



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

List of Domains for Honors:

Honor Degree in Electronics and Communication Engineering

Note: A student must acquire additional 18 credits and out of which at least 6 credits (i.e., 2 Courses of 3 Credits each) must be earned from NPTEL/SWAYAM MOOC Courses

(As per Proc.NoE1/JNTUGV/DAP/Guidelines for B.Tech Honors/2025 Dt: 20-02-2025)

(I) VLSI Circuit Design and Verification

S.No	Course Code	Subject Title	L	T	P	C
1	R234HO01	CMOS Logic Circuit Design	3	0	0	3
2	R234HO02	System on Chip Design	3	0	0	3
3	R234HO03	VLSI Fabrication Technology	3	0	0	3
4	R234HO04	Advanced VLSI Design	3	0	0	3
5	R234HO05	Introduction to CAD for VLSI	3	0	0	3
Total						15

(II) Robotics and Automation

S.No	Course Code	Subject Title	L	T	P	C
1	R234HO06	Industrial Automation	3	0	0	3
2	R234HO07	Robots and Control	3	0	0	3
3	R234HO08	Distributed Embedded systems	3	0	0	3
4	R234HO09	Advanced Controllers	3	0	0	3
5	R234HO10	Industrial Automation	3	0	0	3
Total						15

(III) Cognitive Radio Networks

S.No	Course Code	Subject Title	L	T	P	C
1	R234HO11	Optical Communications	3	0	0	3
2	R234HO12	Wireless and Mobile Networks	3	0	0	3
3	R234HO13	Software Defined Radio	3	0	0	3
4	R234HO14	MIMO Wireless Communications	3	0	0	3
5	R234HO15	Wireless broad band communications	3	0	0	3
Total						15



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

(IV) Multimedia Signal Processing

S.No	Course Code	Subject Title	L	T	P	C
1	R234HO16	Detection & Estimation of Signals (DES)	3	0	0	3
2	R234HO17	Statistical Signal Processing	3	0	0	3
3	R234HO18	Computer Vision	3	0	0	3
4	R234HO19	Audio Signal Processing	3	0	0	3
5	R234HO20	Detection & Estimation of Signals (DES)	3	0	0	3
Total						15

Suggested NPTEL Courses:

1. Microelectronics: Devices to Circuits (Source: IIT Kanpur & NPTEL via SWAYAM)
2. Integrated Photonics Devices and Circuits (Source: IIT Madras & NPTEL via SWAYAM)
3. Mathematical Aspects of Biomedical Electronic System Design (Source: IISc Bangalore & NPTEL via SWAYAM)
4. Signal Processing for mm Wave communication for 5G and beyond (Source: IIT Kharagpur & NPTEL via SWAYAM) MOOCS - 2
5. Deep Learning for Computer Vision (Source: NPTEL)
6. Big Data Computing (Source: IIT Patna & NPTEL via SWAYAM)
7. Fabrication Techniques for MEMS-based sensors: clinical perspective (Source: IISc Bangalore & NPTEL via SWAYAM)
8. Introduction to Industry 4.0 and Industrial Internet of Things (Source: IIT Kharagpur & NPTEL via SWAYAM)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

VLSI Circuit Design and Verification	L	T	P	C
	3	0	0	3
CMOS Logic Circuit Design				

Course Description

The Purpose of the Course is to introduce the Design of CMOS Logic Circuits. The Course aims to provide the technological advances in the Logic Circuit using Digital Systems. The Target audience are Third-Year engineering students. The Combinational and Sequential Circuits working mechanisms are discussed. The types of Semiconductor memories are discussed with applications. The Stake holders will develop Analytical Skills.

Teaching Objectives

1. To discuss basic CMOS logic gates, implementation of AOI and OAI gates
2. Design MOS logic circuits using Transmission gates
3. To analyze different delays and power dissipation in number of stages
4. To understand the design of combinational circuits using cascade and dynamic logic
5. To design different types of Semiconductor Memories

Course Outcomes

1. Able to apply mathematical methods and transistor physics in the analysis of CMOS circuits
2. Able to Design CMOS inverter with different loads for given levels noise margins and propagation delay's.
3. Can execute moderately sized digital logic designs with OAI, AOI, and transmission gates
4. Able to design static and dynamic CMOS circuits (both Combinational and sequential) at transistor level and layout level.
5. Able to design memory architectures that aids the growth of VLSI designs with reduced access time and reduced power consumption

Unit 1: MOS DESIGN

This unit focus on introduction of basic parameters of Pseudo NMOS Logic. The System Time constrains and power parameters will be covered.

Syllabus Topics

Pseudo NMOS Logic – Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Examples/Applications/Case Studies

- Implementing Basic Logic using VHDL Programming
- Understanding System Parameters
- To Learn the Implementation of NMOS,PMOS,CMOS Logic with Layouts

Exercise/Project Problems

1. Use XILINX tool to design CMOS Inverter
2. To analyze the System parameters using Xilinx Tool
3. Dump and Verify the CMOS Inverter Program on a FPGA Board

Tools Study

- XILINX tool *for understanding basic Logic Circuits*
- *FPGA Kits in VLSI Lab*

Learning Outcomes

1. Able to apply mathematical methods and transistor physics in the analysis of CMOS circuits
2. Memorize various system parameters of Digital Logic Circuit

References/e-Resources

- CMOS Digital VLSI Design (Source:IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source:IIT Kharagpur & NPTEL via Swayam)

Unit 2: COMBINATIONAL MOS LOGIC CIRCUITS

This unit focus on design of Combinational Circuits. The Complex Logic Circuit design are studied. This unit will focus logical design of Digital Systems.

Syllabus Topics

MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates , AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

Examples/Applications/Case Studies

- Implementing NAND & NOR gates using VHDL Programming
- Implementing Logic using VHDL Programming Styles
- To Learn the Transmission gates

Exercise/Project Problems

1. Use XILINX tool to design CMOS Full adders
2. To implement Boolean expressions using Xilinx Tool
3. To study CMOS transmission gates

Tools Study

- XILINX tool *for understanding Combinational Logic Circuits*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- Cadence tool *for understanding Combinational Logic Circuits*

Learning Outcomes

1. Can execute moderately sized digital logic designs with OAI, AOI, and transmission gates
2. Design and implementation of Combinational Circuits

References/e-Resources

- CMOS Digital VLSI Design (Source:IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source:IIT Kharagpur & NPTEL via Swayam)

Unit 3: SEQUENTIAL MOS LOGIC CIRCUITS

**This unit focus on design of Sequential Circuits. The Storage Circuits designs are studied.
This unit will focus logical design of Memory Elements.**

Syllabus Topics

Behaviour of Bi-stable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered Flip-flop.

Examples/Applications/Case Studies

- Implementation of Flip flops using VHDL Programming
- Compare the merits and demerits of Flip flops and Latch
- Design of Memory elements with time constrains

Exercise/Project Problems

1. Use XILINX tool to design Flip flop
2. To implement Flip flop using Verilog Programming
3. To study Time constrains of Latch and Flip flop

Tools Study

- XILINX tool *for understanding Sequential Logic Circuits*
- Cadence tool *for understanding Sequential Logic Circuits*

Learning Outcomes

1. To understand the design of Sequential circuits
2. To understand the Timing Constrains

References/e-Resources

- CMOS Digital VLSI Design (Source:IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source:IIT Kharagpur & NPTEL via Swayam)

Unit 4: DYNAMIC LOGIC CIRCUITS

This unit focus on application of Dynamic Logic Circuits with various design strategies .



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Syllabus Topics

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS Transmission gate logic, High performance Dynamic CMOS circuits.

Examples/Applications/Case Studies

- To study CMOS Transmission gate Logic
- To know the prominence of Dynamic Logic Circuits
- Design of CMOS circuits at transistor level and layout level

Exercise/Project Problems

1. To implement Dynamic Circuits using Cadence Tool
2. To understand the merits and demerits of Transmission gates

Tools Study

- XILINX tool *for understanding Dynamic Circuits*
- Cadence tool *for understanding Dynamic Circuits*

Learning Outcomes

1. Able to design static and dynamic CMOS circuits (both Combinational and sequential) at transistor level and layout level
2. Able to understand Transmission gates

References/e-Resources

- CMOS Digital VLSI Design (Source: IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source: IIT Kharagpur & NPTEL via Swayam)

Unit 5: SEMICONDUCTOR MEMORIES

This unit focus on types of Memories. This unit will discuss about parameters affecting storage.

Syllabus Topics

Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

Examples/Applications/Case Studies

- Types of RAM
- Comparing DRAM & SRAM
- Applications of Flash memories

Exercise/Project Problems

1. Use XILINX tool to design Memories
2. To study Types of memories



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Tools Study

- XILINX tool *for design of memories*
- Cadence tool *for study of System constrains of memory implementation*

Learning Outcomes

1. Able to design memory architectures that aids the growth of VLSI designs with reduced access time and reduced power consumption
2. Understand the Memory Implementation

References/e-Resources

- CMOS Digital VLSI Design (Source: IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source: IIT Kharagpur & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Logic gates

- **Lab 1:** To implement Logic gates using VHDL (understanding the concept)
- **Lab 2:** To implement Universal gates using Verilog (understanding the concept)

Week 3-4: Full Adder

- **Lab 3:** To implement Half Adder using VHDL (understanding the concept)
- **Lab 4:** To implement Full Adder using VHDL (understanding the concept)

Week 5-6: Flip Flops

- **Lab 5:** To implement D-Flip Flop & T-Flip Flop using VHDL (understanding the concept)
- **Lab 6:** : To implement SR-Flip Flop & JK-Flip Flop using VHDL (understanding the concept)

Week 7-8: Cadence Tool for design of CMOS Inverter

- **Lab 7:** Schematic design of a CMOS Inverter in Cadence Virtuoso Schematic Editor (understanding the concept)
- **Lab 8:** Layout design of a CMOS Inverter in Cadence Virtuoso Layout Editor (understanding the concept)

Week 9-10: Cadence Tool for Timing Constrains measurement

- **Lab 9:** Extraction of Logical effort and parasitic delay of a CMOS inverter (understanding the concept)
- **Lab 10:** Design and characterization of D-Latch and D-Flip Flop in CMOS Technology

Textbooks and References

Textbooks

1. Ken Martin, (2011). *Digital Integrated Circuit Design*. Oxford University Press.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

2. Sung-Mo Kang, (2011). *CMOS Digital Integrated Circuits Analysis and Design*. TMH

References

1. Ming-BO Lin, (2011). *Introduction to VLSI Systems: A Logic, Circuit and System Perspective*, CRC Press
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, (2017). *Digital Integrated Circuits – A Design Perspective*, PHI.

