



**Bansilal Ramnath Agarwal Charitable Trust's**

# **Vishwakarma Institute of Technology**

*(An Autonomous Institute affiliated to Savitribai Phule Pune University)*

## **Structure & Syllabus of T.Y and Final Year B. Tech. (Electronics Engineering)**

**Pattern C\_19**

**Academic Year 2019-20**

**Prepared by: - Board of Studies in Electronics Engineering**

**Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune**

**Signed by**

**Chairman – Board Of Studies**

**Chairman – Academic Board**



Bansilal Ramnath Agarwal Charitable Trust's  
**VISHWAKARMA INSTITUTE OF TECHNOLOGY – PUNE**  
(An autonomous Institute affiliated to University of Pune)  
666, Upper Indiranagar, Bibwewadi, Pune – 411 037.

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Title: Course Structure						FF No. 653							
Branch: Electronics Engineering		TY B.Tech			Academic Year: 2019-20		Semester		Module:V		Pattern: C-19		
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme					Credits		
			Theory	Lab	Tut	CA			MSE	ESA		Total	
						HA	LAB	GD/PPT					
<b>Elective-1</b>													
1	EL3001	Microcontroller Applications	3	2		10	30	10	15	15	20	100	4
2	EL3025	Sensors & Actuators											
3	EL3003	Data Compression											
<b>Elective-2</b>													
4	EL3004	Power Electronics	3	2		10	30	10	15	15	20	100	4
5	EL3026	Computer Architecture and Operating Systems											
6	EL3006	Computer Vision											
<b>Elective-3</b>													
7	EL3007	Digital Integrated Circuit Design	3	2		10	30	10	15	15	20	100	4
8	EL3009	RF Circuit Design											
9	EL3027	OOPS											
<b>Elective-4</b>													
10	EL3010	Wireless Technologies	3	2		10	30	10	15	15	20	100	4
11	EL3011	Artificial Intelligence											
12	EL3008	Data Base Management System											
5	EL3177	Engineering Design & Innovation-1	1	2	2								4
6	EL3075	Seminar											1
<b>Total</b>													21

Vishwakarma Institute of Technology						Issue 1: Rev No. 1: Dt. 01/07/18							
Title: Course Structure						FF No. 653							
Branch: Electronics Engineering		TY B.Tech		Academic Year: 2019-20			Semester		Module: VI			Pattern: C-19	
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits	
			Theory	Lab	Tut	CA			MSE	ESA			Total
						HA	LAB	GD/PPT		ESE	VIVA		
		<b>Elective-1</b>											
1	EL3012	Electronics Product Design	3	2		10	30	10	15	15	20	100	4
2	EL3014	Data Communication & Networking											
3	EL3002	Robotics											
		<b>Elective-2</b>											
4	EL3016	Digital System Design	3	2		10	30	10	15	15	20	100	4
5	EL3017	Embedded System Design											
6	EL3018	Digital Signal Processing											
		<b>Elective-3</b>											
7	EL3019	Machine Learning	3	2		10	30	10	15	15	20	100	4
8	EL3020	AdHoc Networks											
9	EL3021	Microwave Engineering											
		<b>Elective-4</b>											
10	EL3022	Internet of Things	3	2		10	30	10	15	15	20	100	4
11	EL3023	Industrial Automation											
12	EL3024	VLSI Technologies											
13	EL3178	Engineering Design & Innovation-2	1	2	2								4
14	EL3080	General Proficiency-3											1
<b>Total</b>													21

Vishwakarma Institute of Technology						Issue 1: Rev No. 1: Dt. 01/07/18								
Title: Course Structure				FF No. 653										
Branch: Electronics Engineering		Final Year B. Tech		Academic Year: 2020-21			Semester			Module: VII		Pattern: C-19		
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits		
			Theory	Lab	Tut	HA	CA		MSE	ESA			Total	
							LAB	GD/PPT				ESE		VIVA
<b>Elective-1</b>														
1	EL4003	Engineering Ethics	3			10	30	10	15	15	20	100	3	
2	EL4004	Renewable Energy												
<b>Elective-2</b>														
3	EL4006	CMOS Mixed Signal Design	3	2		10	30	10	15	15	20	100	4	
4	EL4013	Advanced Power Electronics												
<b>Elective-3</b>														
5	EL4014	Artificial Neural Networks	3	2		10	30	10	15	15	20	100	4	
6	EL4015	Antenna Theory												
7	EL4016	Advanced Digital Signal Processing												
8	EL4018	RF Integrated Circuit Design												
9	EL4019	Real Time Operating Systems												
10	EL4071	Major Project 1		8									4	
11	EL4078	Professional Development 3 (Audit Course)												
<b>Total</b>													15	

