# Wireless Communication

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
| --- | --- | --- | --- |
| Electronics & Communication Engineering | 3-1-0, (4) | CORE | EC106101EC |

[Pre-requisites: EC104105EC-Analog Communication,EC105101EC-Digital Communication]

## Course Objectives

1. To understand the concept of Wireless Communication with Cellular Communication as an example
2. To understand the characteristic of wireless channel.
3. To understand the mitigation of multi path fading.
4. To explain various digital signaling techniques for fading channels.

## Course Content

### UNIT-I

Introduction to Wireless and Cellular Communication: Overview of Wireless Communications, Introduction to Cellular Communication, Cellular Concept, Frequency reuse, channel assignment, hand off, interference & system capacity trunking & grade of service, Coverage, and capacity improvement, Multiple Access techniques – FDMA, TDMA, CDMA, Capacity calculations, Introduction to 1G, 2G, 3G, 4G and 5G mobile systems.

### Unit- II

Wireless Channel Models: Radio Wave Propagation Transmit and Receive Signal Models, Free-Space Path Loss, Ray Tracing, Two-Ray Model, The Okumura Model, Hata Model, Shadow Fading. Time-Varying Channel Impulse Response, Narrowband Fading Models, Autocorrelation, Cross Correlation, and Power Spectral Density, Envelope and Power Distributions, Level Crossing Rate and Average Fade Duration, Wideband Fading Models, Power Delay Profile, Coherence Bandwidth, Doppler Power Spectrum and Channel Coherence Time. Capacity calculation of AWGN channel, Flat-Fading Channels. Frequency-Selective Fading Channels, Time-Invariant Channels, Time-Varying Channels.

### Unit- III:

Multipath Mitigation Techniques: Equalizer Noise Enhancement, Equalization, Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity, Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

### Unit- IV:

Digital Signaling for Fading Channels: Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fadingChannels ,Data Transmission using Multiple Carriers, Multicarrier Modulation with Overlapping Sub-channels, Mitigation of Subcarrier Fading, Coding with Interleaving over Time, and Frequency, Frequency Equalization, Precoding, Adaptive Loading, Discrete Implementation of multicarrier, DFT and its Properties, Cyclic Prefix, Orthogonal Frequency Division Multiplexing (OFDM), Matrix Representation of OFDM, Vector Coding, Challenges in Multicarrier Systems, Case Study: The IEEE 802.11a Wireless LAN Standard.

## Course Materials

### Required Text: Text books

1. Wireless Communications by Andrea Goldsmith, Cambridge University Press.
2. Wireless Communications principle and practices, Theodore S. Rappaport.

### Optional Materials: Reference Books

1. Fundamentals of Wireless Communication, David Tse, Pramod Viswanath, Cambridge University Press
2. Principle of Wireless Networks, Kaveh Pahlavan. Prashant Krishnamurthy, PHI

# Microwave Engineering

[6th Semester, Third Year]

Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-1-0, (4) | CORE | EC106102EC |

[Pre-requisites: EC104101EC- Electromagnetic Field Theory]

Course Objectives

1. To understand and analyze the different microwave components and their applications.
2. To understand the principle of working of different type of microwave tubes.
3. To understand the principle of working of different type of semiconductor devices and their applications.

Course Content

Unit- I:

Waveguides: Introduction to waveguides, Rectangular waveguide, Transverse Magnetic (TM) modes, Transverse Electric (TE) modes, Wave propagation in the guide, power transmission and attenuation, Waveguide resonators.

UNIT-II:

Microwave Components: S-parameters and their properties; Scattering matrix of 3- and 4-portjunctions, T-junction power divider; Hybrid ring; directional couplers; planewave propagation in ferrites, Faraday rotation, ferrite circulators, isolators, and phase shifters.

Unit- III:

Microwave Tubes: Failure of conventional tube at high frequency; Klystron- velocity modulation, output power and efficiency calculation; Reflex Klystron- velocity modulation, output power and efficiency calculation; principle of operation of traveling wave tube and magnetron.

Unit- IV:

Microwave Semiconductor Devices: Operation and circuit applications of Gunn diode, Tunnel diode, Varactor diode, IMPATT diode, PIN diode, Crystal Diode, Schottky barrier diode and parametric amplifiers.