Online Resources

- CMOS Digital VLSI Design (Source:IIT Roorkee & NPTEL via Swayam)
- Digital Electronic Circuits (Source:IIT Kharagpur & NPTEL via Swayam)
- Design and Analysis of VLSI Subsystems(Source:IIT Madras & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

VLSI Circuit Design and Verification	L	T	P	C
	3	0	0	3
SYSTEM ON CHIP DESIGN				

Course Description

The Purpose of the Course is to introduce the basics of System on Chip Design. The Course aims to provide the techniques Processor selection and Memory Design for SoC. The Target audiences are Third-Year engineering students. The SoC optimization techniques will be discussed. This will help us to understand the SoC Applications. The Stake holders will develop Creative Skills.

Teaching Objectives

1. To understand the concepts of SOC Testing.
2. To understand the concepts of System on Chip Design Validation.
3. To understand the concepts of System on Chip Design methodology for Logic and Analog

Cores

Course Outcomes

1. Understand about SoC Design Methodology.
2. Ability to understand the design of different embedded memories.
3. Validation and Testing Concepts can be understood.
4. Investigate new techniques for future systems

Unit 1: SYSTEM ARCHITECTURE: OVERVIEW

This unit focus on SoC design requirements and specifications. The Product Economics for SOC will be covered.

Syllabus Topics

Components of the system, Processor architectures, Memory and addressing, system level interconnection, SoC design requirements and specifications, design iteration, System Architecture & complexity, Product Economics for SOC, Dealing with Design Complexity

Examples/Applications/Case Studies

- Processor architectures
- Speech production models
- Product Economics for SOC



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Exercise/Project Problems

4. System level interconnection
5. System Architecture & complexity

Tools Study

- *Synopsys tool*
- *Cadence tool*

Learning Outcomes

3. Understand design requirements and specifications

References/e-Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source: IISc Bangalore & NPTEL via Swayam)

Unit 2: PROCESSOR SELECTION FOR SOC

This unit focus on Processors used for SoC. The basic requirements of Processors will be covered.

Syllabus Topics

Overview - soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost of branches – Robust processors – Vector processors, VLIW processors, Superscalar processors

Examples/Applications/Case Studies

- Interrupts and exceptions
- Superscalar processors

Exercise/Project Problems

1. Robust processors
2. **VLIW processors**

Tools Study

- *Synopsys tool*
- *Cadence tool*

Learning Outcomes

- **Understand Processor types and basic handling mechanisms**

References/e-Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source: IISc Bangalore & NPTEL via Swayam)

Unit 3: MEMORY DESIGN



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

This unit focus on SoC memory specifications. The SoC memory systems will be covered.

Syllabus Topics

SoC external memory, SoC internal memory, Scratch pads and cache memory – Cache organization and write policies – strategies for line replacement at miss time – Split I- and D caches – multilevel caches – SoC memory systems – board based memory systems – simple processor/memory interaction.

Examples/Applications/Case Studies

- SoC internal memory
- Multilevel caches

Exercise/Project Problems

1. Cache organization
2. Board based memory systems

Tools Study

- *Synopsys tool*
- *Cadence tool*

Learning Outcomes

- **Ability to understand the design of different embedded memories**

References/e-Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source: IISc Bangalore & NPTEL via Swayam)

Unit 4: INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION

This unit focus on interconnect architectures. The SoC customization will be covered.

Syllabus Topics

Bus architectures – SoC standard buses – AMBA, Core Connect – Bus Interface Units: Bus Sockets and Bus Wrappers– Contention and Shared Bus-SOC Customization: An Overview-Processor Customization Approaches -Reconfigurable Technologies

Examples/Applications/Case Studies

- SoC standard buses
- Processor Customization

Exercise/Project Problems

1. Core Connect
2. Reconfigurable Technologies

Tools Study

- *Synopsys tool*
- *Cadence tool*

Learning Outcomes

1. Understand types of Bus architectures and Customization Methods



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

References/e-Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source: IISc Bangalore & NPTEL via Swayam)

Unit 5: APPLICATION STUDIES

This unit focus on SoC applications. The Examples are discussed.

Syllabus Topics

SOC Design Approach, AES: Algorithm and Requirements, AES: Design and Evaluation, 3-D Graphics Processors-Analysis: Processing-Analysis: Interconnection-Prototyping, JPEG Compression, Example JPEG System for Digital Still Camera.

Examples/Applications/Case Studies

- AES: Algorithm and Requirements
- Processors-Analysis

Exercise/Project Problems

1. 3-D Graphics Processors
2. JPEG System for Digital Still Camera

Tools Study

- *Synopsys tool*
- *Cadence tool*

Learning Outcomes

1. Investigate new techniques for future systems

References/e-Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source: IISc Bangalore & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: System Architecture

- **Lab 1:** To study Processor architectures (understanding the concept)
- **Lab 2:** To study Product Economics for SoC (understanding the concept)

Week 3-4: Processor Selection for SoC

- **Lab 3:** To study VLIW processors (understanding the concept)
- **Lab 4:** To study Superscalar processors (understanding the concept)

Week 5-6: Memory Design

- **Lab 5:** To Study cache organization (understanding the concept)
- **Lab 6:** To Study board based memory systems (understanding the concept)

Week 7-8: Interconnect Architectures

- **Lab 7:** To Study SoC standard buses (understanding the concept)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- **Lab 8:** To Study Bus Interface Units (understanding the concept)

Textbooks and References

Textbooks

3. Flynn, Michael J., and Wayne Luk. ,(2011) *Computer system design: system-on-chip*. John Wiley & Sons
4. Wayne Wolf ,(2008) “*Modern VLSI Design – System – on – Chip Design*”, Prentice Hall

References

3. Wayne Wolf ,(2008) “*Modern VLSI Design – IP based Design*”, Prentice Hall

Online Resources

- Workshop on ARM based SoC Design (Source: NIELIT Calicut & NPTEL Plus)
- Electronics - ARM Based Development (Source:IISc Bangalore & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

VLSI Circuit Design and Verification	L	T	P	C
	3	0	0	3
VLSI Fabrication Technology				

Course Objectives

This course aims to:

1. Introduce the basic principles and steps involved in VLSI fabrication.
2. Explain various semiconductor processing techniques used in IC manufacturing.
3. Provide an understanding of IC process integration and layout design considerations.
4. Familiarize students with contamination control and yield enhancement techniques.
5. Offer insights into advanced fabrication technologies and trends in the semiconductor industry.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- Explain the sequence of steps involved in CMOS VLSI fabrication.
- Apply various semiconductor processing techniques such as oxidation, diffusion, ion implantation, and lithography.
- Analyze the influence of process parameters on device performance and yield.
- Identify contamination control and cleanroom protocols essential for IC fabrication.
- Understand modern trends in fabrication like FinFETs, SOI, and 3D integration.

Syllabus

Unit 1: Introduction to VLSI Fabrication

Overview of IC fabrication technologies, Cleanroom classifications and contamination control, Wafer types and crystal growth techniques (Czochralski and Float-zone), Wafer preparation and polishing, Moore's Law and technology scaling trends

Unit 2: Oxidation, Diffusion, and Ion Implantation

Thermal oxidation: dry and wet processes, Oxide thickness control and measurement, Diffusion process: Fick's laws, drive-in and pre-deposition, Ion implantation: doping profiles, annealing, channeling, Comparison between diffusion and implantation



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 3: Photolithography and Etching

Photoresist types and characteristics, Exposure systems: contact, proximity, projection, Resolution and alignment issues, Etching techniques: wet and dry (plasma, RIE), Lithography for sub-micron technologies (EUV, DUV)

Unit 4: Thin Film Deposition and Metallization

Deposition techniques: CVD, LPCVD, PECVD, PVD, Step coverage and film stress issues, Epitaxial growth: homoepitaxy and heteroepitaxy, Metallization: materials (Al, Cu), silicides, barrier layers, Chemical Mechanical Planarization (CMP)

Unit 5: Process Integration and Advanced Technologies

NMOS, PMOS and CMOS process flows, Isolation techniques: LOCOS, STI, Yield analysis, reliability, and failure mechanisms, Advanced fabrication techniques: SOI, FinFETs, 3D ICs, Process simulation tools and current trends in semiconductor manufacturing

Textbooks

1. **S.M. Sze, Kwok K. Ng**, *Physics of Semiconductor Devices*, 3rd Edition, Wiley, 2006.
2. **S.K. Ghandhi**, *VLSI Fabrication Principles: Silicon and Gallium Arsenide*, 2nd Edition, Wiley, 1994.

Reference Books

1. **James D. Plummer, Michael D. Deal, Peter B. Griffin**, *Silicon VLSI Technology: Fundamentals, Practice, and Modeling*, Pearson Education, 2000.
2. **Stephen A. Campbell**, *The Science and Engineering of Microelectronic Fabrication*, 2nd Edition, Oxford University Press, 2001.
3. **Gary S. May, Simon M. Sze**, *Fundamentals of Semiconductor Fabrication*, Wiley, 2003.
4. **Harry J. Levinson**, *Principles of Lithography*, 4th Edition, SPIE Press, 2019.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

VLSI Circuit Design and Verification	L	T	P	C
	3	0	0	3
Advanced VLSI Design				

Course Objectives

This course aims to:

1. Deepen understanding of VLSI design beyond the basics, focusing on advanced digital and analog circuits.
2. Introduce design methodologies for high-performance and low-power integrated circuits.
3. Explore advanced circuit topologies, layout optimization, and device scaling effects.
4. Provide insight into clocking, timing analysis, and signal integrity challenges in VLSI.
5. Familiarize students with modern CAD tools and industry-standard design flows.