Vishwakarma Institute of Technology						Issue 1: Rev No. 1: Dt. 01/07/18					
Title: Course Structure									FF No. 653		
Branch: Electronics Engineering		Final Year B. Tech		Academic Year: 2020-21		Semester		Module:VIII		Pattern: C-19	
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme					Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		
						HA	LAB			ESE	VIVA
<b>Elective-1</b>											
1	EL4080	Research Internship									15
	EL4081	Project Internship									
	EL4082	Industry Internship									
	EL4083	International Internship									
EL4282	Industry Internship										
<b>Total</b>											15

Vishwakarma Institute of Technology						Issue 1: Rev No. 1: Dt. 01/07/18																
Title: Course Structure								FF No. 653														
Branch: Electronics Engineering		Final Year B. Tech		Academic Year: 2020-21		Semester		Module: VIII		Pattern: C-19												
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme					Credits											
			Theory	Lab	Tut	HA	CA		MSE	ESA		Total										
						LAB	GD/PPT	ESE		VIVA												
<b>Elective-1</b>																						
1	EL4003	Engineering Ethics	3			10	30	10	15	15	20	100	3									
2	EL4004	Renewable Energy																				
<b>Elective-2</b>																						
3	EL4006	CMOS Mixed Signal Design	3	2		10	30	10	15	15	20	100	4									
4	EL4013	Advanced Power Electronics																				
<b>Elective-3</b>																						
5	EL4014	Artificial Neural Networks	3	2		10	30	10	15	15	20	100	4									
6	EL4015	Antenna Theory																				
7	EL4016	Advanced Digital Signal Processing																				
8	EL4018	RF Integrated Circuit Design																				
9	EL4019	Real Time Operating Systems																				
10	EL4072	Major Project 2		8									4									
<b>Total</b>													15									





**Course Code: EL3001**

**Course Name-Microcontroller Applications**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

AVR Atmega32 Architecture, Instruction Set, Assembly Language Programming, Embedded C Programming, Simple I/O Interfacings

**Section 2:**

AVR Atmega-32 On-chip Peripherals, Communication Protocols, Interfacing Sensors & Actuators

**List of Practicals:**

1. Write an ALP code to flash LEDs connected to PORT
2. Write an ALP to display 0 to 9 numbers on 7-Segment Display using Timer
3. Write a C program to display message on 16 X 2 LCD
4. Write a C program to interface 4 X 4 matrix keypad
5. Write a C program to use on chip ADC
6. Write a C program to read/write on chip EEPROM.
7. Write a C program to control DC motor using PWM
8. Write a C program for serial communication using on chip UART
9. Write a C program to implement I2C protocol for RTC
10. Write a C program to read switch and control AC Lamp load using relay.

**List of Project areas:**

1. Industrial Automation
2. Home automation
3. Robotics
4. Medical Electronics
5. Communication
6. Automotive Electronics

Examples: - Design of Electronic Lock, Design of Temperature Controller

**Text Books:-**

1. *Mohammad Ali Mazidi, Sarmad Naimi & Sepehr Naimi; The AVR Microcontroller and Embedded Systems using Assembly and C; 1st Edition; Pearson Education India.*
2. *Dhananjay Gadre; Programming and Customizing the AVR Microcontroller; 1st Edition; McGraw Hill.*

**Reference Books:**

*1. Atmel 8-Bit AVR Microcontroller & ATmega32A Datasheet complete*

**Course Outcomes:**

The student will be able to –

1. Explain AVR Microcontroller Architecture.
2. Develop an Assembly Language Program & Embedded C Program for AVR Microcontroller.
3. Make use of internal peripherals of AVR Microcontroller.
4. Develop an interface for Sensors and Actuators

**Course Code : EL3025**

**Course Name: Sensors and Actuators**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Sensor static and dynamic characteristics, Sensor selection criteria, Sensor operating principle: Temperature, linear and rotary displacement, optical, pressure and strain gauge. Smart sensors. Classification of actuators, Relays and solenoids, Relay circuits, Pneumatic and Hydraulic linear and rotary actuators, Control circuits for actuators.

**Section2:**

Analog signal processing circuits: Preamplifier, gain amplifier, Power amplifier. LNA, Op amp based signal conditioning circuits. Digital signal processing circuits: ADC and DAC, Types, selection criteria, designing with analog and digital signal processing circuits.