Course Materials

Required Text: Text books

1. Microwave Devices and Circuits by Samuel Y. Liao, 3rd Ed., Pearson Education
2. Microwave Engineering, D.M Pozar, John Wiley & Sons

Optional Materials: Reference Books

1. Antenna Theory Analysis and Design, Constantine A. Balanis, John Wiley and Sons
2. Microwave and Radar Engg., M. Kulkarni, Umesh Publication.

# VLSI Design

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
| --- | --- | --- | --- |
| Electronics & Communication Engineering | 3-1-0, (4) | CORE | EC106103EC |

[Pre-requisites: EC103102EC-Microelectronic Devices and Circuits, EC103104EC-Digital logic design]

## Course Objectives

1. To model the behavior of a MOS Transistor.
2. To design combinational and sequential circuits using CMOS gates.
3. To draw layout of a given logic circuit.
4. To realize logic circuits with different design styles.
5. To demonstrate an understanding of working principle of operation of different types of memories.

## Course Content

### UNIT-I

Introduction to VLSI Design, Layout Design Rules, Metal Oxide Semiconductor: Structure, type, Current-Voltage characteristics, MOS Modeling, Scaling and Short channel effects, MOS capacitance.

### Unit- II

Resistive load inverters, CMOS Inverter: Static Characteristics, Delay, Interconnect, Parasitics, Switching Characteristics, Power Dissipation of CMOS Inverter.

### Unit- III

Combinational CMOS Circuits: Static CMOS Design: Complementary CMOS, Gates, Pass-Transistor Logic, Dynamic CMOS Design.

### Unit- IV

Sequential Circuits: SR Latch, Clocked Latch and Flip Flop, Semiconductor Memories: Read-Only Memory Circuits (ROM), Static Read-Write Memory Circuits (SRAM), Dynamic Read-Write Circuits (DRAM), Dynamic logic circuits.

## Course Materials

### Required Text: Text books

1. CMOS Digital Integrated Circuits: Analysis and Design by Sung-MO Kang, Yusuf Leblebici.

### Optional Materials: Reference Books

1. Digital Integrated Circuits: A Design Perspective, J. Rabaey, Prentice Hall India.
2. Principles of CMOS VLSI Design, Addison Wesley N. Weste and K. Eshranghi Addison Wesley.

# Advanced Digital Signal Processing

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106201EC |

[Pre-requisites: EC104102EC-Digital Signal Processing]

## Course Objectives

1. To understand the basic concept of DFT it's less computational complexity version.
2. To understand the fundamental concept of adaptive filter and its practical application domains
3. To understand the basic concept and advantages of increasing or decreasing the sampling rate of signal.
4. To understand the basic concept of wavelet transform and its applications.

## Course Content

### Unit- I

INTRODUCTION TOADAPTIVESIGNAL PROCESSING: FIR adaptive filters- steepest descent adaptive filter- LMS algorithm- convergence of LMS algorithms- Application noise cancellation- channel equalization- adaptive recursive filters- recursive least squares.

### Unit-II

INTRODUCTION TOMULTIRATESIGNAL PROCESSING: Decimation by a factor D, Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures- Poly phase filter structure.

### Unit-III

INTRODUCTION TOWAVELETTRANSFORMS: Fourier Transform: Its power and limitations, Short Time Fourier Transform, The Gabor Transform, Discrete Time Fourier Transform and filter banks, Continuous Wavelet Transform, Wavelet Transform Ideal Case, Perfect Reconstruction Filter Banks and wavelets, Recursive multi-resolution decomposition, Harr Wavelet, Daubechies Wavelet.

### Unit-IV

POWER SPECTRAL ESTIMATION: Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods.

## Course Materials

### Required Text: Text books


1. Digital Signal Processing Principles, Algorithms, and Applications, John G. Proakis, Prentice Hall International Inc, 4th Edition, 2012.
2. Theory and Application of Digital Signal Processing, Lawrence R. Rabiner and Bernard Gold.