Course Outcomes (COs)

After completing this course, students will be able to:

- Analyze and design complex digital and analog VLSI circuits with performance constraints.
- Apply advanced low-power design techniques to reduce power consumption.
- Perform timing analysis and implement clock distribution strategies.
- Optimize layouts considering parasitic effects and process variations.
- Utilize CAD tools for simulation, synthesis, and verification of VLSI designs.

Syllabus

Unit 1: Advanced CMOS Digital Circuits

Review of CMOS logic styles and scaling trends, Complex logic gates and compound gates, Pass transistor logic, transmission gates, and complementary pass logic, Static and dynamic logic design, Design of arithmetic circuits (adders, multipliers)

Unit 2: Low-Power VLSI Design Techniques

Power dissipation sources in CMOS circuits, Dynamic and static power reduction techniques, Multi-threshold CMOS, power gating, and clock gating, Voltage scaling and adaptive body biasing, Power estimation and modeling



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 3: High-Speed and High-Performance Design

Critical path analysis and pipeline design, Clock distribution networks and skew management, Signal integrity issues: crosstalk, ground bounce, Interconnect modeling and optimization, Timing analysis and closure techniques

Unit 4: Layout Design and Parasitics

Layout principles and design rules for advanced nodes, Parasitic capacitances and resistances, Extraction and modeling of parasitic effects, Layout optimization techniques for speed and power, Design for manufacturability (DFM) and variability considerations

Unit 5: VLSI Design Methodologies and Tools

Design flow overview: RTL to GDSII, Hardware description languages (Verilog, VHDL), Logic synthesis and optimization, Static timing analysis (STA), Verification methodologies: simulation, formal verification, Overview of popular CAD tools (Cadence, Synopsys, Mentor Graphics)

Textbooks

1. **David A. Hodges, Horace G. Jackson**, *Analysis and Design of Digital Integrated Circuits*, 3rd Edition, McGraw-Hill, 2014.
2. **Neil H.E. Weste, Kamran Eshraghian**, *Principles of CMOS VLSI Design*, 4th Edition, Pearson, 2015.

Reference Books

1. **Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic**, *Digital Integrated Circuits: A Design Perspective*, 2nd Edition, Pearson, 2003.
2. **Sung-Mo Kang, Yusuf Leblebici**, *CMOS Digital Integrated Circuits: Analysis and Design*, 4th Edition, McGraw Hill, 2014.
3. **Bhaskar Ghose**, *Advanced VLSI Design: Circuits and Systems*, PHI Learning, 2010.
4. **Kang and Leblebici**, *CMOS Digital Integrated Circuits*, 3rd Edition, McGraw Hill, 2003.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

VLSI Circuit Design and Verification	L	T	P	C
	3	0	0	3
Introduction to CAD for VLSI				

Course Objectives

This course aims to:

1. Introduce the principles and methodologies of computer-aided design (CAD) tools used in VLSI.
2. Provide understanding of the various stages in VLSI design automation.
3. Familiarize students with hardware description languages and synthesis tools.
4. Explain algorithms for layout, verification, and optimization of VLSI circuits.
5. Develop skills to use CAD tools for design, simulation, and testing of integrated circuits.

Course Outcomes (COs)

Upon completion of the course, students will be able to:

- Describe the role and flow of CAD tools in VLSI design automation.
- Apply HDL coding and simulation for digital circuit design.
- Use synthesis tools to convert RTL to gate-level netlists.
- Understand and apply algorithms for placement, routing, and floorplanning.
- Perform verification and testing using CAD methodologies.

Syllabus

Unit 1: Overview of VLSI CAD Tools and Design Flow

Introduction to VLSI design automation, Design flow: Specification to fabrication, Types of CAD tools: front-end and back-end, Design representation: netlists, layouts, and formats, Design challenges and automation benefits

Unit 2: Hardware Description Languages (HDL)

Introduction to Verilog and VHDL, Design units and simulation models, Behavioral, dataflow, and structural modeling, Testbench creation and simulation, Case study: Simple digital design using HDL

Unit 3: Logic Synthesis and Optimization



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

RTL to gate-level synthesis, Technology libraries and mapping, Logic optimization techniques, Boolean algebra and DAG representation, Power, area, and timing trade-offs

Unit 4: Physical Design Automation

Floor planning and partitioning, Placement algorithms: combinatorial and analytical, Routing algorithms: maze routing, channel routing, Clock tree synthesis and timing closure, Design rule checking (DRC) and layout versus schematic (LVS)

Unit 5: Verification and Testing in CAD

Simulation vs formal verification, Static timing analysis (STA), Design for Testability (DFT) concepts, Built-in self-test (BIST), CAD tools for verification and test automation

Textbooks

1. **Sabih H. Gerez**, *Algorithms for VLSI Design Automation*, 3rd Edition, Wiley, 2009.
2. **Neil Weste, Kamran Eshraghian**, *Principles of CMOS VLSI Design*, 4th Edition, Pearson, 2015.

Reference Books

1. **Sanjay Churiwala**, *VLSI Design and EDA Tools*, Wiley, 2020.
2. **Stephen Brown, Zvonko Vranesic**, *Fundamentals of Digital Logic with VHDL Design*, 3rd Edition, McGraw-Hill, 2008.
3. **Wayne Wolf**, *Modern VLSI Design: IP-Based Design*, 4th Edition, Pearson, 2008.
4. **Rajesh K. Gupta**, *VLSI CAD: Algorithms and Tools*, 1st Edition, Springer, 2012.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Robotics and Automation	L	T	P	C
	3	0	0	3
Industrial Automation				

Course Objectives

This course aims to:

1. Introduce the fundamental concepts and components of industrial automation systems.
2. Provide knowledge of sensors, actuators, and control devices used in automation.
3. Explain programmable logic controllers (PLCs) and their programming.
4. Explore industrial communication protocols and supervisory control systems.
5. Familiarize students with modern automation trends including robotics and SCADA.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

- Explain the components and architecture of industrial automation systems.
- Select and apply appropriate sensors and actuators in industrial environments.
- Program and troubleshoot PLCs for automated industrial processes.
- Understand industrial communication standards and supervisory control.
- Describe the role of robotics and SCADA in modern industrial automation.

Syllabus

Unit 1: Introduction to Industrial Automation

Evolution and benefits of automation, Types of automation: fixed, programmable, flexible, Components of automation systems: sensors, actuators, controllers, Industrial control systems overview, Safety and standards in automation

Unit 2: Sensors and Actuators

Classification and working principles of sensors (proximity, temperature, pressure, flow, level), Signal conditioning and data acquisition, Actuators: hydraulic, pneumatic, electric, Motor types and control (DC, AC, stepper, servo motors), Drives and converters

Unit 3: Programmable Logic Controllers (PLCs)



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

PLC architecture and operation, PLC input/output modules, Ladder logic programming and instruction set, Timers, counters, and sequencers, PLC applications and troubleshooting

Unit 4: Industrial Communication and SCADA

Industrial communication protocols: Modbus, Profibus, Ethernet/IP, CAN, Fieldbus and networked control systems, Supervisory Control and Data Acquisition (SCADA) systems, Human Machine Interface (HMI) basics, Data acquisition and process monitoring

Unit 5: Robotics and Advanced Automation

Industrial robots: types, configurations, and applications, Robot kinematics and control basics, Automation trends: IIoT (Industrial Internet of Things), smart manufacturing, Introduction to MES (Manufacturing Execution Systems), Case studies on automation in various industries

Textbooks

1. **Groover, M.P.**, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 4th Edition, Pearson, 2015.
2. **Frank D. Petruzella**, *Programmable Logic Controllers*, 5th Edition, McGraw Hill, 2016.

Reference Books

1. **Katsundo Hitomi**, *Industrial Robots*, 2nd Edition, Taylor & Francis, 2017.
2. **J. David Irwin**, *Industrial Automation and Process Control*, 1st Edition, Cengage, 2013.
3. **L.A. Bryan, E.A. Bryan**, *Programmable Controllers: Theory and Implementation*, 3rd Edition, Momentum Press, 2014.
4. **Thomas A. Hughes**, *Measurement and Control Basics*, 4th Edition, ISA, 2016.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

	L	T	P	C
Robotics and Automation	3	0	0	3
Robots and Control				

Course Objectives

This course aims to:

1. Introduce fundamental concepts of robotics and control theory.
2. Explain robot kinematics, dynamics, and motion control.
3. Provide knowledge of robot manipulators, sensors, and actuators.
4. Explore control strategies for robotic systems.
5. Discuss recent advancements and applications of robotics in industry.

Course Outcomes (COs)

After completing this course, students will be able to:

- Describe the components and classifications of robots.
- Analyze forward and inverse kinematics of robotic manipulators.
- Model robot dynamics and apply motion control techniques.
- Design control algorithms for robot movement and interaction.
- Understand sensor integration and applications in robotic systems.

Syllabus

Unit 1: Introduction to Robotics

History and evolution of robots, Classification and types of robots (articulated, SCARA, Cartesian, mobile), Robot components: manipulators, sensors, actuators, controllers, Robot applications in industry and research, Degrees of freedom and workspace analysis

Unit 2: Robot Kinematics

Reference frames and coordinate transformations, Forward kinematics: position and orientation calculation, Inverse kinematics: analytical and numerical methods, Homogeneous transformation matrices, Velocity kinematics and Jacobian matrices

Unit 3: Robot Dynamics



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Force and torque in robotic arms, Newton-Euler formulation for manipulator dynamics, Lagrangian formulation, Dynamic equations of motion, Simulation of robot dynamics

Unit 4: Robot Control Systems

Control system fundamentals and feedback principles, Joint space and task space control, PID controllers and advanced control strategies (adaptive, robust, nonlinear), Trajectory planning and motion control, Stability analysis and control performance evaluation

Unit 5: Sensors, Actuators, and Advanced Topics

Types of sensors in robotics: position, velocity, force, tactile, vision, Actuators: electric, hydraulic, pneumatic, Robot programming and interfacing, Introduction to mobile robots and autonomous systems, Recent trends: AI in robotics, collaborative robots, and human-robot interaction

Textbooks

1. **John J. Craig**, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson, 2018.
2. **Saeed B. Niku**, *Introduction to Robotics: Analysis, Control, Applications*, 3rd Edition, Wiley, 2010.