**List of Practical:**

1. Rotary and linear encoder for displacement measurement.
2. Comparative study of temperature sensors.
3. Strain gauge with Wheatstone's' Bridge configurations.
4. Design and development of signal conditioning circuits.
5. Design and development of R-2R ladder 4 bit DAC.
6. Evaluation of ADC performance parameters.
7. Implementation of relay circuits.
8. Design and testing of fluid power circuits.
9. Co-ordinated motion of multiple actuators.
10. Simulation of P and H circuits.

**List of Projects:**

1. Automatic door opening closing system.
2. Designing of Automatic Weighing scale.
3. Designing Pneumatic circuit for sorting of jobs running on conveyor belt.
4. Data Acquisition System.

**Text Books:**

1. Ramon Pallas-Areny, John G. Webster; *Sensors and Signal Conditioning; Second Edition;* Wiley India.
2. Anthony Esposito; *Fluid Power with Applications.*
3. Walt Jung; *Op Amp Application Handbook;* Newnes.

**Reference Books:**

1. *Analog Devices; Practical Design Techniques for Sensor Signal Conditioning.*
2. *FESTO Didactic; Basic Principles of Pneumatics and Electro pneumatics.*
3. *C. D. Johnson; Process Control Instrumentation Technology; Eighth Edition; Pearson.*

**Course Outcomes:**

The student will be able to –

1. Understand sensors in terms of behavior or response to external physical variables.
2. Design application based on electro-pneumatic/electro-hydraulic circuits.
3. Experiment with analog signal conditioning circuits.
4. Demonstrate to interface between analog and digital domain.

**Course Code: EL3003**

**Course Name: Data Compression**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1: Lossless Compression Techniques**

Introduction to Information Theory, Entropy, Uniquely Decodable Codes, Prefix Codes, Shannon Fano Coding, Huffman Coding, Extended Huffman Codes, Adaptive Huffman Codes, Golomb and Rice Codes, Linear block codes, Arithmetic Coding, Dictionary Techniques: Static and Adaptive Dictionary; Lempel Ziv Approaches: LZ77, LZ78, LZW; File Formats

**Section 2: Lossy Compression Techniques**

Uniform Quantizer, Adaptive Quantizer; Forward and Backward, Jayant Quantizer, Non-Uniform Quantizer, Vector Quantization, Linde-Buzo-Grey LBG Algorithm, Necessity of Transforms, Discrete Cosine, Hadamard Transform, Haar Transform, Wavelet Transform, Quantization and Coding of Transform Coefficients, Baseline JPEG Image Compression

**List of Practicals:**

1. Implement Unique Decodability Test
2. Implement Huffman Coding
3. Implement Arithmetic encoding and Decoding
4. Implement Golomb encoding Table
5. Implement LZ77 Dictionary Technique
6. Implement Discrete Cosine Transform(DCT)
7. Implement Walsh and Hadamard Transform
8. Implement Uniform Quantization
9. Implement vector quantization
10. Multiresolution analysis using Wavelet Transform

**List of Project areas:**

1. A photograph of large size required huge amount of memory to store and transmit. Hence compress the image using JPEG standard. Calculate compression ratio and MSQE. Also observe quantization effects on quality of decompressed image.
2. A text or bio-medical data needs to be stored and transmitted. To reduce the storage requirement, compress data using lossless methods like Huffman coding, Golomb, runlength, dictionary techniques. Compare results in terms of compression ratio, execution time, time complexity, suitability for the chosen data.
3. A photograph of crowd or natural scene requires huge amount of memory. Apply Transform based Lossy compression techniques for 1D or 2D images. Compare performance of Lossless and Lossy compression techniques.
4. Project based on Lossless Compression Methods

5. Project based on Lossy Compression Methods
6. Project based on Quantization effects on Signal/Image

**Text Books:**

1. *Khalid Sayood; Introduction to Data Compression; 3rd Edition; Elsevier publication*
2. *Graham Wade; Coding Techniques – Introduction to compression and Error control; Palgrave Publications*
3. *Simon Hyakins; Communication systems; 4th Edition; Wiley Publications*

**Reference Books:**

1. *Ranjan Bose; Information Theory and cryptography; Tata McGraw Hill, 2002/2006*
2. *Saloman; Data compression – Complete reference; Springer Verlag; 3rd Edition*
3. *Levis W.J; Data compression; Springer; 2nd Edition*
4. *Nelson Mark, Gaily. Jean, Loup; Data Compression book; 2nd Edition; BPB Publication*

**Course Outcomes:**

The student will be able to –

1. Explain encoding and decoding of lossless compression methods.
2. Calculate effect and efficiency of compression algorithms.
3. Explain encoding and decoding of lossy compression methods
4. Implement suitable Compression algorithms on Text/ Signal /Image.

