-1		15 Marks	**Unit 1-Unit 3**
Presentation-2		15 Marks	**Unit 4-Unit 5**
Presentation-3		20 Marks	**Unit 6-Unit 7**
Day to day work	Attendance	10 Marks	**50 Marks**
	Sincerity	10 Marks	
	Report	15 Marks	
	Performance	15 Marks	
Total		**100 Marks**	

Learning Resources:
Students with concern to the faculty will develop some new areas in the field of electronics and communications and related information they will acquire from the faculty and internet.

Text Books:

[1] Proceedings of the Multi-Conference, Himanshu B. Soni, Universal Publishers, 2011.
[2] Electronics for you (Monthly Magazine).

Reference Books/Material:

[1] "Electronics project management and design", D. Joseph Stadtmiller, Pearson; 1 edition 2000.
[2] "50 Electronics Projects for Beginners", A. K. Maini, Pustak Mahal; First Edition 2007.

Web References:

[1] https://www.engineersworldonline.com
[2] https://www.seminarsonly.com

Journals References:

[1] Journal of Communications Technology and Electronics
[2] IEEE Transaction on communication
[3] Science direct journal of digital control system
[4] IRE Transactions on Industrial Electronics

Title: Detection and Estimation Theory **Code:**
L-T Scheme: 3-0 **Credit: 3**

Prerequisite: Students must have the knowledge of "*Probability Theory and Random Variables*"

Objective:

1. To develop to understand the concept of detection and estimation of signals.

Learning outcomes: At the end of the course the students will have knowledge of random andstochastic processes, detection of signals, detection and estimation of parameters.

Course outcomes	Description
CO1	Outline the basic concepts of stochastic models and processes
CO2	Describe the hypothesis testing using different methods
CO3	Evaluation of signal detection procedures based on their performance
CO4	Estimation methods and cost functions
CO5	Designing of filters for the estimation of signals
CO6	Demonstrate the applications of detection and estimation in communication systems

Course content:

Unit-1: Review of Probability and Stochastic Processes: Review of probability: joint and conditional probability, Bayes Theorem, Random variables, distribution & density functions, correlation and covariance of random variables, Review of stochastic Processes, Stationary processes; Gauss-Markov Models, Likelihood and Sufficiency.

Unit-2: Concept of Detection: Binary hypothesis testing, decision criteria; Bayes, minimax and Neymann- Pearson tests; Composite hypothesis testing.

Unit-3: Detection of Signals: Detection of known signal in white noise and colored noise; Detection of signals with unknown parameters, Detection in discrete time: Models and detector structures; detection in Gaussian noise: Detection of stochastic signals, Performance Evaluation of signal Detection Procedures.

Unit-4: Concept of Estimation: Basic estimation of parameters using Pseudo Inverse, weighted least square estimate, MMSE, MAP and ML estimates, Cost functions & minimization of Baye's risk, Invariance of estimates, Estimation of non random parameters; Properties of Estimators, Linear Mean-Square Estimation.

Unit-5: Estimation of signals: Wiener filtering problem – smoothing, filtering & prediction, construction of Wiener filter by pre-whitening. Kalman filter. Wiener – Kolgomorov filtering.

Unit-6: Detection and Estimation of Parameters: Nonparametric Detection, Locally Optimal Detection, Robust Detection and Estimation, Detection and Parameter Estimation in Radar Systems:

Radar Target Models, Target Detection, Parameter Estimation in Radar Systems.

Teaching Methodology:
This course is introduced to help students to formulate detection and parameter estimation problems using statistical signal models. Students will also understand how to characterize system performance both analytically, and by use of simulations.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on Detection and Estimation (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:
[1] Poor, H. Vincent, An Introduction to Signal Detection and Estimation, Second Ed., Springer 1998.
[2] Srinath, M.D., P.K. Rajasekaran, and R. Viswanathan, Introduction to Statistical Signal Processing with Applications, Pearson Education, 2003.

Reference Books:
[1] Papoulis, A., and Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill International, Singapore, 2002.

Web Resources:
[1] www.princeton.edu
[2] www.ece.uic.edu

Journal Resources:
[1] IEEE transactions on signal processing

Title: Speech Processing **Code:**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have basic concepts of various transforms and must have studied "*Digital Communication*" course and "*Digital signal processing*" course.

Objective:

To develop to understand the concept of speech production, various processing and analysis of speech signal. They would get the knowledge of various speech signals and its analysis which would be helpful for various applications. This subject could be extended and can be utilized as research point of view by the students.