Reference Books

1. **Richard D. Klafter, Thomas A. Chmielewski, Michael Negin**, *Robotics Engineering: An Integrated Approach*, 2nd Edition, Prentice Hall, 2005.
2. **M. Spong, S. Hutchinson, M. Vidyasagar**, *Robot Modeling and Control*, Wiley, 2006.
3. **T. R. Kurfess**, *Robotics and Automation Handbook*, 2nd Edition, CRC Press, 2004.
4. **Mark W. Spong**, *Robot Dynamics and Control*, Wiley, 2006.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Robotics and Automation	L	T	P	C
	3	0	0	3
Distributed Embedded Systems				

Course Objectives

This course aims to:

1. Introduce the principles and architecture of distributed embedded systems.
2. Explain communication mechanisms and protocols for embedded networked devices.
3. Explore real-time operating systems and scheduling for distributed applications.
4. Provide knowledge on fault tolerance, synchronization, and security in distributed embedded systems.
5. Discuss design methodologies, middleware, and case studies of industrial distributed embedded systems.

Course Outcomes (COs)

Upon successful completion, students will be able to:

- Understand the architecture and characteristics of distributed embedded systems.
- Analyze communication protocols and middleware for embedded distributed networks.
- Design real-time scheduling and resource management schemes.
- Apply fault-tolerance and synchronization techniques in embedded distributed systems.
- Evaluate security challenges and solutions in distributed embedded environments.

Syllabus

Unit 1: Introduction and Architecture

Definition and examples of distributed embedded systems, Characteristics and design challenges, Architectural models: client-server, peer-to-peer, publish-subscribe, Hardware and software components, Case studies: automotive, aerospace, industrial automation

Unit 2: Communication in Distributed Embedded Systems

Network topologies and protocols (CAN, LIN, FlexRay, Ethernet, Wireless), Message passing and remote procedure calls (RPC), Middleware for distributed embedded systems, Real-time communication protocols, Quality of Service (QoS) and resource constraints



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 3: Real-Time Operating Systems and Scheduling

RTOS basics and features, Task models and process synchronization, Scheduling algorithms: rate monotonic, earliest deadline first, etc., Resource management and deadlock avoidance, Timing analysis and predictability

Unit 4: Fault Tolerance, Synchronization, and Security

Fault types and detection mechanisms, Redundancy and recovery techniques, Clock synchronization methods, Security challenges in distributed embedded systems, Cryptography and secure communication

Unit 5: Design Methodologies and Case Studies

Model-based design and simulation tools, Middleware architectures and frameworks, Design for scalability and maintainability, Case studies: smart grids, autonomous vehicles, industrial IoT, Emerging trends: edge computing, cyber-physical systems

Textbooks

1. **Sanjay E. Sarma, David M. Tilbury**, *Distributed Embedded Control Systems*, Wiley, 2015.
2. **Jane W. S. Liu**, *Real-Time Systems*, 2nd Edition, Pearson, 2000.

Reference Books

1. **J. M. Lee**, *Embedded Software and Systems*, 1st Edition, Wiley, 2007.
2. **Peter Marwedel**, *Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems*, 2nd Edition, Springer, 2017.
3. **Muhammad Ali Mazidi**, *Distributed Embedded Systems*, Pearson, 2018.
4. **Rajib Mall**, *Real-Time Systems: Theory and Practice*, 2nd Edition, Pearson, 2013.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Robotics and Automation	L	T	P	C
	3	0	0	3
Advanced Controllers				

Course Objectives

This course aims to:

1. Introduce advanced control system concepts beyond classical PID control.
2. Develop analytical skills for modeling and designing advanced controllers.
3. Cover modern control techniques such as state-space, optimal, and robust control.
4. Explore adaptive and nonlinear control strategies.
5. Apply advanced control techniques to real-world engineering problems.

Course Outcomes (COs)

After successful completion, students will be able to:

- Model dynamic systems using state-space representation.
- Design and analyze optimal control systems.
- Understand and implement robust control methods for uncertain systems.
- Develop adaptive and nonlinear control solutions.
- Apply advanced controllers to practical engineering systems.

Syllabus

Unit 1: State-Space Control Design

State-space representation of systems, Controllability and observability, State feedback control and pole placement, Observers and state estimation (Luenberger observer), Design of full-order and reduced-order observers

Unit 2: Optimal Control

Formulation of optimal control problems, Calculus of variations and Pontryagin's minimum principle, Linear Quadratic Regulator (LQR) design, Riccati equations and solutions, Applications in engineering systems



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 3: Robust Control

Introduction to robustness and system uncertainties, H-infinity control theory basics, Sensitivity and complementary sensitivity functions, Loop shaping and robust controller design, Applications to practical uncertain systems

Unit 4: Adaptive Control

Concepts of adaptive control, Model Reference Adaptive Control (MRAC), Self-tuning regulators, Stability analysis of adaptive systems, Applications and challenges

Unit 5: Nonlinear Control

Nonlinear system characteristics, Phase plane analysis, Lyapunov stability theory, Feedback linearization, Sliding mode control and applications

Textbooks

1. **Katsuhiko Ogata**, *Modern Control Engineering*, 5th Edition, Prentice Hall, 2010.
2. **D. E. Kirk**, *Optimal Control Theory: An Introduction*, Dover Publications, 2004.

Reference Books

1. **M. Vidyasagar**, *Nonlinear Systems Analysis*, 2nd Edition, SIAM, 2002.
2. **B. C. Kuo**, *Automatic Control Systems*, 9th Edition, Wiley, 2014.
3. **Zhou, Doyle, and Glover**, *Robust and Optimal Control*, Prentice Hall, 1996.
4. **Ioannou and Sun**, *Robust Adaptive Control*, Dover, 2012.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Cognitive Radio Networks	L	T	P	C
	3	0	0	3
Optical Communications				

Course Objectives

This course aims to:

1. Introduce fundamentals of optical fiber communication systems.
2. Explain the physical principles of light propagation in fibers.
3. Discuss components and devices used in optical communication.
4. Cover optical transmitter, receiver, and system design.
5. Present recent developments and challenges in optical networks.

Course Outcomes (COs)

Upon completion, students will be able to:

- Explain the basic principles of optical fiber and wave propagation.
- Analyze fiber characteristics and losses.
- Understand and design optical transmitters and receivers.
- Evaluate performance parameters of optical communication systems.
- Discuss modern optical network architectures and technologies.

Syllabus

Unit 1: Introduction to Optical Fiber Communications

History and evolution, Basic components of optical communication system, Electromagnetic spectrum and optical windows, Advantages of optical communication

Unit 2: Optical Fiber Fundamentals

Structure and types of optical fibers, Light propagation: total internal reflection, acceptance angle, numerical aperture, Modes of propagation: single-mode and multimode fibers, Fiber fabrication techniques

Unit 3: Fiber Losses and Dispersion



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Attenuation mechanisms: absorption, scattering, bending losses, Chromatic dispersion and modal dispersion, Polarization mode dispersion, Dispersion compensation techniques

Unit 4: Optical Sources and Detectors

Light sources: LEDs, LASER diodes, VCSELs, Modulation techniques, Photodetectors: PIN diode, Avalanche photodiode (APD), Receiver sensitivity and noise considerations

Unit 5: Optical System Design and Networks

Optical link design and power budget analysis, Noise and bandwidth considerations, Optical amplifiers: EDFA, Raman amplifiers, Wavelength division multiplexing (WDM) and Dense WDM (DWDM), Optical switching and networking basics

Textbooks

1. **Gerd Keiser**, *Optical Fiber Communications*, 5th Edition, McGraw-Hill, 2017.
2. **John M. Senior**, *Optical Fiber Communications: Principles and Practice*, 3rd Edition, Pearson, 2009.

Reference Books

1. **Govind P. Agrawal**, *Fiber-Optic Communication Systems*, 4th Edition, Wiley, 2010.
2. **Joseph C. Palais**, *Fiber Optic Communications*, 5th Edition, Pearson, 2005.
3. **Stuart E. Miller**, *Optical Networks: A Practical Perspective*, 3rd Edition, Morgan Kaufmann, 2010.
4. **R. Ramaswami, K. N. Sivarajan**, *Optical Networks: A Practical Perspective*, 3rd Edition, Morgan Kaufmann, 2009.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

	L	T	P	C
Cognitive Radio Networks	3	0	0	3
Wireless and Mobile Networks				

Course Description

The Purpose of the Course is to introduce the basic principles of Wireless communications. The Course aims to provide information about Spread spectrum. The Target audience are Third-Year engineering students. The multiplexing methods are also introduced. The Stake holders will acquire concepts of Cellular Communication.

Teaching Objectives

- 1.To understand the Wireless Channel Modeling
- 2.To study concepts of Spread Spectrum
- 3.To understand Multiplexing and Multiple Access
- 4.To understand the Cellular systems

Course Outcomes

- 1.Identify the limitations of conventional mobile telephone systems; understand the Concepts of cellular systems..
- 2.Understand the Multiplexing and Multiple Access in cellular systems
- 3.Understand the architectures of various cellular systems
- 4.Understand the concepts of Spread Spectrum and Diversity

Unit 1: EVOLUTION OF MOBILE RADIO COMMUNICATION FUNDAMENTALS

This unit focus on introduction of operation of cellular systems. The Wireless Channel Modeling is discussed.

Syllabus Topics

General Model of Wireless Communication Link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing; Wireless Channel Modeling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Okumura and Hata Path Loss Model; Channel Modeling: Stochastic, Flat Fading, Wideband Time-Dispersive Channel Modeling.