**Course Code : EL3004**

**Course Name: Power Electronics**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Power Devices- power diode, SCR, GTO, power BJT and MOSFET, IGBT- Structure, Characteristics, Selection criterion, Driver Circuits, Comparison.

Single phase-controlled converters (line commutated), Performance analysis for resistive and inductive load, Evaluation of average and rms load voltage, supply current harmonics, power factor, current distortion factor, device ratings

Single phase inverters-bridge and push-pull type, Performance analysis for resistive and inductive load, harmonic analysis of voltage for square-wave and PWM inverters.

**Section 2:**

Step down/ up DC-DC converters (Choppers), Analysis for resistive and inductive load, Load voltage calculations, Single, two and four quadrant operational analysis.

AC to AC controllers, Half and full cycle control, Analysis for resistive and inductive load, Load voltage estimation, Gating signal requirement for inductive load.

Fly back and Forward SMPS, Concept of resonant converter, ZVS and ZCS switches, On – line and Off-line UPS, Battery selection, HVDC transmission, Industrial applications of different converters.

**List of Practicals:**

1. Study of Triggering/ Driver Circuit for SCR
2. Study of Triggering/ Driver Circuit for MOSFET
3. Study of Single Phase Controlled Converter (Half controlled) with Load
4. Study of Single Phase Controlled Converter (Fully Controlled) with Load
5. Study of DC-DC Converter (Step down with MOSFET/ IGBT) with Load
6. Study of DC-DC Converter (Step up with MOSFET/ IGBT) with Load
7. Study of DC-AC Converter (Single Phase Bridge) with Load
8. Study of Single Phase AC-AC Controller with Load
9. Simulation of Single Phase Converter (AC-DC/ DC-DC) with R, RL Load
10. Simulation of Single Phase Converter (AC-AC/ DC-AC) with R, RL Load

**List of Projects:**

1. Develop a switching/triggering circuit for a power device (SCR / power BJT / power MOSFET / IGBT)
2. PWM generation for device switching  
Develop a single-phase power converter for utility application as listed below (Any one).  
Source available is AC Mains/ DC battery.
3. Battery charger



4. Fan regulator
5. Intensity control of lighting
6. Inverter
7. SMPS
8. Power control by Integral Cycle Switching
9. Verify, through simulation, the performance of AC-DC/ DC-DC power conversion systems for suitable load. Comment on the results.
10. Verify, through simulation, the performance of DC-AC/ AC-AC power conversion systems for suitable load. Comment on the results.

**Text Books:**

1. *M D Singh, K B Khanchandani; Power Electronics; 2 nd Edition; TMH.*
2. *M. H. Rashid; Power Electronics Circuits, Devices and Applications; 3 rd Edition; PHI.*

**Reference Books:**

1. *N. Mohan, T. M. Undeland and W.P. Robbins; Power Electronics: Converters, Applications, and Design; 3rd edition; John Willey and Sons, Singapore.*
2. *P. C. Sen; Modern Power Electronics; S. Chand and Co, New Delhi.*

**Course Outcomes:**

The student will be able to –

1. Describe the operation, characteristics and applications of power devices like power diode, SCR, power BJT, power MOSFET, and IGBT.
2. Analyze controlled converter and inverter circuits in terms of performance parameters.
3. Analyze dc-dc converter and ac controller circuits in terms of performance parameters.
4. Illustrate the role of Power Electronics in utility-related applications.

**Course Code: EL3026      Course Name: Computer Architecture & Operating System**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Functional Units of a Computer: ALU, Control Unit, Memory, IO Units; Software Hardware Interaction/Interface; Basic Structure of a CPU: Overview of X 86 Family, Multicore, Mics and GPGPU; CPU Bus Architecture; Advancement in Computer Architectures

ALU: Block Diagram, Data Representation: Computer Arithmetic with Signed/Unsigned Numbers, Multiplication with Signed Numbers: Booths Algorithm, Control Unit, I/O Module Functions and I/O Block Diagram, Accessing I/O Devices, Direct Memory Access

**Section 2:**

Memory System: Characteristics, CPU Memory Interaction, Hierarchical Memory System, Types and Characteristics of Memories: Cache Memories, Memory Management Techniques: Virtual Memory, Paging, Segmentation, Associative Memories.