Learning Outcomes:

Course Outcome	Description
CO1	Outline of speech signal processing and various signals and human vocal system.
CO2	Describe the real voice signal created by human and description of various speech signals.
CO3	Develop the various quantization and coding techniques.
CO4	Identify the various models and coding scheme used in practical aspect.
CO5	Relate and analyze the coding techniques and quantization methods which would be helpful in real applications.
CO6	Develop different quantization and coding methods which would minimize the error of speech signal in practical application.

Course Content:

Unit-1: Introduction- Speech production and modeling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs –quality, coding delays, robustness.

Unit-2: Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.

Unit-3: Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.

Unit-4: Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer,logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.

Unit-5: Scalar Quantization of LPC- Spectral distortion measures, Quantization based onreflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF.

Unit-6: Linear Prediction Coding- LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.

Unit-7: Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729 standards .

Teaching Methodology:
This course is introduced so that student will be able to understand the basics of speech signal. Student will be able to understand the speech production and perception in human being. The student would be able to design the speech production system.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Lecture slides on Speech Processing (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] "Digital Speech" by A. M. Kondoz, Second Edition (Wiley Students_ *Edition), 2004.*
[2] "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, Wiley Inter science, 2003.

Reference Books/Material:

[1] Speech and Audio signal processing by B. Gold, John Willey and sons.
[2] Speech and Audio Signal Processing by A.R.Jayan, PHI Learning

Web References:

[1] http://isle.illinois.edu/~hasegawa/notes/
[2] https://sites.google.com/site/samahghanem/lecture-notes-in-speech-signal-processing

Journals References:

[1] EURASIP Journal on Audio, Speech, and Music Processing
[2] IEEE Transactions on Audio, Speech, and Language Processing

Title of Course: CMOS Digital Design Technique **Course Code:**
L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students should be studied the courses, " *Digital Circuit Design*" and "*VLSI Design*".

Objective:
1. To develop and understand the concept of MOS circuit techniques.
2. To design the CMOS digital Circuits by using the static and dynamic CMOS circuits.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various MOS device characteristics and short channel effects with respect to their roles in the Integrated Circuit (IC) design and concepts of device modeling.
CO2	Description of the RC modeling, Propagation delay, Rise and fall time, DC design and transient design.
CO3	Development of the design of Transmission Gate (TG) based switch logic gates and n-FET based storage circuits.
CO4	Identification and use of various cost estimation techniques used in IC design.
CO5	Application of IC design techniques on a given assignment.
CO6	Demonstration and deployment of SRAM, DRAM and ROM designs.

Course Content:

Unit 1: Basics of MOSFETS and CMOS inverter, MOSFET characteristics, Current voltage characteristics, Modeling, Scaling theory and Small device effects. Basic inverter circuit and DC operation, Switching characteristics, RC modeling, Propagation delay, Rise and fall time, DC design, transient design, Power dissipation, Driving large loads.

Unit 2: Complementary CMOS design, Transmission gate logic Circuits BASIC structure, Electrical analysis, RC modeling, TG based switch logic gates ,TG register, D flip flop, n-FET based storage circuits, pass transistor logic, Dynamic CMOS design and DCVSL logic .

Unit 3: Basics of latch and flip flop, CMOS register Dynamic latches and registers. Alternative register styles, concept of pipelining.

Unit 4: Basics of timing, setup hold time, clock skew and jitter problems, how to avoid skew and jitter problems, PLL.

Unit-5: Designing arithmetic building blocks: Adder, Multipliers, shifters using CMOS
Memory: Designing SRAM, DRAM, ROM using CMOS.

Teaching Methodology:
This course is introduced to help students to understand the basics of MOS IC circuit techniques. Starting from front end development, the student will slowly progress to learn other aspects of design including CMOS logic circuits. Circuit technologies that are helpful for digital IC designer. The entire course is based on: Fundamental and Designing, back-end & Technologies. Each section includes multiple circuit

technologies to help a student to gain design experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1
Test-2	25 Marks	Based on Unit-2, Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture notes/slides on digital IC Design (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:
1. John P. Uyemura," Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc, 2002.
2. J. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits: A Design Perspective, 3rd Edition 2003.

Reference Books:
[1] Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw-Hill Edition 2003.