Examples/Applications/Case Studies

- Study of Handoff Strategies
- Study of Multipath Fading
- Wireless Channel Modeling

Exercise/Project Problems

1. Frequency reuse
2. Channel Modeling

Tools Study

- MATLAB

Learning Outcomes

1. Identify the limitations of conventional mobile telephone systems; understand the concepts of cellular systems..

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source: IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source: IIT Kanpur & NPTEL via Swayam)

Unit 2: SPREAD SPECTRUM AND DIVERSITY

This unit focuses on understanding the concepts of Spread Spectrum and Diversity. The Diversity Combining Techniques are discussed.

Syllabus Topics



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques, Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation.

Examples/Applications/Case Studies

- Study of Vocoders
- Study of Time Hopping
- Detection Strategies

Exercise/Project Problems

1. Spread Spectrum Modulation
2. Diversity Combining Techniques

Tools Study

- MATLAB

Learning Outcomes

1. Understand the concepts of Spread Spectrum and Diversity

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source: IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source: IIT Kanpur & NPTEL via Swayam)

Unit 3: EQUALIZATION AND MULTIPLE ACCESS

This unit focuses on Multiplexing and Multiple Access. The Multiple Access for Radio Packet Systems is discussed.

Syllabus Topics



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms; Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, SC- FDMA, IDMA Schemes and Hybrid Method of Multiple Access Schemes, RAKE Receiver; Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes.

Examples/Applications/Case Studies

- Study of Equalization Techniques
- Study of Multiplexing and Multiple Access
- Hybrid Method of Multiple Access Schemes

Exercise/Project Problems

1. Adaptive Equalizers
2. Pure ALOHA, Slotted ALOHA

Tools Study

- MATLAB

Learning Outcomes

1. Understand the Multiplexing and Multiple Access in cellular systems

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source: IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source: IIT Kanpur & NPTEL via Swayam)

Unit 4: CELLULAR NETWORKS

This unit focus on study on CDMA . The Long Term Evolution is discussed.

Syllabus Topics

GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA Based Standards: IS 95 to CDMA 2000, Wireless Local Loop, IMT 2000 and UMTS, Long Term Evolution (LTE), Mobile Satellite Communication.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Examples/Applications/Case Studies

- Study of General Packet Radio Service
- Study of Long Term Evolution

Exercise/Project Problems

1. Mobile Satellite Communication
2. CDMA Based Standards

Tools Study

- MATLAB

Learning Outcomes

- 1.Understand the architectures of various cellular systems

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)

Unit 5: OTHER WIRELESS NETWORKS

This unit focus on introduction of operation of cellular systems. The Wireless Channel Modeling is discussed.

Syllabus Topics

Introduction to Mobile Adhoc Networks, Bluetooth, Wi-Fi Standards, WiMax Standards, Li-Fi Communication, Ultra-Wideband Communication, Mobile data networks, Wireless Standards IMT 2000, Introduction to 4G & 5G and concept of NGN.

Examples/Applications/Case Studies

- Study of Mobile Adhoc Networks
- Study of Ultra-Wideband Communication

Exercise/Project Problems



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

1. Wi-Fi Standards

2. Mobile data networks

Tools Study

•MATLAB

Learning Outcomes

1. Understand the concept of Ultra-Wideband Communication

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source: IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source: IIT Kanpur & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Mobile radio communication fundamentals

- Lab 1: Operation of Cellular Systems (understanding the concept)
- Lab 2: Wireless Channel Modeling (understanding the concept)

Week 3-4: Spread Spectrum and Diversity

- Lab 3: Vocoders (understanding the concept)
- Lab 4: Diversity Combining Techniques (understanding the concept)

Week 5-6: Equalization and Multiple Access

- Lab 5: FDMA, TDMA, CDMA (understanding the concept)
- Lab 6: Pure ALOHA, Slotted ALOHA, CSMA (understanding the concept)

Week 7-8: Cellular Networks

- Lab 7: Long Term Evolution (understanding the concept)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- Lab 8: Mobile Satellite Communication (understanding the concept)

Textbooks

- 1.T.S. Rappaport, (2002). “Wireless Communication-Principles and practice”, Pearson Publications.
- 2.Upena Dalal, (2015). “Wireless Communication and Networks”, Oxford
- 3.T L Singal, (2010). “Wireless Communications”, McGraw Hill Publications.

References

- 1.Andrea Goldsmith, (2005). “Wireless Communications”, Cambridge University Press,
- 2.S. Haykin & M. Moher, (2005). “Modern wireless communication”, Pearson.

Online Resources

1. Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
2. Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

	L	T	P	C
Cognitive Radio Networks	3	0	0	3
Software Defined Radio (SDR)				

Course Objectives

This course aims to:

1. Introduce the principles and architecture of Software Defined Radio.
2. Explain signal processing techniques used in SDR.
3. Explore hardware platforms and software tools for SDR implementation.
4. Discuss design, testing, and deployment of SDR systems.
5. Provide insights into emerging SDR applications and standards.

Course Outcomes (COs)

After completing the course, students will be able to:

- Understand SDR architecture and key components.
- Apply digital signal processing techniques in SDR systems.
- Develop and simulate SDR algorithms using software tools.
- Select appropriate hardware platforms for SDR implementation.
- Analyze and evaluate SDR applications in modern wireless communications.

Syllabus

Unit 1: Introduction to Software Defined Radio

Evolution of radio communication systems, Definition and characteristics of SDR, SDR architecture and components, Benefits and challenges of SDR, Overview of cognitive radio and adaptive radio

Unit 2: Signal Processing for SDR

Analog to digital and digital to analog conversion, Sampling theorem and quantization, Digital modulation and demodulation techniques, Channel coding and decoding, Signal processing algorithms: FFT, filtering, mixing

Unit 3: Hardware Platforms for SDR



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Overview of hardware components: RF front-end, ADC/DAC, FPGA, DSP, microcontrollers, Popular SDR platforms: USRP, RTL-SDR, HackRF, LimeSDR, Hardware-software co-design considerations, Performance metrics and constraints

Unit 4: Software Tools and Development

SDR software frameworks: GNU Radio, MATLAB/Simulink, LabVIEW, Real-time signal processing and implementation, Software architecture and API programming, Testing, debugging, and validation techniques

Unit 5: Applications and Case Studies

SDR in cellular communications, Wi-Fi, Bluetooth, Cognitive radio and dynamic spectrum access, SDR in satellite and military communications, Emerging trends: 5G, IoT, and 6G potential with SDR, Case studies of SDR deployment

Textbooks

1. **Joseph Mitola III, Gerald Q. Maguire Jr.**, *Cognitive Radio: Making Software Radios More Personal*, Wiley, 2009.
2. **Ettus Research**, *Software Defined Radio for Engineers*, 1st Edition, Artech House, 2014.

Reference Books

1. **Harald Kayser**, *Software Defined Radio: Enabling Technologies*, Wiley, 2006.
2. **Dr. Jeffrey H. Reed**, *Software Radio: A Modern Approach to Radio Engineering*, Prentice Hall, 2002.
3. **Peter Athanas**, *Software Defined Radio: Architectures, Systems and Functions*, Wiley, 2013.
4. **Mathur, S., Kaur, H.**, *Software Defined Radio Systems and Techniques*, Wiley, 2018.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Cognitive Radio Networks	L	T	P	C
	3	0	0	3
MIMO Wireless Communications				

Course Objectives

This course aims to:

1. Introduce the fundamental concepts of Multiple-Input Multiple-Output (MIMO) wireless systems.
2. Explain the theory behind MIMO channel modeling and capacity analysis.
3. Explore various MIMO transmission techniques and signal processing algorithms.
4. Discuss practical implementation challenges and performance evaluation.
5. Present emerging trends and applications of MIMO in modern wireless standards.

Course Outcomes (COs)

After completing this course, students will be able to:

- Understand the principles of MIMO systems and channel characteristics.
- Analyze MIMO channel capacity and diversity gains.
- Apply MIMO transmission schemes such as spatial multiplexing and diversity.
- Design and implement signal detection and channel estimation algorithms for MIMO.
- Evaluate the performance of MIMO systems in real-world wireless scenarios.

Syllabus

Unit 1: Introduction to MIMO Systems

Overview of MIMO technology and historical perspective, MIMO system architecture and components, Benefits of MIMO: capacity increase, diversity, and multiplexing gains, Wireless channel characteristics for MIMO

Unit 2: MIMO Channel Modeling

Statistical channel models: Rayleigh and Rician fading, Correlation and antenna spacing effects, Channel state information (CSI), Channel capacity concepts for MIMO: ergodic and outage capacity



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 3: MIMO Transmission Techniques

Spatial multiplexing (e.g., V-BLAST), Diversity techniques: Alamouti scheme, space-time coding, Beamforming and precoding, MIMO-OFDM integration

Unit 4: Signal Processing for MIMO

Channel estimation methods, Detection algorithms: Zero-Forcing, MMSE, ML detection, Linear and nonlinear receivers, Performance analysis and complexity considerations

Unit 5: Practical Aspects and Applications

MIMO in 4G LTE and 5G NR standards, Massive MIMO concepts and challenges, Implementation issues: hardware complexity, synchronization, MIMO for mmWave and IoT applications, Future trends in MIMO wireless communications

Textbooks

1. **Arogyaswami J. Paulraj, Rohit Nabar, Dhananjay Gore**, *Introduction to Space-Time Wireless Communications*, Cambridge University Press, 2003.
2. **David Tse and Pramod Viswanath**, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005.