OS: Architecture, Goals and Structures of OS., Hardware Abstraction Layer, Types of OS: Process Management, Resource Management, Deadlock, Uniprocessor Scheduling; Types of Scheduling: Scheduling Algorithms

**List of Practical:**

1. Designing of 4-bit adder with look ahead carry generator
2. Designing and implementing Booths multiplier
3. Designing of Combinational Multiplier
4. Designing of ALU
5. Designing of Memory Unit
6. Designing of Directly Mapped Cache.
7. Design of Control Unit
8. Simulation of CPU Scheduling Algorithm
9. Implementation of Semaphore

**List of Projects:**

1. Design an instruction set for a limited functionality machine having all instructions of 8-bits fixed length only, including opcode and operands.
2. Simulate a word multiplier.
3. Simulate a word divider
4. Design a minimal CPU architecture for controlling the washing machine.
5. Design a 2 bit CPU which can execute minimum five instructions

**Text Books:**

1. *Carl Hamacher and Zaky; Computer Organization; 5th Edition; Mcgraw Hill publication.*
2. *William Stallings; Computer organization and architecture; 9th Edition; Pearson Publication.*
3. *William Stalling; Operating Systems; 5th Edition; Pearson Education.*

**Reference Books:**

1. *A. Tanenbaum; Structured Computer Organization; 4th Edition; Prentice Hall of India.*
2. *Abraham Silberschatz, Peter Baer Galvin; Operating system concepts; John Wiley and Sons, 6th Edition.*

**Course Outcomes:**

The student will be able to –

- Elaborate basic concepts of computer architecture.
- Describe functional units of the CPU including the ALU and control unit.
- Explain the organization of memory and memory management techniques.
- Understand the role of the operating system in interfacing with the computer hardware

**Course Code: EL3006**

**Course Name: Computer Vision**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours/ Week**

**Section 1:**

Human Vision System; Computer Vision System; Camera Geometry Fundamentals, Probability Distribution Models. Geometric Primitives and Transformations; Photometric Image Formation; Digital Camera; Point Operators; Neighborhood Operators; Pyramids and Wavelets. Feature Detection and matching; Hough Transform; Edge Linking.

**Section 2:**

Object Recognition, Segmentation and Classification, Global Methods; Active Contours; Normalized Cuts; Support Vector Machine; Histogram of Oriented Gradients; Adaboost Classifiers. Triangulation; Two-Frame Structure from Motion; Factorization; Bundle Adjustment; Translational Alignment; Motion estimation techniques; Tracking, Stereo Vision. Real-world Computer Vision Systems applications.

**List of Practicals:**

1. Develop an algorithm for pre-processing of an input image for geometric transformation of image.
2. Develop an algorithm for pre-processing of an input image for enhancement of image.
3. Develop an algorithm for feature extraction of an input image using point detector
4. Develop an algorithm for segmentation of an input image
5. Develop an algorithm for recognition of an object from input image
6. Develop an algorithm for motion estimation from given video sequence.
7. Design an algorithm for SVM classifier
8. Design an algorithm for adaboost classifier
9. Line detection using Hough transform
10. To design and develop optical flow algorithm for motion estimation

**List of Project areas:**

Select any one project from the list below and execute it.

1. Develop an application for vision-based security system during day/night time. The system should trigger an audio- visual alarm upon unauthorized entry.
2. Develop motion estimation/ tracking system to recognize object of interest related to one of the following applications. (Automobile tracking/ face tracking/ human tracking)
3. Develop motion estimation/ tracking system to recognize object of interest related to one of the following applications. (Space vehicle tracking/ solar energy tracking/ crowd pattern tracking)

**Text Books:**

1. *Richard Szeliski; Computer Vision: Algorithms and Applications; Springer.*
2. *Forsyth, Ponce; Computer Vision-A Modern Approach; Low Price Edition, Pearson Education.*
3. *Bernd Jahne and Host HauBecker; Computer Vision and applications-A Guide for Students and Practitioners; Elsevier.*

**Reference Books:**

1. *Milan Sonka, Vaclav Hlavac, Roger Boyle; Image Processing, Analysis, and Machine Vision; Thomson Learning*
2. *Robert Haralick and Linda Shapiro; Computer and Robot Vision; Vol I, II, Addison Wesley, 1993.*
3. *Dana H Ballard and Christopher M. Brown; Computer Vision; Prentice Hall*

**Course Outcomes:**

The student will be able to –

1. Explain camera geometry fundamentals and image formation.
2. Apply pre-processing algorithms to acquired images
3. Develop feature descriptor for object detection purpose.
4. Make use of Computer Vision algorithms to solve real-world problems

**Course Code: EL3007**

**Course Name: Digital Integrated Circuit Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours/ Week**

**Section 1:**

Introduction to MOSFET, I-V, CLM, Body bias and sub-micron effects, CMOS Inverter - DC Analysis, VTC, Propagation Delay, Components of Power, Transistor Sizing, Inverter Layout; Impact of Technology Scaling Combinational Circuits - static CMOS, Ratioed Logic, Pass Transistor, Transmission Gate Logic, DCVSL, Introduction to Dynamic Logic – DOMINO and NORA, Cascading Dynamic Logic Gates, Sequential Circuits - Sequential Logic, Bi-stability, Latches vs Registers, MUX based Latch, Setup/Hold Timing, clocked MOS logic - C<sup>2</sup>MOS, TSPC, Issues of Clock Overlapping, Pipelining.