Web References:
[1] https://www.udemy.com/
[2] https://swayam.gov.in/nd1_noc20_ee29/preview

Journals References:
[1] VLSI Design— An Open Access Journal - Hindawi
[2] IEEE Transactions on Very Large Scale Integration

Title: Digital Image Processing **Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

1. To study the human visual system and perception, image sampling and quantization
2. To learn various filers used in image processing.
3. To study about the coding and compression in image processing.

Learning Outcomes: The students will be able to:

Course Outcome	Description
CO1	Outline general terminology of digital image processing and noises in images
CO2	Describe concept of gray level transformation, histogram processing.
CO3	Develop the concept of morphological image processing
CO4	Identify different approaches for Image analysis and restoration
CO5	Apply different transforms for image coding
CO6	Demonstrate the concept of lossy and lossless compression, entropy coding, transform coding, sub band coding and image compression standards.

Course Content:

Unit 1: Introduction: Human visual system and perception, Image sensing and acquisition, Visual perception, Noise in images, Image sampling and quantization, Pixel connectivity.

Unit 2: Image Enhancement: Gray level transformation, histogram processing, Smoothing and sharpening spatial Filters, Smoothing and sharpening frequency domain filters.

Unit 3: Morphological Image Processing: Binary morphology- erosion, dilation, opening and closing operations, applications and multistage morphological edge detection. Basic gray-scale morphology operations.

Unit 4: Image analysis and restoration: Edge and line detection, Hough transform, segmentation, feature extraction, classification image texture analysis, Color models and color image processing, Linear degradation model, inverse and Wiener filtering.

Unit 5: Transforms for image coding and compression: Unitary transforms, 2D-DFT, DCT, KLT and Harr transform, Lossy and lossless compression, entropy coding, transform coding, sub band coding, image compression standards.

Teaching Methodology:

The course will use the mixed technique of interactive lectures, and regular assignments. In the lectures the fundamental concepts of digital image processing will be introduced.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Lecture slides on Digital Image Processing (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:
[1] "Digital Image Processing", R.C. Gonzalez and Richard E. Woods, Pearson Education, 3e 2008.
[2] "Digital Image Processing using MATLAB", R.C. Gonzalez, Richard E. Woods and Steven L. Eddins, Pearson Education, 3e, 2004.

Reference Books/ Material:

[1] "Fundamental of Digital Image Processing", A. K. Jain, PHI Publication, 3e, 1989.

Web References:
[1] https://www.iare.ac.in
[2] https://www.cs.nmt.edu

Journals References:
[1] EURASIP Journal on Image and Video Processing
[2] IEEE Transactions on Pattern Analysis and Machine Intelligence
[3] Journal of Digital Imaging, Springer
[4] International Journal of Wireless Personal Communication

Title: Advanced Error Control Coding **Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Not Applicable

Objective:

1. To develop an understanding and awareness of different coding techniques principles and practice along with their application area.
2. After completion of the course, students should be able to design modern coding systems, including encoders and decoders.

Learning outcomes: At the end of the course the students will have knowledge of different type of codes, channel and source coding.

Course Outcome	Description
CO1	Review the basic Modulation and coding, M L decoding
CO2	Design the optimal codes using entropy coding.
CO3	Describe Groups, Fields, Binary field arithmetic, Galois field.
CO4	Comprehend various error control code properties.
CO5	Apply linear block codes for error detection and correction
CO6	Apply convolution codes for performance analysis & Turbo codes, LDPC codes for error detection and correction.

Course content:

Unit 1: Introduction and Preview: Coding for reliable digital transmission and storage, Type of codes, Modulation and coding, M L decoding, Error control strategies, Performance measures.

Unit 2: Algebra Background: Groups, Fields, Binary field arithmetic, Galois field GF(2^m)-basic properties and its construction, Vector spaces over GF(2)

Unit 3: Linear Block Codes: Generator and parity check matrices, Syndrome and error detection, Error correction and detecting capabilities of a Code, Standard array and syndrome decoding, Hamming codes..

Unit 4: Cyclic Codes: Polynomial rings, Ideals, Algebraic description of cyclic codes, Systematic encoding, Cyclic encoding, Syndrome decoding..

Unit 5: Convolutional Codes: Structural properties, Tree, trellis and state diagrams, Encoding of convolutional codes, Polynomial and rational encoders, Constraint length and minimal encoders, Systematic encoders, ML decoding of convolutional codes – the Viterbi algorithm..