### Optional Materials: Reference Books


1. Discrete-time signal processing, Alan V. Oppenheim, Pearson Education India, 1999.
2. Digital signal processing: a computer-based approach, Mitra, Sanjit Kumar, and Yonghong Kuo. Vol. 2. New York: McGraw-Hill Higher Education, 2006.
3. Wavelet Transforms: Introduction to Theory and Applications, Raghuveer M. Rao, Ajit S, Bopardikar, Pearson Education, Asia, 2000.

# Computer Communication Networks

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106202EC |

[Pre-requisites: EC104105EC- Analog Communication, EC105101EC-Digital Communication,CS10I010CS-Computer Programming]

## Course Objectives

1. To understand the layering architecture of OSI reference model and TCP/IP protocol suite.
2. To understand the protocols associated with each layer.
3. To learn the different networking architectures and their representations.
4. To learn the various routing techniques and the transport layer services.

## Course Content

### UNIT-I

Introduction to Data Communications, Components, Representations, Data Flow, Networks, Physical Structures, Network Types, Switching, Types of switching, Circuit switching, packet switching, virtual circuit switching, their advantages and disadvantages. Introduction to Internet.

Network Models: Protocol Layering: Scenarios, Principles, Logical Connections, ISO-OSI Model and Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP.

### Unit- II

Data-Link Layer: Nodes and Links, Services, Categories of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Practical Error control, Data Link Layer Protocols: Simplex Protocol, Stop and Wait protocol, sliding window protocols Piggybacking. MAC Sublayer, Types of Media Accessing Schemes, Random Access schemes: ALOHA, CSMA, CSMA/CD, CSMA/CA. Controlled Access Schemes: Reservation, Polling, Token Passing Ethernet Protocol: IEEE802.3 Ethernet Evolution, Standard Ethernet: Characteristics,, Access Method, Efficiency, Implementation, Fast Ethernet: Access Method, Physical Layer, Gigabit Ethernet: MAC Sublayer, Physical Layer, 10 Gigabit Ethernet Wireless LANs: Introduction: Architectural Comparison, Characteristics, IEEE 802.11 Architecture, MAC Sublayer, Addressing Mechanism, Physical Layer Connecting Devices: Hubs, Switches, Virtual LANs: Membership, Configuration, Communication between Switches, Advantages. Network Layer.

### Unit- III

Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing, DHCP, Network Address Resolution, Forwarding of IP Packets: Based on destination Address and Label Network Layer Protocols: Internet Protocol (IP): Datagram Format, Fragmentation, Options, IPv4 Datagrams, ICMPv4: Messages, Debugging Tools, Mobile IP: Addressing, Agents, Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Shortest Path vector routing, Internet Routing , Routing Information Protocol, Open Shortest Path First, Border Gateway Protocol.

### Unit- IV

Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol, User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Flow control, Error control, TCP congestion control.

## Course Materials

### Required Text: Text books

1. Data Communications and Networking, Forouzan, 5th Edition, McGraw Hill, 2016 ISBN: 1-25-906475-3
2. Communication Networks, A Leon-Garcia, I Widjaja, McGraw Hill Education India.
3. Data and Computer Communications, William Stallings, Pearson Higher Education.

4. Computer Networks, Andrew S. Tanenbaum, David j. Wetherall, Pearson Higher Education.

Optional Materials: Reference Books

1. Computer Networking: A top-down approach, J F Kurose, K W Ross, Pearson Education.
2. Data Networks, 2 ed, D P Bertsekas, R G Gallagar, Prentice Hall.
3. Computer Networks and Internets with Internet Applications, Douglas E. Comer Pearson Higher Education.
4. Internetworking With TCP/IP: Principles, Protocols, and Architecture (Volume 1), Douglas E. Comer Pearson Higher Education.

# Metaheuristic Optimization

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106203EC |

[Pre-requisites: None]

## Course Objectives

1. Understand the basic concept of optimization, definition of optimality condition and the concept of linear programming.
2. Understand the basic conception of metaheuristic optimization techniques and step by step procedure towards its application.
3. Apply optimization techniques on different fields of engineering.

## Course Content

### Unit-I

Introduction to Optimization: Engineering application of Optimization, Statement of an Optimization problem, Optimal Problem formulation, Classifications of Optimization problems and algorithms. Optimum design concepts: Definition of Global and Local optima, Optimality criteria - Global optimality. Linear programming Problem (LPP): Problem Formulation, Graphical Method, general LPP, Simplex method, Artificial Variable techniques, Duality Concept.