Reference Books

1. **Lajos Hanzo, Yong Soo Choi, Brian L. Yeap**, *MIMO-OFDM for LTE, WiFi and WiMAX: Coherent versus Non-Coherent and Cooperative Turbo-Transceivers*, Wiley, 2010.
2. **Emil Björnson, Jakob Hoydis, Luca Sanguinetti**, *Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency*, Cambridge University Press, 2017.
3. **Ezio Biglieri, Robert Calderbank, Anthony Constantinides**, *MIMO Wireless Communications*, Cambridge University Press, 2007.
4. **A. Goldsmith**, *Wireless Communications*, Cambridge University Press, 2005.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

	L	T	P	C
Cognitive Radio Networks	3	0	0	3
Wireless Broadband Communications				

Course Description

The Purpose of the Course is to introduce the next generation networks. The Course aims to provide information about IP Multimedia Sub-System. The Target audience are Third-Year engineering students. The architecture of a next generation network is also introduced. The Stake holders will acquire concepts of Wireless Broad Communications

Teaching Objectives

1. To learn the technical, economic and service advantages of next generation networks.
2. To learn the basic architecture of a next generation network (NGN) with reference
3. To understand NGN services
4. To learn the role of IP Multimedia Sub-System (IMS), network attachment and admission control functions
5. To learn and compare the various methods of providing connection-oriented services over NGN.

Course Outcomes

1. Understand the concepts of Wireless LAN.
2. Understand the concepts of Mobile Network Layer & Transport Layer
3. Understand the concepts of High Speed Packet Data
4. Understand the basic architecture of a next generation network (NGN) with reference.

Unit 1: EVOLUTION OF WIRELESS NETWORKS

This unit focus on introduction of operation of Wireless systems. The Wireless LAN Protocols is discussed.

Syllabus Topics

Review of cellular standards, migration and advancement of GSM architecture and CDMA architecture, WLAN – IEEE 802.11 and HIPERLAN, Bluetooth..



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Examples/Applications/Case Studies

- GSM Architecture
- Wireless LAN advantages
- Bluetooth applications

Exercise/Project Problems

1. CDMA architecture
2. HIPERLAN advantages

Tools Study

- *MATLAB*

Learning Outcomes

1. Understand the concepts of Wireless LAN.

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)

Unit 2: WIRELESS PROTOCOLS

This unit focus on Understand the concepts of Mobile network layer. The Mobile transport layer Techniques is discussed.

Syllabus Topics

Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements Indirect TCP, snooping TCP, Mobile TCP.

Examples/Applications/Case Studies



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- Compare IPv4 & IPv6
- Study of Congestion control
- Mobile TCP

Exercise/Project Problems

1. IP mobility management
2. Data forwarding procedures

Tools Study

- *MATLAB*

Learning Outcomes

1. Understand the concepts of Mobile Network Layer & Transport Layer
- ..

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)

Unit 3: 3G EVOLUTIONS

This unit focus on CDMA concepts. The High Speed Data Packet concepts are discussed.

Syllabus Topics

IMT-2000 - W-CDMA, CDMA 2000 – radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA,HSUPA..

Examples/Applications/Case Studies

- Study of UMTS-services
- Study of Channel Allocation

Exercise/Project Problems

1. CDMA 2000
2. HSDPA

Tools Study



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- *MATLAB*

Learning Outcomes

1. Understand the concepts of High Speed Packet Data

..

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)

Unit 4: 4G AND BEYOND

This unit focus on study on network architectures . The Long Term Evolution is discussed.

Syllabus Topics

Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, E- UTRAN architecture - mobility management, resource management, services, channel -logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure..

Examples/Applications/Case Studies

- Study of network architectures
- Study of Long Term Evolution

Exercise/Project Problems

1. Random access procedure
2. MAC control element

Tools Study

- *MATLAB*

Learning Outcomes

1. Understand the basic architecture of a next generation network (NGN) with reference..

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 5: LAYER-LEVEL FUNCTIONS

This unit focus on introduction of MAC scheme. The multimedia broadcast/multicast services are discussed.

Syllabus Topics

Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.

Examples/Applications/Case Studies

- Study of wireless channels
- Study of location-based services

Exercise/Project Problems

1. SC-FDMA
2. Services - multimedia broadcast/multicast

Tools Study

- *MATLAB*

Learning Outcomes

1. To understand the methods of providing connection-oriented services over NGN

References/e-Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)

Laboratory Exercises

Week 1-2:Wireless Networks fundamentals

- **Lab 1:** Wireless LAN (understanding the concept)
- **Lab 2:** Bluetooth (understanding the concept)

Week 3-4: Wireless Protocols

- **Lab 3:** IP Addressing (understanding the concept)
- **Lab 4:** TCP (understanding the concept)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Week 5-6: 3G

- **Lab 5:** W-CDMA (understanding the concept)
- **Lab 6:** HSDPA (understanding the concept)

Week 7-8: 4G

- **Lab 7:** Long Term Evolution (understanding the concept)
- **Lab 8:** EPC network architecture (understanding the concept)

Textbooks and References

Textbooks

1. Kaveh Pahlavan, (2008). *“Principles of wireless networks”*, Prentice-Hall of India.
2. Vijay K.Garg, (2013). *“Wireless Network Evolution- 2G & 3G”* Pearson.

References

1. Clint Smith,P.E, Dannel Collins, (2008). *“3G Wireless Networks”* , Tata McGraw-Hill.
2. Jochen H.Schiller, (2014). *“Mobile Communications”*, Pearson.

Online Resources

- Introduction to Wireless and Cellular Communications (Source:IIT Madras & NPTEL via Swayam)
- Advanced 3G and 4G Wireless Mobile Communications (Source:IIT Kanpur & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Multimedia Signal Processing	L	T	P	C
	3	0	0	3
DETECTION & ESTIMATION OF SIGNALS				

Course Description

The Purpose of the Course is to introduce the basic Detection and Estimation of Signals. The Course aims to provide the techniques implemented for analysis of Random Processes. The Target audience are Third-Year engineering students. The statistical Techniques will be discussed for Signal analysis in real time scenarios.. The Stake holders will develop Analytical Skills.

Teaching Objectives

1. The main objective of this course is to provide basic estimation and detection background
2. This course provides the main concepts and algorithms for detection and estimation
3. Students learn the statistics and estimating the parameters of Random Process from detection
4. To apply estimation methods for real time engineering problems.

Course Outcomes

1. Understand the basic Random Process and detection methods.
2. Know the significance of Probability of error
3. Learn about basic estimation methods and filters
4. Measure the statistical parameters for random processes

Unit 1: RANDOM PROCESSES

This unit focuses on introduction of Random Processes. The statistical parameters of Random Processes will be covered.

Syllabus Topics

Discrete Linear Models, Markov Sequences and Processes, Point Processes and Gaussian Processes.

Examples/Applications/Case Studies

- Types of Random Processes
- Conditions of Random Processes
- To study the importance of Gaussian Random Process

Exercise/Project Problems

1. Use MATLAB tool to study Random Processes
2. To Compute Moments in a Random Processes
3. To Study Signal Processing Tool box in MATLAB



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Tools Study

- *MATLAB tool for understanding Random Processes*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

2. Understand the basic of Random Process

References/e-Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)

Unit 2: DETECTION THEORY

This unit focuses on introduction of Classifier. The stakeholders Mathematical Skills will be improved.

Syllabus Topics

Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)- minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

Examples/Applications/Case Studies

- To study Probability of Error
- To study Bayes Decision Rule
- To study the types of classifier

Exercise/Project Problems

1. Use MATLAB tool to study Classifier
2. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Probability of Error & Classifier*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

3. Understand the basic of Detection Theory

References/e-Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)

Unit 3: LINEAR MINIMUM MEAN-SQUARE ERROR FILTERING

This unit focuses on introduction of Mean Squared Error Estimators. The stakeholders will be introduced with Real time Digital Filters .

Syllabus Topics



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

Examples/Applications/Case Studies

- To study Minimum Mean Squared Error
- To study Digital Filters
- To compare Wiener Filter and Kalman Filter

Exercise/Project Problems

1. Use MATLAB tool to study Digital Filter
2. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Digital Filter*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

1. Learn about basic estimation methods and filters

References/e-Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)

Unit 4: STATISTICS

This unit focuses on introduction of Non Parametric Estimators. The stakeholders will be introduced with Regression Models.

Syllabus Topics

Measurements, Non parametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

Examples/Applications/Case Studies

- To study Non Parametric Estimators
- To study Regression models

Exercise/Project Problems

1. Use MATLAB tool to study Non Parametric Estimators
2. To Study Signal Processing Tool box in MATLAB

Tools Study



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- *MATLAB tool for understanding Regression Models*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

1. Learn about Regression Models

References/e-Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)

Unit 5: ESTIMATING THE PARAMETERS OF RANDOM PROCESSES FROM DATA

This unit focuses on Parameters of Random Processes. The stakeholders Analytical Skills will be improved.

Syllabus Topics

Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Spectral Density Functions..

Examples/Applications/Case Studies

- To study conditions of Stationarity and Ergodicity
- To study relation between Auto Correlation Function and Power Spectrum Density

Exercise/Project Problems

1. Use MATLAB tool to compute Power Spectrum Density
2. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Random Process Parameters*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

1. Measure the statistical parameters for random processes

References/e-Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Random Processes

- **Lab 1:** To generate Gaussian Random Processes (understanding the concept)
- **Lab 2:** To generate Markov Sequence(understanding the concept)

Week 3-4: Detection Theory



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- **Lab 3:** To study Bayes Decision Rule (understanding the concept)
- **Lab 4:** To study Neyman-Pearson Classifier (understanding the concept)

Week 5-6: Filtering

- **Lab 5:** To Study Wiener Filter (understanding the concept)
- **Lab 6:** To Study Kalman Filter(understanding the concept)

Week 7-8: Statistics

- **Lab 7:** To Study Simple Linear Regression using MATLAB (understanding the concept)
- **Lab 8:** To Study Multiple Linear Regression using MATLAB (understanding the concept)

Week 9-10: Parameters of Random Processes

- **Lab 9:** To Study Stationarity and Ergodicity (understanding the concept)
- **Lab 10:** To Study Autocorrelation Functions, Power Spectral Density Functions (understanding the concept)

Textbooks and References

Textbooks

3. K. Sam Shanmugan & A.M.Breipohl (2011).*Random Signals: Detection, Estimation and Data Analysis*, Wiley India Pvt. Ltd.
4. Lonnie C. Ludeman, (2010).*Random Processes: Filtering, Estimation and Detection*, Wiley India Pvt. Ltd.