Unit 6: Turbo Codes, LDPC Codes: Introduction. Distance properties, Performance bounds, Encoding parallel concatenated codes, Iterative decoding of turbo codes, MAP decoding-BJSR algorithm. Construction and notation, Tanner graphs, Factor graphs, Sum-product algorithm, MAP decoding of LDPC codes using the sum-product algorithm , Irregular LDPC codes, Encoding LDPC codes .

Teaching Methodology:
Lectures would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-2, 3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4,5 and Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on Advanced Error Control Coding (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:
[1] Shu lin & D.J. Costello: Error Control Coding, 2nd Edn, Pearson, 2004.
[2] T.K. Moon Error Correction Coding, Wiley, 2006

Reference Books:
[1] Error Control Coding: Fundamentals and Applications -- Shu Lin / Daniel J. Costello, Jr., Prentice Hall
[2] Error Control Systems for Digital Communication and Storage Stephen B. Wicker, Prentice Hall
[3] The Theory of Information and Coding, 2nd Edition R. J. McEliece, Cambridge, UK: Cambridge University Press.
[4] Theory and Practice of Error Control Codes -- R.E. Blahut
[5] Error Correcting Codes -- W. W. Peterson, E. J. Weldon
[6] Digital Communications / Fourth Edition -- John G. Proakis, McGraw Hill

Web References:
[1] www.nptel.ac.in
[2] www.tutorialspoint.com
[3] www.smartzworld.com

Journal References:
[1] IEEE transactions on Information Theory
[2] International Journal of Information and Coding theory

Title of Course: Analogue VLSI Design **Course Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students should be studied the courses, *"VLSI Design"*.

Objective:

1. To develop and understand the concept of Analog VLSI circuit design.
2. To design the linear CMOS Circuits by using the CMOS amplifier.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various second order effects, Small signal equivalent circuit for MOSFETs, Noise in MOSFETs.
CO2	Description of the Single Stage Amplifier, Current Sources, Source Follower and Differential Stage Amplifier.
CO3	Development of the design of Operational Transconductance Amplifier, Operational Amplifier.
CO4	Identification and use of various cost estimation techniques used in analog IC design.
CO5	Application of IC design techniques on a given assignment.
CO6	Demonstration and deployment of Analog CMOS circuit/layout for Oscillators.

Course Content:

Unit 1: Introduction, Structure of MOSFET, V/I characteristics, Parasitic Capacitance, Second order effects.

Unit 2: Small signal equivalent circuit for MOSFETs and Noise in MOSFETs.

Unit 3: Single Stage Amplifier, Current Sources, Source Follower, Differential Stage Amplifier.

Unit 4: Operational Trans- conductance Amplifier, Operational Amplifier.

Unit-5: Switched Capacitor Filters, Analog CMOS Layout Issues, Oscillators.

Teaching Methodology:

This course is introduced to help students to understand the basics of analog MOS IC circuit design. Starting from frontend development, the student will slowly progress to become to other aspects of design including CMOS circuits. Analog circuit technologies those are helpful for analog IC designer. The entire course is based on: back-end designs & Technologies. Each section includes multiple circuit technologies to help a student to gain analog circuit design experience.

Evaluation Scheme:

Exams	Marks	Coverage

Test-1	15 Marks	Based on Unit-1
Test-2	25 Marks	Based on Unit-2, Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture notes/slides on analog VLSI Design (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] B.Razavi, Design of Analog CMOS Integrated Circuits, TMH 2001
[2] Philip E.Allen, Douglas R. Holberg, CMOS Analog Circuit Design (2nd Edition), Oxford Univ. Press, 2003.
[3] Paul R.Gray. Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, Analysis and Design of Analog Integrated Circuits (4th Edition), John Wiley & Sons, 2001.

Reference Books:

[1] D.A. Johns, K. Martin, Analog Integrated Circuit Design, J. Wiley & Sons, 1997.
[2] R. Gregorian, G.C. Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley & Sons, Inc., 1986.
[3] Y.P. Tsividis, Operation and Modeling of the MOS Transistor, New York: McGraw-Hill, 1987.
[4] BSIM3v3 User Manual, University of California, Berkeley.

Web References:
[1] https://www.udemy.com/
[2] https://swayam.gov.in/nd1_noc20_ee29/preview

Journals References:
[1] VLSI Design— An Open Access Journal - Hindawi
[2] IEEE Transactions on Very Large Scale Integration

Title: Digital Signal Processors and Applications **Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have basic concepts of "*Digital Electronics, Digital signal processing, Microprocessors and Microcontrollers"*.