### Unit II

Metaheuristic optimization Algorithms: Classification of metaheuristic techniques; Study on Inspiration, mathematical models, steps and flowchart of PSO, DE, GA, SOS etc. with some variants.

### Unit-III

Application on Digital Signal Processing: Fundamental concepts of FIR, IIR, Differentiator, Integrator, s to z converter, Adaptive Filter, Kalman Filter, System Identification of Linear and Non-linear Plants etc; Conventional and metaheuristic approaches.

### Unit IV

Application on Biomedical Signal Processing: Characteristics of ECG, EEG, EMG etc signals, Fundamental Concepts Adaptive Noise Cancellor, Metaheuristic approach of design.

## Course Materials

### Required Text: Text books

1. Optimization for engineering design-algorithms and examples, Kalyanmoy Deb, PHI, India, (2018).
2. Engineering Optimization: Theory and Practice, S. S. Rao, 4th Edition, John Wiley & Sons (2009).
3. Digital Signal processing, T K Rawat, Oxford.

### Optional Materials: Reference Books

1. Modern heuristic optimization techniques: theory and applications, Kwang Y. Lee, Mohamed A. El-Sharkawi, Kluwer (2008)
2. Handbook of Biomedical instrumentation, R S Khandpur.
3. Kalman Filtering: Theory and Practice Using MATLAB, M S Grewal and A P Andrews, John Wiley & Sons.

# Statistical Signal Processing

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106204EC |

[Pre-requisites: EC104102EC-Digital Signal Processing]

## Course Objectives

1. To apply the knowledge of the discrete-time stochastic processes & its measures and understand various stochastic models.
2. To develop algorithms for optimum linear filtering and prediction for the given observation processes.
3. To develop steepest descent, Least Mean Square (LMS), and Recursive Least Squares (RLS) adaptive filter algorithms.
4. To formulate parametric spectral estimators based upon autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models, and detail their statistical properties.

## Course Content

### UNIT-I:

Random processes: Stationary processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, Random signal modeling: MA, AR, ARMA models.

### Unit- II:

Optimum Linear Filtering: Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non causal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

### Unit- III:

Adaptive Filtering: Principle and Application, Steepest Descent Algorithm, Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters. RLS algorithm: Exponentially weighted RLS algorithm derivation, Matrix inversion Lemma, Initialization.

### Unit- IV:

Spectrum Estimation: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR spectral estimation.
Frequency Estimation, Eigen decomposition of Autocorrelation matrix, Detection of Harmonic signals: Pisarenko's method, MUSIC algorithm, ESPRIT method, Propagator method.

## Course Materials

### Required Text: Text books


1. Statistical Digital Signal Processing and Modelling, M.H. Hayes, John Wiley,1996.
2. Spectral Analysis of signals, P. Stroica& R. Moses, Pearson, 2005.
3. Fundamentals of Statistical Signal Processing, S. M. Key, Prentice Hall PTR, 1998.

# Soft Computing

[6th Semester, Third Year]

Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106205EC |

[Pre-requisites: None]

Course Objectives

1. To make the student to understand the role of imprecision and uncertainty in real world scenarios.
2. To explain the role of Soft Computing in addressing the imprecision and uncertainty.
3. To explain the principal components of soft computing that include Fuzzy Sets and Fuzzy Logic, Genetic Algorithms and Rough Sets.
4. To explain the design of hybrid systems which is combination of one or more soft computing methodologies mentioned.

Course Content

UNIT-I:

Introduction to Soft Computing, Different Tools and Techniques, Fuzzy Sets and Fuzzy Logic: Introduction, Fuzzy Sets Versus Crisp Sets, Operations on Fuzzy Sets, Extension Principle, Fuzzy Relations and Relation Equations, Fuzzy Numbers, Linguistic Variables, Fuzzy Logic, Linguistic Hedges, Applications,

Unit- II:

Interference in fuzzy logic: fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzifications and Defuzzificataions, Fuzzy Controller, Fuzzy Controllers, FuzzyPattern Recognition, Fuzzy Image Processing, Fuzzy Database.