References

3. Steven. M. Kay,(1998).*Fundamentals of Statistical Signal Processing: Volume I Estimation Theory*, Prentice Hall.
4. Srinath, Rajasekaran, Viswanathan, (2003).*Introduction to Statistical Signal Processing with Applications* , PHI.
5. Louis L.Scharf, (1991),*Statistical Signal Processing: Detection, Estimation and Time Series Analysis* ,Addison Wesley.

Online Resources

- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)
- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Multimedia Signal Processing	L	T	P	C
	3	0	0	3
STATISTICAL SIGNAL PROCESSING				

Course Description

The Purpose of the Course is to introduce the basic of Statistical Signal Processing. The Course aims to provide the techniques implemented for Noise estimation & Adaptive Filtering. The Target audience are Third-Year engineering students. The Spectral analysis are discussed for real time scenarios.. The Stake holders will develop Analytical Skills.

Teaching Objectives

1. To familiarize with Random Signal Modeling
2. To provide students an understanding of the concepts related to application of statistical hypothesis testing to the detection of signals in noise
3. To familiarize students on the concepts of statistical parameter estimation methods to extract information from signals in noise.
4. To summarize the adaptive of filtering in signal detection and estimation process.
5. To explore the students with spectral analysis

Course Outcomes

1. Able to learn Random Signal Modeling
2. Able to use the statistical information in basic detection theory to solve the problems that involve detection of signals in the presence of noise
3. Able to Learn about filtering techniques for Noise Estimation
4. Able to understand Adaptive filtering
5. Able to understand Spectral Analysis

Unit 1: REVIEW OF RANDOM VARIABLES

This unit focuses on introduction of Random Variables. The statistical parameters of Random Processes will be covered. The Random Signal Modeling is discussed

Syllabus Topics

Distribution and density functions, moments, independent, Uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random 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. Random signal modelling: MA(q), AR(p), ARMA(p,q) models..

Examples/Applications/Case Studies



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- To Study Orthogonality
- To Study Random Processes
- To study the Random Signal Modeling

Exercise/Project Problems

3. Use MATLAB tool to study Random Processes
4. Use MATLAB to learn Random Signal Modeling Algorithms
5. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Random Signal Modeling*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

3. Able to learn Random Signal Modeling

References/e-Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)

Unit 2: PARAMETER ESTIMATION THEORY

This unit focuses on statistical information in basic detection theory to solve the problems that involve detection of signals in the presence of noise

Syllabus Topics

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Baysean estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

Examples/Applications/Case Studies

- To study MMSE
- To study Estimation techniques

Exercise/Project Problems

3. Use MATLAB tool to study Estimation techniques
4. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Estimation techniques*
- *Online Octave Compiler for MATLAB*

Learning Outcomes



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

1. Able to use the statistical information in basic detection theory to solve the problems that involve detection of signals in the presence of noise

References/e-Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)

Unit 3: FILTERING TECHNIQUES FOR NOISE ESTIMATION

This unit focuses on introduction of filtering techniques for noise estimation. The stakeholders will be introduced with IIR & FIR Filters .

Syllabus Topics

Estimation of signal in presence of white Gaussian Noise, 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.

Examples/Applications/Case Studies

- To study LMMSE Filtering
- To study FIR & IIR filter techniques
- To study prediction error Filter

Exercise/Project Problems

3. Use MATLAB tool to study IIR & FIR Filter techniques
4. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding IIR & FIR Filter techniques*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

2. Learn about filtering techniques for Noise estimation

References/e-Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)

Unit 4: ADAPTIVE FILTERING & KALMAN FILTERING

This unit focuses on introduction of Adaptive Filters. The stakeholders will be introduced with advantages of Kalman Filtering.



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Syllabus Topics

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, derivation, Matrix inversion Lemma, Initialization, tracking of non stationarity.

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Examples/Applications/Case Studies

- To study LMS Algorithm
- To study Kalman Filtering

Exercise/Project Problems

3. Use MATLAB tool to study Adaptive Filters
4. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Adaptive Filters*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

- **Able to understand Adaptive filtering.**

References/e-Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)

Unit 5: SPECTRAL ANALYSIS

This unit focuses on Spectral Analysis. The stakeholders will understand the concept of Parametric Estimation methods .

Syllabus Topics

Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p), Spectral estimation and detection of Harmonic signals, MUSIC algorithm

Examples/Applications/Case Studies

- To study about Periodogram
- To study Parametric Estimation Methods

Exercise/Project Problems

3. Use MATLAB tool to compute Periodogram



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

4. To Study Signal Processing Tool box in MATLAB

Tools Study

- *MATLAB tool for understanding Parametric Estimation Methods*
- *Online Octave Compiler for MATLAB*

Learning Outcomes

1. Able to understand Spectral Analysis

References/e-Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Random Signal Modeling

- **Lab 1:** To study MA model(understanding the concept)
- **Lab 2:** To study ARMA model(understanding the concept)

Week 3-4: Parameter Estimation

- **Lab 3:** To study Bayes Estimation (understanding the concept)
- **Lab 4:** To study Cramer Rao bound (understanding the concept)

Week 5-6: Filtering

- **Lab 5:** To Study FIR Wiener filter (understanding the concept)
- **Lab 6:** To Study IIR Wiener filter (understanding the concept)

Week 7-8: Adaptive Filtering

- **Lab 7:** To Study Kalman filtering using MATLAB (understanding the concept)
- **Lab 8:** To Study RLS algorithm using MATLAB (understanding the concept)

Textbooks and References

Textbooks

5. Charles W. Therrien, (1992). *Discrete Random Signals and Statistical Signal Processing*, Prentice Hall Signal Processing Series
6. K. Sam Shanmugan & A.M.Breipohl (2011).*Random Signals: Detection, Estimation and Data Analysis*, Wiley India Pvt. Ltd.
7. Lonnie C. Ludeman, (2010).*Random Processes: Filtering, Estimation and Detection*, Wiley India Pvt. Ltd.

References

6. D.G. Manolakis, V.K. Ingle and S.M. Kogon,(2000). *Statistical and Adaptive Signal Processing*, McGraw Hill .
7. Srinath, Rajasekaran, Viswanathan, (2003).*Introduction to Statistical Signal Processing with Applications* , PHI.



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

8. Louis L.Scharf, (1991), *Statistical Signal Processing: Detection, Estimation and Time Series Analysis*, Addison Wesley.

Online Resources

- Stastical Signal Processing (Source:IIT Guwahati & NPTEL via Swayam)
- Signal Detection and Estimation Theory(Source:IIT Guwahati & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

	L	T	P	C
Multimedia Signal Processing	3	0	0	3
COMPUTER VISION				

Course Description

The Purpose of the Course is to introduce the Computer Vision. The Course aims to provide the techniques implemented for Object Recognition. The Target audience are Third-Year engineering students. The Techniques will deal with Pattern Recognition. This will help us to understand the Real time Tracking of Objects for Civil and Commercial applications. The Stake holders will develop Analytical Skills.

Teaching Objectives

1. To introduce students the fundamentals of image formation
2. To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition
3. To develop an appreciation for various issues in the design of computer vision and object recognition systems
4. To provide the student with programming experience from implementing computer vision and object recognition applications

Course Outcomes

1. Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
2. Describe known principles of feature detection and matching
3. Describe basic methods of computer vision related to image stitching, photography like high dynamic range imaging and blur removal.
4. Suggest a design of a computer vision system for a 3D Reconstruction, Albedos, image based rendering views and depths

Unit 1: INTRODUCTION

This unit focus on introduction of basic Operators in Image Processing. The Data transformation techniques are introduced

Syllabus Topics

Image Formation: Geometric Primitives and Transformation, Photometric Image Formation, Digital Camera, Image Processing: Point Operators, Linear Filtering, More Neighborhood Operators, Fourier Transforms, Pyramids and Wavelets, Geometric Transformations, Global Optimization.



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Examples/Applications/Case Studies

- Study of Digital Camera
- Importance of Transformation for Data Storage and optimization
- Study of Wavelets for Data Compression

Exercise/Project Problems

6. Use MATLAB toolbox to understand Fourier Transform
7. Study of Wavelets using Image Processing Toolbox in MATLAB

Tools Study

- *MATLAB tool for understanding Image Processing Techniques*

Learning Outcomes

4. Identify basic concepts, terminology, theories, models and methods in the field of computer vision
5. To understand the concepts of Data Transformation

References/e-Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)

Unit 2: FEATURE DETECTION AND MATCHING

This unit focus on Feature extraction. The real time Feature based Alignment methods are covered. This unit will focus on Feature Estimation and Calibration.

Syllabus Topics

Points and Patches, Edges, Lines, Segmentation: Active Contours, Split and Merge, Mean Shift and Mode Finding, Normalized Cuts, Feature-Based Alignment: 2D and 3D Feature-based Alignment, Pose Estimation, Geometric Intrinsic Calibration.

Examples/Applications/Case Studies

- Study of Segmentation Techniques
- Study of Feature Alignment and Estimation

Exercise/Project Problems

1. Using MATLAB tool to understand Segmentation
2. Study of Feature estimation using Image Processing Toolbox in MATLAB

Tools Study

- *MATLAB tool for understanding Feature estimation Techniques*

Learning Outcomes



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

4. Analyze the principles of feature detection and matching
5. To understand Segmentation Techniques

References/e-Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)

Unit 3: STRUCTURE AND MOTION

This unit focus on Motion Estimation. The real time Structure Modeling will be covered. This unit will focus on improvement of Analytical Skills of Stake holders

Syllabus Topics

Triangular, Two-frame Structure from Motion, Factorization, Bundle Adjustment, Constrained Structure and Motion, Dense Motion Estimation: Translation Alignment, Parametric Motion, Spline-based Motion, Optical Flow, Layered motion.