Objective:

1. In this course student would learn: Architecture of a Real time Signal Processing Platform, Different Errors introduced during A-D and D-A converter stage, Digital Signal Processor Architecture,
2. Difference in the complexity of programs between a General Purpose Processor and Digital Signal Processor

Learning outcomes:

1. The students will be able to understand and implement the real time DSP systems such as FIR, IIR filters.

Course Outcome	Description
CO1	Evolution of Digital Signal Processors, Comparative Performance with General Purpose Processor
CO2	Signal Modeling: Difference Equation, Convolution, Transfer Function, Frequency Response.
CO3	Implementation of various DSP algorithms and applications:
CO4	Applications of audio and video processing, Graphics, image enhancement, 3- D rendering, Frequency domain filtering - FIR and IIR
CO5	Basic architecture of DSP kits and programming concepts
CO6	Study on various real time systems.

Course Contents:

Unit-1: Evolution of Digital Signal Processors, Comparative Performance with General Purpose Processor classes: General Purpose - high performance, embedded processors and processor cores

Unit-2: Microcontrollers etc. Signal Modeling: Difference Equation, Convolution, Transfer Function, and Frequency Response.

Unit-3: Signal Processing: Data Manipulation Algorithms Filtering Estimation, Correlation. Implementation of various DSP algorithms and applications:

Unit -4: Communications, Audio and video processing, Graphics, image enhancement, 3- D rendering, Frequency domain filtering - FIR and IIR

Unit -5: Frequency- time transformations – FFT. Basic architecture of DSP kits, programming concepts for various real time systems.

Teaching Methodology:

1. Lectures would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.

2. Practice sheets will have conceptual and numerical questions that would aid in strengthening the numerical ability of students.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15	Based on Unit-1 & Unit-2
Test-2	25	Based on Unit-2 & Unit-3 and around 30% from coverage of Test-1
Test-3	35	Based on Unit-3, Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Tutorials	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Quiz	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 & Unit-5
Attendance	5	Based on attendance in the theory classes
Total	**100**	

Learning Resources:

Tutorials and lecture slides on Digital Signal Processors and Applications (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] Sen M. Kuo and Woon-Senq Gan-Digital Signal Processors: Architectures, Implementations and Applications: United States Edition.

[2] B. Bhaskar and M Venkataramani: Digital Signal Processors: Architecture, Programming & Applications, McGraw Hill.

Reference Books:

[1] Rulph Chassaing and Donald Reay: Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, John Wiley & Sons.

Web References:

[1] https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

[2] https://www.tutorialspoint.com/e_commerce/index.htm

Journals References:

[1] Journal of Digital Signal Processing, Elsevier

[2] IEEE Signal Processing Magazine

[3] Journal of Signal Processing Systems, Springer

Title: Performance Evaluation of Communication System **Code:**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Student must have studied the course like Analog communication, Digital Communication, Signal and System, Digital signal processing, Advance Wireless and mobile communication, Probability and Random variables.

Objective:

1. To build basic concepts of system performance measures like average SNR, Outage Probability, Average bit and symbol error rate (BEP and SEP).
2. The objective is to give an in-depth knowledge of the procedure to calculate the average SNR and bit error rate of digital communication system in different environment like in AWGN channel, in fading channel.
3. To give the knowledge about different types of fading, random variables, moment generating function, probability density function of different types.

Learning outcomes:

The students shall acquire the generic skills to determine and analyze the performance of any type of communication system in different types of channel. They will also learn about the random variable theory.

Course Outcome	Description
CO1	Modulation techniques Source Coding: Formatting data, Noise effect
CO2	Study and characteristics of Random variable theory, Random function
CO3	Probability of error analysis of baseband and bandpass modulation techniques
CO4	Average signal to noise ratio (SNR), Average Bit error Probability (BEP)
CO5	Design and analysis of Fading Channel Characterization and modeling
CO6	Study on advanced multi carrier communication systems

Course Contents:

Unit-1: Introduction: Introduction to Analog and Digital Communication Systems. Different types of modulation techniques and different types of shift keying methods (BPS, QPSK, FSK, and QAM).

Unit-2: Random variable theory, Random function, probability density function (PDF), cumulative distributive function (CDF) and moment generating functions.