Unit- III:

Evolutionary and Stochastic Techniques: Genetic Algorithm (GA), Genetic Representations, (Encoding) Initialization and Selection, Different Operators of GA, Analysis of Selection Operations, Hypothesis of Building Blocks, Schema Theorem and Convergence of Genetic Algorithm, Simulated Annealing and Stochastic Models, Boltzmann Machine, Applications.

Unit- IV:

Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables and Applications. Hybrid Systems: Neural- Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications

Course Materials

Required Text: Text books

1. Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, S.Rajsekar and G.A. Vijayalakshmi Pai, Prentice Hall of India.
2. Rough Sets, Z.Pawlak, Kluwer Academic Publisher,1991.
3. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher,1997

Optional Materials: Reference Books

1. Artificial Intelligence and Intelligent Systems, N.P.Padhy, Oxford University Press.
2. Neural Fuzzy Systems, Chin-Teng Lin & C. S. George Lee, Prentice HallPTR. Addison-Wesley
3. Learning and Soft Computing, V. Kecman, MIT Press,2001
4. Fuzzy Sets and Fuzzy Logic, Klir & Yuan, PHI,1997

# Biomedical Signal Processing

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106206EC |

[Pre-requisites: Signals and systems, Digital signal processing]

## Course Objectives

1. To understand sources, types and characteristics of various biomedical signals.
2. To be able to design various filters for artifact removal from Biomedical signals.
3. To understand and apply various methods of analyzing biomedical signals.

## Course Content

### Unit-I

Introduction to biomedical signals: Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

### Unit II

Removal of Noise and Artifacts from Biomedical Signal Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering.

### Unit-III

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis Ad Coherence Analysis of EEG Channels.

### Unit IV

Analysis of non-stationary signals: Heart Sounds and Murmurs, Characterization of Nonstationary Signals and Dynamic Systems, Short-Time Fourier Transform, Considerations in Short-Time Analysis and Adaptive Segmentation.

## Course Materials

### Required Text: Text books

1. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons.
2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill

### Optional Materials: Reference Books

1. Tompkins, W.J., 1993. Biomedical digital signal processing. Editorial Prentice Hall.
2. Sörnmo, L. and Laguna, P., 2005. Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press.

# VLSI Technology

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106207EC |

[Pre-requisites: EC103102EC - Microelectronics Devices and Circuits]

## Course Objectives

1. To study various VLSI fabrication steps such as oxidation, lithography, etc.
2. To understand the process of VLSI circuit implementation.
3. To exlore new techniques of fabrication and characterzation.

## Course Content

### UNIT-I

Solid state diffusion modeling and technology, ion implantation technology and damage annealing, characterization of impurity profiles, Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra-thin films, Oxidation techniques, characterization of oxides films.

### Unit- II

Environment for VLSI Technology, Clean room and safety requirements, Wafer cleaning process and wet chemical etching techniques.

### Unit- III

Lithography: Photolithography, e-beam lithography and newer lithography techniques for VLSI/ULSI, mask generation.

Chemical vapor deposition techniques: CVD techniques for deposition of polysilicon, silicon dioxide, silicon nitrite and metal films, epitaxial growth of silicon. Metal film deposition: Evaporation and sputtering techniques, failure mechanisms in metal interconnect multilevel metallization schemes.

### Unit- IV

Plasma and rapid thermal processing, PECVD, plasma etching and RIE techniques, RTP techniques for annealing , growth and deposition of various films for use in ULSI.

## Course Materials

### Required Text: Text books

1. VLSI Technology,S. M. Sze,McGraw Hill, II , 1988.
2. VLSI fabrication principles, S. K. Gandhi,,"John Wiley, New York",1983.
3. ULSI Technology,C. Y. Chang. S. M. Sze,McGraw Hill companies,1996.

# Semiconductor Device Modeling

[6th Semester, Third Year]

Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | ELECTIVE | EC106208EC |

[Pre-requisites: EC103102EC - Microelectronics Devices and Circuits]

Course Objectives

1. Understand Semi-classical Bulk Transport in semiconductor devices.
2. Apply suitable approximations and techniques to derive the model referred to above starting from drift-diffusion transport equations (assuming these equations hold).
3. Simulate characteristics of a simple device using MATLAB, SPICE and ATLAS / SYNOPSYS.