**Section 2:**

Arithmetic Structures - Adders, Multipliers, Shifters Semiconductor Memories - MOS NOR and NAND ROM, EEPROM, 6-T SRAM Cell, DRAM Cell, Sense Amplifier Hardware Description Language - Introduction to HDL, Hardware Concurrency, Notion of Delta Delay, Combinational Logic Design, VHDL for Sequential Circuit, Introduction to Verilog, Sample Coding in Verilog

Fabrication and Layout - Basic CMOS Fabrication Flow, N well, Twin tub, Design of process flow, Stick diagram, Standard Cell, Design rules, Layout of Combinational/Sequential Circuits

**List of Practicals:**

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Simulation of I-V characteristics of MOSFET to see the effect of CLM and body bias on the performance of the device
2. Design of symmetrical VTC CMOS inverter, Pre-layout simulation, Parasitic extraction, Post layout simulation.
3. Simulation of static and dynamic logic gates
4. Simulation of latch and flip-flop
5. Simulation of arithmetic structures – adders, shifters
6. Simulation of combinational and sequential circuits in VHDL/Verilog
7. Layout of CMOS inverter
8. Layout of combinational circuit
9. Layout of sequential circuit
10. Post layout (back annotation) simulation of combinational and/or sequential circuit

**List of Projects:**

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Multi Precision Arithmetic Adders
2. Efficient Floating-Point Multiplier

**Text Books:**

1. *Rabaey Jan, AnanthaChandrasan, and Bora Nikolic; Digital Integrated Circuits: A Design Perspective; Prentice Hall*
2. *Jayram Bhasker; VHDL Primer*

**Reference Books:**

1. *Sung-Mo Kang and Yusuf Leblebici; CMOS Digital Integrated Circuits*
2. *N. Weste and K.Eshraghian; Principles of CMOS VLSI Design*
3. *ZainalabedinNavabi; VHDL*
4. *Charles H. Roth; Fundamentals of Logic Design*

**Course Outcomes:**

The students will be able to

1. Calculate the output voltage of pass transistor
2. Identify combinational function implemented in CMOS logic
3. Differentiate between latch and flip-flop
4. Implement logic function in MOS ROM
5. Draw logic gate circuit from VHDL code
6. Draw stick diagram from Euler's path

**Course Code: EL3009**

**Course Name: RF Circuit Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

High Frequency behavior of components, HF device models, Transmission Line Analysis, Filter Design, Use of Smith Chart

**Section 2:**

Impedance transformation, Impedance matching, Y and S parameters, RF amplifier design, RF Transformer.

**List of Practicals:**

1. To study the behavior of R, L, C components at high frequency.
2. Study Smith chart.
3. Design a LC high pass filter.
4. Design a band pass filter with given specifications
5. Design of T-Matching network.
6. RF Amplifier design.

**List of Projects:**

1. Design of RF Filter for given specifications
2. Design of Impedance matching circuits under given conditions
3. To develop RF Amplifier for given specifications.

**Text Books:**

1. *Reinhold Ludwig, Pavel Bretchko; RF Circuit Design: Theory and Applications; Pearson.*
2. *Chris Bowick; RF Circuit Design; Newnes, Butterworth-Heinemann*

**Reference Books:**

1. *Fred Lefrak, How RF Transformers Work and How They are Measured, an-20-001 rev: b m150261 04/15/15) file: an20001.w61. This document and its contents are the property of mini-circuits*
2. *Jens Vidkjær, RF-CIRCUITS, Class Notes, 31415 RF-Communication Circuits*

**Course Outcomes:**

The student will be able to –

1. Understand high frequency behavior of components
2. Demonstrate transmission line analysis.
3. Design RF filter.
4. Develop impedance matching circuits.