Unit-3: System Performance Measures like Average signal to noise ratio (SNR), Outage Probability, Average Bit error Probability (BEP)

Unit-4: Coherent and Non-coherent detection, Fading Channel Characterization and modeling, Slow and fast fading, flat and frequency selective fading, Rayleigh, Nakagami-m, Rice.

Unit-5: Weibull and Beckmann distribution, Integrals involving the Gaussian Q function, Marcum Q function, Probability of error expression in different types of fading channel. Performance of multi channel receivers (diversity), performance of multi-user communication, multi-carrier communication

systems.

Teaching Methodology:
Lectures & tutorial would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15	Based on Unit-1 & Unit-2
Test-2	25	Based on Unit-2, Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35	Based on Unit-4, Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Tutorials	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Quiz	5	Based on Unit-1, Unit-2, Unit-3, Unit-4 , Unit-5 & Unit-6
Attendance	5	Based on attendance in the theory classes
Total	100	

Text Books:

[1] Digital Communications, Fourth Edition, J.G. Proakis, McGraw Hill, 2000.
[2] T.S. Rappaport, "Wireless Communication", Second Edition, Pearson Education, 2002.
[3] A. Papoulis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th Edition,

Reference Books:

[1] M. K. Simon and M. S. Alouini, "Digital communication over fading channels", 2nd Edition, Willey.
[2] M. Abramowitz and I. A. Stegun "Handbook of mathematical functions".

Web References:

[1] www.w3.com
[2] https://www.tutorialspoint.com/e_commerce/index.htm
[3] www.nptel.ac.in

Journals References:

[1] ACM Transactions on the communication
[2] ACM Transactions on the Information and communication Systems

Title: Spread Spectrum Theory **Code: EC716**

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Not applicable

Objective:

1. In this course student should be able to understand the architecture and elements of a spread-spectrum system and a CDMA system, characteristics of spread-spectrum signal waveforms,
2. Application of knowledge of communications technology to CDMA and wireless systems, methods for spread-spectrum and CDMA system performance analysis and capture most recent development in CDMA and its role in 3G & 4G wireless systems.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various models of time-invariant and time-variant multipath fading channels
CO2	Describe different multiple assess communication strategies to enhance system capacity
CO3	Develop equalization and coding schemes to control bit error rate
CO4	Apply various wireless diversity and reception techniques to improve signal to noise ratio
CO5	Design high data-rate indoor and outdoor wireless communication systems
CO6	Identify different codes used in communication system

Course Content:

Unit -1: Spread Spectrum Systems: Direct sequence spread spectrum methods employing BPSK, QPSK and MSK - Frequency Hop spread spectrum methods - Coherent slow frequency Hop technique - Non coherent slow and fast frequency Hop spread spectrum techniques - Hybrid DS/FH spread spectrum - Complex envelope representation of spread spectrum systems. Communication in the presence of pulse noise jamming - Low probability detection scheme - Direct Sequence Spread Spectrum (DSSS) and Frequency Hop Spread Spectrum Systems and examples of Spread Spectrum Systems.

Unit 2: Binary Shift Register Sequences for Spread Spectrum Systems: Definition - PN sequence generator fundamentals - Maximal length sequences - Properties, Power spectrum and Polynomial tables for maximal length sequences - Gold codes - Rapid Acquisition systems - Non-linear code generators.

Unit 3: Synchronization of Spread Spectrum Systems: Optimal tracking of wideband signals - Early-late tracking loops - Code tracking loops for FHSS-Optimum synchronization techniques - Multiple dwell and sequential detectors - Synchronization using a matched filter - Synchronization by estimating the received spreading code.

Unit-4: Performance of Spread Spectrum System: SS Systems communications models - Performance without coding under AWGN and different jamming environments - spread spectrum systems performances with forward error correction - Block coding - Convolutional coding and specific error correcting codes - Inter leaving - Random coding bounds.

Unit-5: Orthogonal Walsh Codes CDMA Standards, CDMA One (IS-95A, IS-95B), CDMA 2000 (IX, Dill V), W-CDMA CDMA for mobile communications – issues, GSM standards, GSM Architecture, Protocols Radio resource management Interfacing between BTS and MSC Restoration technique.