Course Content

UNIT-I

Semi-classical Bulk Transport – Qualitative Model At the end of this module you should be able to explain qualitatively the following in semiconductors The reason for terming certain mechanisms of carrier motion as semi-clasical The concepts of scattering, effective mass and carrier.

Unit- II

Drift-Diffusion Transport Model – Equations, Boundary Conditions, Mobility and Generation / Recombination At the end of this module, you should be able to write, for the widely used drift-diffusion transport model, its three coupled equations in electron concentration, n, hole concentration, p, and potential ψ the conditions imposed on n, p and ψ at the contacted and non-contacted boundaries of the device, to solve he coupled equations the equations for field dependent mobility in bulk and inversion layers the equations for different generation-recombination mechanisms.

Unit- III

2-terminal MOS device: threshold voltage modeling (ideal case as well as taking into account the effects of Qf, Φms and Dit.); C-V characteristics (ideal case as well as taking into account the effects of Qf, Qm and Dit); MOS capacitor as a diagnostic tool ( measurement of non-uniform doping profile, estimation of Qf, Qm and Dit)

Unit- IV

4-terminal MOSFET: threshold voltage (considering the substrate bias); above threshold I-V modeling (SPICE level 1,2,3 and 4); subthreshold current model; scaling; effect of threshold tailoring implant (analytical modeling of threshold voltage using box approximation); buried channel MOSFET; short channel, DIBL and narrow width effects; small signal analysis of MOSFETs (Meyer's model) SOI MOSFET: basic structure; threshold voltage modeling Advanced topics: hot carriers in channel; EEPROMs; CCDs; high-K gate dielectrics

Course Materials

Required Text: Text books

1. M. Lundstrom,"Fundamentals of Carrier Transport", Cambridge University Press, 2000.
2. C.Snowden,"Introduction to Semiconductor Device Modeling", World Scientific, 1986.
3. Y. Tsividis and C. McAndrew,"MOSFET modeling for Circuit Simulation", Oxford University Press, 2011.

Other Reference Materials

4. BSIM Manuals available on BSIM homepage on the internet.

# Machine Learning and Pattern Recognition

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | OPEN ELECTIVE | EC106301EC |

[Pre-requisites: MA10I001MA- Mathematics I, MA10I002MA- Mathematics II, MA103001MA-Mathematics III]

## Course Objectives

1. To understanding the basic principles of machine learning in modern world.
2. To understand the application of Bayesian decision theory in machine learning.
3. To learn various linear and nonlinear classification algorithms.
4. To learn and understand various clustering algorithms.

## Course Content

### Unit-I

Introduction to machine learning: Feature, feature vectors and classifiers; Supervised, unsupervised and semi-supervised learning. Classifiers based on Bayes decision theory: Discriminant functions and decision surfaces; Bayesian classification for normal distribution; Estimation of unknown probability density functions.

### Unit II

Linear classifiers: Linear discriminant functions and decision hyperplanes, Perceptron algorithm, Least squares methods, Logistic discrimination. Nonlinear classifiers: Multilayer perceptrons, Decision tree algorithm.

### Unit-III

Support Vector Machines: Structural and empirical risk, Margin of a classifier, Support Vector Machines, learning nonlinear hypothesis using kernel functions. Ensemble classifier.

### Unit IV

Clustering: Definitions and application of clustering analysis, Different measures of clustering, Hard clustering algorithms, Fuzzy clustering algorithms, Possibilistic clustering, Cluster validity.

## Course Materials

### Required Text: Text books

1. Pattern Recognition, 4ed, Sergios Theodoridis, Konstantinos Koutroumbas, Elsevier, 2009.
2. Neural networks and learning Machines, Simon Haykin.

### Optional Materials: Reference Books

1. Pattern Classification, R. O. Duda, P. E. Hart, and D. G. Stork, John Wiley and Sons, 2012.
2. Pattern Recognition and Machine Learning,C. M. Bishop, Springer, 2010.