Examples/Applications/Case Studies

- Study of Motion estimation Techniques
- Study of Factorization

Exercise/Project Problems

1. Using MATLAB tool to understand Structure from Motion
2. Study of Structure analysis using Image Processing Toolbox in MATLAB

Tools Study

- *MATLAB tool for understanding Motion estimation Techniques*

Learning Outcomes

1. Analyze the principles of Motion Estimation
2. To understand algorithms for Structure analysis

References/e-Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)

Unit 4: IMAGE STITCHING



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

This unit focus on Dynamic Range Imaging. The Super-Resolution topics will be covered. This unit will focus on improvement of Analytical Skills of Stake holders.

Syllabus Topics

Motion Models, Global Alignment, Composing, Computational Photography: Photometric Calibration, High Dynamic Range Imaging, Super-Resolution and Blur Removal, Image Matting and Compositing, Texture Analysis and Synthesis.

Examples/Applications/Case Studies

- Study of Motion Models
- Study of High Dynamic Range Imaging
- Study of Texture Synthesis

Exercise/Project Problems

1. Using MATLAB tool to understand Super Resolution
2. Study of Texture analysis using Image Processing Toolbox in MATLAB

Tools Study

- *MATLAB tool for understanding Image Stitching Techniques*

Learning Outcomes

1. Able to understand the methods of computer vision related to image stitching
2. Able to understand the methods photography like high dynamic range imaging and blur removal

References/e-Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)

Unit 5: 3D RECONSTRUCTION

This unit focus on Algorithms for 3D Reconstruction. This unit will discuss about Image based Rendering.

Syllabus Topics

Shape From X, Active Range Finding, Surface Representation, Point- based Representation, Volumetric Representation, Model-based Reconstruction, Recovering Texture Maps and Albedos, Image- based Rendering: View Interpolation, Layered Depth Images, Light Fields and Lumigraphs, Environment Mattes, Video-based Rendering



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Examples/Applications/Case Studies

- Study of Texture Maps
- Study of Lumigraphs
- Study of Model based Reconsruction

Exercise/Project Problems

1. Using MATLAB tool to understand Image based Rendering
2. Study of 3D Reconstruction using Image Processing Toolbox in MATLAB

Tools Study

- *MATLAB tool for understanding 3D Reconstruction Techniques*

Learning Outcomes

1. Able to understand the design of a computer vision system for a 3D Reconstruction, Albedos, image based rendering views and depths

References/e-Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Transformation Techniques

- **Lab 1:** To Study basic operations on Images(understanding the concept)
- **Lab 2:** To Apply Fourier Transform on Image Storage and Reconstruction (understanding the concept)

Week 3-4: Wavelets

- **Lab 3:** To Study Haar Wavelet on Image Storage(understanding the concept)
- **Lab 4:** To Study Low Frequency Components of Wavelet on Image Storage (understanding the concept)

Week 5-6: Motion Estimation

- **Lab 5:** To Study about Dense Motion Estimation (understanding the concept)
- **Lab 6:** To Study about High Dynamic Range Imaging (understanding the concept)

Week 7-8: 3D Reconstruction

- **Lab 7:** To Study about Volumetric Representation (understanding the concept)
- **Lab 8:** To Study about Model-based Reconstruction (understanding the concept)

Textbooks and References

Textbooks



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

8. Richard Szeliski, (2011). *Computer Vision: Algorithms and Applications*. Springer-Verlag London Limited.
9. Simon J.D Prince, (2012). *Computer Vision: Models, Learning and Inference*,. Cambridge University Press

References

9. D. Forsyth and J. Ponce, (2012). *Computer Vision - A modern approach*, Pearson
10. Haralick & Shapiro, (1992). *Computer and Robot Vision*, Addison-Wesley.

Online Resources

- Computer Vision(Source:IIT Kharagpur & NPTEL via Swayam)
- Computer Vision and Image Processing - Fundamentals and Applications (Source:IIT Guwahati & NPTEL via Swayam)
- Modern Computer Vision (Source:IIT Madras & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Multimedia Signal Processing	L	T	P	C
	3	0	0	3
AUDIO SIGNAL PROCESSING				

Course Description

The Purpose of the Course is to introduce the basics of Audio Signal Processing. The Course aims to provide the techniques implemented for Speech analysis and Synthesis. The Target audiences are Third-Year engineering students. The Signal enhancement techniques will be discussed. This will help us to understand the Audio Processing Applications. The Stake holders will develop Analytical Skills.

Teaching Objectives

1. To Study Speech Processing Models
2. To understand Signal Enhancement
3. To study Speech Analysis and Synthesis Systems
4. To study the Algorithms for Audio processing Applications

Course Outcomes

1. Understand different characteristics of Audio signals.
2. Understand Signal Acquisition and Enhancement Mechanisms
3. Analyze different speech analysis and synthesis systems.
4. Understand Acoustics for Audio Processing
5. Design models and algorithms for audio and speech processing applications

Unit 1: INTRODUCTION

This unit focus on introduction of basic of Speech Production Models . The Vocal cord models will be covered.

Syllabus Topics

Audio Signal Characteristics, Production model, Hearing and Auditory model, Acoustic characteristic of speech, Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model

Examples/Applications/Case Studies

- Audio Signal characteristics
- Speech production models
- Equivalent Circuits for Speech Production

Exercise/Project Problems

8. Use MATLAB tool to understanding speech processing
9. Study of Speech Processing Models

Tools Study



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- *MATLAB tool for understanding Speech Processing Techniques*

Learning Outcomes

6. Understand different characteristics of Audio signals
7. Study of Vocal Tract Model

References/e-Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)

Unit 2: SIGNAL ENHANCEMENT

This unit focus on introduction of basic of Speech Enhancement. The Enhancement models will be covered.

Syllabus Topics

Audio signal acquisition, Representation and Modeling, Enhancement of audio signals: Spectral Subtraction, Wiener based filtering, Neural nets

Examples/Applications/Case Studies

- Audio Signal acquisition
- Audio Signal enhancement

Exercise/Project Problems

1. Use MATLAB tool to understanding Enhancement techniques
2. Audio Signal Filtering

Tools Study

- *MATLAB tool for understanding Speech Enhancement Techniques*

Learning Outcomes

1. Understand Signal Acquisition and Enhancement Mechanisms
2. Study of Filtering Techniques

References/e-Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)

Unit 3: AUDIO / SPEECH ANALYSIS AND SYNTHESIS SYSTEMS

This unit focus on introduction of basic of Speech Analysis. The Speech Analysis models will be discussed.

Syllabus Topics

Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction., Linear Predictive Coding Analysis.

Examples/Applications/Case Studies



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA - VIZIANAGARAM

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

- Spectral Analysis
- Short Time Fourier transform
- Sound Spectrogram

Exercise/Project Problems

1. Use MATLAB tool to understanding Spectral Analysis
2. Linear Predictive Coding Analysis

Tools Study

- *MATLAB tool for understanding Speech Analysis and Synthesis Techniques*

Learning Outcomes

1. Analyze different speech analysis and synthesis systems

References/e-Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)

Unit 4: ACOUSTICS

This unit focus on impact of basic of Acoustic Models . The Audio processing models will be covered.

Syllabus Topics

Psychoacoustics, Multi-microphone audio processing: Room acoustics, Array beam forming.
Acoustic sound source localization and tracking

Examples/Applications/Case Studies

- Room acoustics
- Acoustic sound source localization

Exercise/Project Problems

1. Use MATLAB tool to understanding Acoustic Models
2. Study of source localization and tracking

Tools Study

- *MATLAB tool for understanding Acoustic Models*

Learning Outcomes

1. Understand Acoustics for Audio Processing

References/e-Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Unit 5: APPLICATIONS

This unit focus on Applications of Audio Signal Processing . The importance of HMM will be covered.

Syllabus Topics

Principles of Automatic Speech Recognition (ASR), Theory and implementation of Hidden Markov Model (HMM) for ASR, Speaker Recognition, Evolution of Speech APIs, Natural Language Processing, Sound source separation models

Examples/Applications/Case Studies

- Hidden Markov Model
- Speaker Recognition
- Sound source separation models

Exercise/Project Problems

1. Use MATLAB tool to understanding Hidden Markov Model
2. Study of Speech Processing Applications

Tools Study

- *MATLAB tool for understanding Speech Processing Applications*

Learning Outcomes

1. Design models and algorithms for audio and speech processing applications

References/e-Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)

Laboratory Exercises

Week 1-2: Speech production models

- **Lab 1:** To study Hearing and Auditory model (understanding the concept)
- **Lab 2:** To study Vocal Cord Model (understanding the concept)

Week 3-4: Enhancement of audio signals

- **Lab 3:** To study Spectral Subtraction (understanding the concept)
- **Lab 4:** To study Weiner based filtering (understanding the concept)

Week 5-6: Audio/ Speech Analysis and Synthesis

- **Lab 5:** To Study Spectral structure of speech (understanding the concept)
- **Lab 6:** To Study Pitch Extraction (understanding the concept)

Week 7-8: Applications

- **Lab 7:** To Study HMM for Automatic Speech Recognition (understanding the concept)
- **Lab 8:** To Study Sound source separation models (understanding the concept)

Textbooks and References



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - GURAJADA -
VIZIANAGARAM**

VIZIANAGARAM – 535 003 Andhra Pradesh (India)

B. Tech ECE (R23-COURSE STRUCTURE & SYLLABUS)

Textbooks

10. Sen, Soumya, Dutta, Anjan Dey, Nilanjan,(2019) *Audio Processing and Speech Recognition*, Springer
11. Gold. B, Morgan.N, Ellis.D. ,(2011) *Speech and audio signal processing: processing and perception of speech and music*. Wiley.

References

11. Sadaoki Furui ,(2001). *Digital Speech Processing, Synthesis and Recognition*, CRC Press
12. Rabiner and Schafer, (1978). *Digital Processing of Speech Signals*, Pearson.

Online Resources

- Digital Speech Engineering(Source:IIT Kharagpur & NPTEL via Swayam)
- Real-Time Digital Signal Processing (Source:IISc Bangalore & NPTEL via Swayam)