Teaching Methodology:
This course is introduced to help the students to familiar with various keying techniques and spread spectrum systems. In this course, the mixed technique of interactive lectures, tutorials, and regular assignments will be used. In the lectures the fundamental theoretical concepts regarding performance of spread spectrum system and different CDMA standards will be introduced. Discussion in lecture will be done based on GSM.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Lecture slides and tutorials on Spread Spectrum theory (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] J. S. Lee and L. E. Miller, CDMA Systems Engineering Handbook, Artech House, 1998.
[2] R. L. Peterson, R. E. Ziemer, and D. E. Borth, Introduction to Spread Spectrum Communications, Prentice Hall, 1995.
[3] R. C. Dixon, Spread Spectrum Systems with Commercial Applications, 3rd ed., John Wiley & Sons, 1994.
[4] T. S. Rappaport, Wireless Communications: Principles and Practice (2nd Edition), Prentice Hall, 2001.

Reference Books:

[1] W. C. Y. Lee, Mobile Communications Engineering: Theory and Applications, 2nd edition, McGraw Hill, 1997.
[2] J. G. Proakis, M. Salehi, and G. Bauch, Contemporary Communication Systems Using MATLAB and Simulink, Second edition, Brooks/Cole Pub Co., 2004.
[3] A. J. Viterbi, CDMA: Principles of Spread Spectrum Communication, Addison-Wesley, 1995

Web References
[1] www.tutorialspoint.com/digitalcommunication
[2] www.wirelesscommunication.nl/cdma
[3] www.accesscience.com/content/spread-spectrum

Journal References

[1] International Journal of Communication, Elsevier

[2] International Journal of Vehicular Communications, Elsevier

[3] International Journal of Communication Systems, John Wiley

[4] Journal of International Communication, Springer

[5] International Journal of Communication Networks and Information Security

[6] AEÜ - International Journal of Electronics and Communications, Elsevier

Title: E M Theory for Microwaves & Fiber Optics **Code: EC718**

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "*Electromagnetic Field theory"*

Objective:

1. To learn and be able to implement concepts of Electromagnetic theory
2. To develop the abilities of introduction to electromagnetic theory, wave propagation and different types of fiber optics

Learning Outcomes:

Course Outcome	Description
CO1	Get familiar with processes of full stack Electromagnetic theory.
CO2	Have a good grounding of electromagnetic theory, Boundary conditions, Wave Equations, Poynting's Theorem. Scalar and Vector Potentials.
CO3	Acquire demonstrative skills in using and applying Poynting's Theorem
CO4	To learn the advanced information about metallic waveguides and dielectric Waveguides
CO5	Apply electromagnetic theory approaches required to study of periodic structures and electromagnetic waves in dispersive Media
CO6	Work as a team on a project of electromagnetic theory and fiber optics application

Course Content:

Unit-1: Basic Electromagnetic Theory: Maxwell's Equations, Plane Wave Propagation**,** Sinusoidal uniform plane waves, Wave polarization, Reflection and refraction.

Unit-2: Time – Varying Boundary Value Problems: The Uniqueness Theorem, Solution of Helmholtz equations in rectangular and circular cylindrical coordinates Vector Eigen functions and normal modes.

Unit-3: Metallic Waveguides: Classification of wave solutions, General Characteristics of metallic waveguides, Rectangular hollow waveguides, Circular cylindrical hollow waveguides.

Unit-4: Dielectric Waveguides: Circular cylindrical waveguides and optical fibers, Periodic Structures, Characteristics of slow waves, Periodic systems, Disk-loaded waveguide, The Sheath helix and the tape helix models.

Unit-5: Electromagnetic Waves in Dispersive Media: Classical theory of dispersion in material media, Wave velocities, Waves in Electron beams**,** Permittivity tensor for an electron beam, Space charge waves.

Unit-6: Gaussian beams: Fundamental Gaussian beams. Characteristics of Gaussian beams. Higher-order modes of Gaussian beams.

Teaching Methodology:
This course is introduced to help the students understand the basic concepts of wireless and mobile network architecture, wireless application protocol, distributed mobile computing.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on: E. M. Theory for Microwaves & Fiber Optics (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:
[1] K.Zang and D.Li, "Electromagnetic Theory for Microwaves and Optoelectronics," Springer, 1998.
[2] R.E.Collin, "Foundations for Microwave Engineering (2nd edition)" IEEE Press,2005

Reference Books/Material:
[1] K.K. Sharma, "Optics: Principles and Applications", Elsevier, 2006.