# Information Theory and Coding

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 3-0-0, (3) | OPEN ELECTIVE | EC106302EC |

[Pre-requisites: EC105101EC-Digital Communication]

## Course Objectives

1. To understand the concepts of information, entropy, and mutual information.
2. To understand measures of information for discrete and continuous sources.
3. To understand and utilize Shannon's source and channel coding theorem.
4. To understand various source coding algorithms and write practical programs based on them.
5. To understand various channel coding algorithms and write practical programs based on them.

## Course Content

### UNIT-I

SOURCE CODING: Uncertainty and information, Average mutual information and entropy, Information measures for continuous random variables, Source coding theorem, Huffman coding, Lempel-Ziv algorithm.

### UNIT II

CHANNEL CODING: Channel capacity, Information capacity theorem, Shannon limit, Random codes, Linear block codes and syndrome decoding, Error probability after coding, Cyclic codes, CRC codes.

### UNIT III

BCH and Reed-Solomon codes: Primitive elements, minimal polynomial, Generator polynomial in terms of minimal polynomial, Encoding and decoding of BCH codes, Reed Solomon codes.

### UNIT IV

CONVOLUTIONAL CODES: Tree codes and trellis codes, Polynomial description of convolutional codes, Generating function, Viterbi decoding, Distance bounds, Performance bounds.

## Course Materials

### Required Text: Text books


1. Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGraw Hill.
2. Digital Communication, John G Proakis, McGraw Hill.


### Optional Materials: Reference Books


1. Elements of Information Theory, Cover & Thomas, Wiley.

# Microwave Lab

[6th Semester, Third Year]

Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 0-0-2, (1) | CORE | EC106401EC |

Course Objectives

1. Understand and analyze the different microwave components and their applications.
2. Understand the principle of working of different type of microwave tubes.
3. Understand the principle of working of different type of semiconductor devices and their applications

List of Experiments

1. Study of Microwave Components and Instruments.
2. Study of Reflex Klystron Characteristics.
3. Study of Wavelength & VSWR measurement for X-band.
4. Study of Gunn Oscillator
5. Verify the Properties of Directional Coupler
6. Study of power division in E-plane & H-plane Tee.
7. Study of power division in Magic Tee.
8. Verify the properties of Isolator and Circulator Characteristics
9. Verify the characteristics of Reciprocal and Non-Reciprocal devices with the help of Microwave Power Meter
10. Study of Characteristics of Different antennas using Vector Network Analyzer
11. Study of characteristics of PIN Modulator using microstrip trainer kit.
12. Verify PIN diode as a SPST switch using microstrip trainer kit.
13. Verify PIN diode as a SPDT switch using microstrip trainer kit.
14. Verify Operation of Frequency Mixer using microstrip trainer kit.
15. Verify Schottky diode as a detector using microstrip trainer kit.

Course Materials

Required Text: Text books

1.Microwave Devices and Circuits by Samuel Y. Liao, 3rd Ed., Pearson Education
2. Microwave Engineering, D.M Pozar, John Wiley & Sons

# VLSI Design Lab

[6th Semester, Third Year]

## Course Description

| Offered by Department | Credits | Status | Code |
|---|---|---|---|
| Electronics & Communication Engineering | 0-0-2, (1) | CORE | EC106402EC |

## Course Objectives

1. To model the behavior of a MOS Transistor
2. To design combinational and sequential circuits using CMOS gates
3. To draw layout of a given logic circuit
4. To realize logic circuits with different design styles
5. To demonstrate an understanding of working principle of operation of different types of memories

## List of Experiments

1. Study of the output and transfer characteristics of an n-channel and p-channel MOSFET.
2. Study of the static (VTC) and dynamic characteristics of a digital CMOS inverter.
3. Design of a 3-inverter ring oscillatorand study of its output characteristics.
4. Study of dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
5. Design of a 4x1 multiplexer using pass transistor logic.
6. Design of a multiplexer using dynamic logic.
7. Study of the characteristics of a positive and negative latch.
8. Study of thecharacteristics of a master-slave positive and negative edge triggered registers.
9. Design and analysis of 1-bit SRAM cell for read and write operations.
10. Design and analysisof 1-bit DRAM cell for read and write operations.

## Course Materials

### Required Text: Text books

1. CMOS Digital Integrated Circuits: Analysis and Design by Sung-MO Kang, Yusuf Leblebici.