5. Design RF amplifier.
6. Explain RF transformer.

**Course Code: EL3027      Course Name: Object Oriented Programming Systems**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / week**

**Section 1:**

Introduction to Object Oriented Programming, Basic Concepts of Object-Oriented Programming – Classes, objects, data abstraction and encapsulation, inheritance, polymorphism, dynamic binding and message passing, Benefits of OOP, Applications of OOP. Java Fundamentals: Features of Java, Comparison of Java with other programming languages, Java Environment, Simple Java Program, Java Tokens, Java Statements, Constants, variables, data types. Control statements- Decision making & branching, Decision making & looping. Classes, Methods & Objects in Java, Constructors, Destructors.

**Section 2:**

Inheritance: Types of Inheritance: Single, Multilevel, Hierarchical, Method Overloading and Method Overriding, Interface and Package, Multithreading, Life Cycle of Thread, Priority in Multithreading, Concept of Exception handling: Introduction, Types of errors, Exception handling syntax, Multiple catch statements.

**List of Practicals:**

1. Write some simple programs in C++ such as
  - a) Find first N even numbers and its sum.
  - b) Find first 10 prime numbers
2. Write a C++ program to define a class to represent a bank account.
3. Write a program in C++ to implement a Calculator with simple arithmetic operations
4. WAP to implement following constructors.
  - a) Default constructor
  - b) Parameterized constructor
5. Write a C++ program based on concept of Inheritance.
6. Write a C++ program which use try and catch for exception handling.
7. Create a class named 'Rectangle' with two data members 'length' and 'breadth' and two methods to print the area and perimeter of the rectangle respectively. Its constructor having parameters for length and breadth is used to initialize length and breadth of the rectangle. Let class 'Square' inherit the 'Rectangle' class with its constructor having a parameter for its side (suppose s) calling the constructor of its parent class as 'super(s,s)'. Print the area and perimeter of a rectangle and a square.
8. Create a class to print the area of a square and a rectangle. The class has two methods with the same name but different number of parameters. The method for printing area of rectangle has two parameters which are length and breadth respectively while the other method for printing area of square has one parameter which is side of square.
9. Write a program to create multiple threads and demonstrate how two threads communicate with each other.
10. Write a C++ program which use try and catch for exception handling.

**Project areas:**

1. Design an application such as calculator, notepad, using OOP concepts.

**Text Books:**

1. *Herbert Schildt; Java: The complete reference; 7th Edition; Tata McGraw Hill.*
2. *Yashwant Kanitkar; Let Us Java; 2nd Edition; BPB Publications.*

**Reference Books:**

1. *T. Budd; Understanding OOP with Java; Pearson Education.*
2. *E Balagurusamy; Programming with Java A Primer; 3<sup>rd</sup> Edition; Tata McGraw Hill.*

**Course Outcomes:**

The student will be able to –

1. Identify potential benefits of object-oriented programming.
2. Code a program using C++ constructs.
3. Apply the concepts of classes, methods to write programs C++.
4. Develop programming application using inheritance, exception handling.

**Course Code: EL3010**

**Course Name: Wireless Technologies**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / week**

**Section 1:**

Modern Wireless Communication Technologies: 2G, 2.5G, 3G, 4G, LTE, 5G, Cellular Technology ; Multiple Access Technologies for Wireless Communication: TDMA, FDMA, CDMA, CSMA, SDMA

**Section 2:**

Wireless Systems and Standards: GSM, DECT, PACS; Wireless Application Protocol, IEEE 802.x based wireless Technologies: Bluetooth, Wireless LANs; Planning and designing of Wireless Systems

**List of Practicals**

1. Installation of Linux and ns-2
2. Simulation of wired networks
3. Simulation of multi-node network-Link break.
4. Study of X-Graph
5. Simulation of 2-node wireless network
6. Simulation of multi node wireless network

**List of Projects:**

1. Measure the energy consumption and the residual energy of wireless nodes in a network.
2. Measure the packet loss, packet delivery ratio and throughput in a wireless network.
3. Predict link failure in a wired / wireless network.
4. Compare the throughput, PDR, packet loss, energy consumption of 802.11 and 802.15.4
5. Compare the total network energy consumption in 802.11 and 802.15.4 protocols
6. Compare the latency of 802.11 and 802.15.4 protocols
7. Study the effect of mobility on energy consumption, packet delivery ratio, throughput in a wireless network.

**Text Books:**

1. *T.S. Rappaport; Wireless Communications; 2<sup>nd</sup> Edition; Pearson.*

**Reference Books:**

1. *Dr. Sunil Kumar.S. manvi; Wireless and Mobile Networks; 2nd edition; Wiley.*

**Course Outcomes:**

The student will be able to –

1. Design Cellular Networks
2. Analyze the Wireless Channel Access Protocols
3. Compare the 802.11x and 802.15.x wireless technologies
4. Plan and design wireless systems.