Web References:
[1] www.springer.com
[2] https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_quick_guide.html

Journals References:
[1] International Journal for Research in Applied Science & Engineering Technology
[2] Microwave and Optical Technology Letters

Title: VLSI Signal Processing **Code:**

L-T Scheme: 3-0-0 **Credits:3**

Prerequisite: Students must have already studied courses, "*Signal processing*" and "*VLSI Design*".

Course Objectives:
To know how to design high-speed, low-area, and low-power VLSI systems for a broad range of SP applications. Explore optimization techniques indispensable in modern VLSI signal processing. Immediate access to state-of-the-art, proven techniques for designers of DSP applications in wired, wireless, or multimedia communications.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various signal processing tasks from VLSI perspective
CO2	Description of the algorithmic transformations using pipelining, retiming, parallel processing techniques for the development of high speed and lower systems,
CO3	Development of area efficient systems using folding and distributed arithmetic approaches.
CO4	Identification and use of efficient signal processing techniques for VLSI implementation of machine learning tasks.
CO5	Application of VLSI signal processing on a given assignment/ project.
CO6	Demonstration and deployment of the VLSI systems for the signal processing tasks.

Course Content:

Unit-1 Introduction: Review of IIR and FIR Filters, Multi-rate Signal Processing: Sampling rate conversion by rational factors, Implementation of sampling rate conversion, Multistage Implementation, Applications of multi-rate signal processing, Digital filter banks, Wavelets.

Unit-2 DSP Systems: Graph Theoretic Representation of DSP programs, Data Flow graphs (DFGs), Single rate and multi rate DFGs, Iteration bound, Loop, Loop Bound, Iteration rate, Critical loop, Critical path analysis, Area-Speed-Power trade-offs, Precedence constraints, Acyclic Precedence graph, Longest Path Matrix (LPM) and Minimum Cycle Mean (MCM) Algorithms, Pipelining and parallel processing of DSP Systems, Pipelining and parallel processing for Low Power Consumption.

Unit-3 Algorithmic Transformations: Retiming, Cut-set retiming, Feed-Forward and Feed-Backward, Clock period minimization, register minimization, Unfolding, Sample period reduction, Parallel processing, Bit-serial, Digit-serial and Parallel Architectures of DSP Systems, Folding, Folding order, Folding Factor, Folding Bi-quad filters, Retiming for folding, Register Minimization technique, Forward Backward Register Allocation technique.

Unit-4 Systolic Architecture Design and Fast Convolution: Systolic architecture design methodology, Projection vector, Processor Space vector, Scheduling vector, Hardware Utilization efficiency, Edge mapping, Design examples of systolic architectures, Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution.

Unit-5 Algorithm Strength Reduction: Introduction, Parallel FIR filters, Polyphase decomposition, Fast FIR filters Algorithms, Discrete Cosine Transform and Inverse Discrete Cosine Transform, Algorithm Architecture Transformation, DIT Fast DCT, Pipelined and Parallel Recursive, Look-Ahead Computation, Look-Ahead Pipelining, Decompositions, Clustered Look-Ahead Pipelining, Scattered Look-Ahead pipelining, Parallel processing in IIR Filters

Unit-6 Distributed Arithmetic and Signal processing for Machine Learning: Distributed Arithmetic (DA) for MAC circuits, Efficient Resource utilization using Distributed Arithmetic, Area efficient hardware realization using DA, Convolution Neural Networks (CNNs), Winograd filtering based CNN for VLSI implementation.

Teaching Methodology:
Lectures would cover the core theoretical and practical concepts that are explained in the text and reference materials with adequate examples. Lab sessions will have conceptual and logic building approach that would aid in strengthening the design principles and testing of Complex Digital systems on chip level.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 and Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on VLSI Signal Processing (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] Parhi, K.K., VLSI Digital Signal Processing Systems: Design and Implementation, John Wiley (2007).

[2] Oppenheim, A.V. and Schafer, R.W., Discrete-Time Signal Processing, Prentice Hall (2009) 2nded.

Reference Books/Material:

[1] Proakis, J.G., Digital Filters: Analysis, Design and Application, McGraw Hill (1981) 2nd ed.
[2] Proakis, J.G., and Manolakis, D.G., Digital Signal Processing, PHI (2001) 3rd ed.
[3] Mitra, S.K., Digital Signal Processing. A Computer Based Approach, McGraw Hill (2007)3rded.

Web References:

[1] https://www.tutorialspoint.com/
[2] https://nptel.ac.in/

Journals References:

[1] IEEE Journal of signal processing
[2] IEEE Transactions on VLSI