**Course Code: EL3011**

**Course Name: Artificial Intelligence**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours/Week**

**Section 1:**

**Introduction to Artificial Intelligence :-** AI task domain, problem representation in AI, Problem characteristics. Game playing using AI.

**Searching Techniques:** - A.I. search process, non-heuristic and heuristic search techniques, constrain satisfaction and their applications.

**Knowledge Representation:** - Hierarchy of knowledge, types of knowledge, knowledge representation, methods for knowledge representation, predicate logic, Problems on predicate logic.

**Section 2:**

**Planning :-** Components of planning system, goal stack planning technique. Nonlinear Planning using Constraint Posting.

**AI Tools:-** Expert System Shells, Explanation, and Knowledge Acquisition. Human expert behaviors, Expert system components, structure of expert system, the production system, Expert system development for application.

**Natural language processing:** - Introduction, Syntactic Processing, Semantic Analysis, . Architectures and functions in ANN, various learning rules. Building an ANN.

**List of Practicals:**

1. Develop a medical system using expert system.
2. Develop crypto-arithmetic puzzles.
3. Develop a system for Robotics planning.
4. Develop a knowledge representation system.
5. Implement the Breadth first search.
6. Implement the Depth first search.
7. Implement the Best first search.
8. Implement the A\* first search.
9. Implement the AO\* breadth first search.
10. Implement the search.

**List of Projects:**

1. Develop a project for the expert system.
2. Design a robotic arm using A I Technique.

**Text Books:**

*1. Elain Rich and Kevin Knight; Artificial Intelligence; Third edition; Tata McGraw- Hill Publishing Company Limited.*

2. *Kishan Mehrotra, Chilukurik Mohan, Sanjay Rankia; Elements of Artificial Neural Networks; Second edition; Penram International Publishing (India) Pvt. Ltd.*

**Reference Books:**

1. *Kishan Mehrotra, Sanjay Rawika, K. Mohan; Artificial Neural Network; Second Edition; Pearson Publication.*
2. *Rajendra Akerkar; Introduction to Artificial Intelligence; Second Edition; Prentice Hall Publication.*
3. *Relevant IEEE papers.*

**Course Outcomes:**

The student will be able to –

1. Identify real world problems of AI domain.
2. Write algorithms for searching techniques.
3. Develop an AI tool for practical application.
4. Develop an expert system

**Course Code: EL3008**

**Course Name: Database Management Systems**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

**Introductory concepts of DBMS:** Introduction, purpose and applications of DBMS, Database System architecture- levels

**Entity-Relationship model:** Entity, Relationship and Attribute types, Design issues, E-R diagrams, extended E-R features

**Relational Model and Design Theory:** Structure of relational databases, Relational algebra, and Mapping of ER diagram to Relational Schemas, Codd's Twelve Rules, Normalization

**Section 2:**

**SQL Concepts:** Basics of SQL, DDL,DML, Primary key, foreign key, functions, Built-in functions, sub-queries, , transaction control commands

**Storage and Query Processing:**Storage and file structures, indexed files, single level and multi level indices, B+ trees, Query processing

**Transaction Management and emerging trends:**Transaction concepts, state diagram, deadlock, NoSQL, RDBMS vs NoSQL, NewSQL, Distributed database, Parallel database, Data warehouse and data mining.

**List of practicals:**

1. Implementation of DDL commands of SQL: Create function, Alter function, Drop function, Insert function
2. Implementation of DML commands: Insert function, Update function, Delete function
3. Implementation of functions in SQL: Number function , Aggregate function , Character function, Convergence function, Date function
4. Implementation of operators in SQL: Arithmetic operator, Logical operator, Set operator (IN and NOT IN), Comparison operator
5. Study and implementation of different types of JOINS like Inner join, Outer join, Nature join
6. Study and implementation of different types clause: GROUP BY clause, HAVING clause, ORDER BY clause, Indexing clause
7. Study and implementation of sub queries and views
8. Study and implementation of SQL queries ( creating database/table and managing users)
9. Study and implementation of PL/SQL
10. Study of standard database models

**List of project areas:**

1. Student information system
2. Library management
3. Courier service

4. Hospital management
5. Employee database management
6. MSRTC database management
7. Inventory database management
8. Exam database management

**Text Books:**

1. *Abraham Silberschatz, Henry F. Korth, S. Sudarshan; Database System Concepts; 6th Edition, McGraw-Hill Education*
2. *RamezElmasri, Shamkant B. Navathe; Fundamentals of Database Systems; 6th Edition; Pearson*

**Reference Books:**

1. Thomas M. Connolly, Carolyn E. Begg; Database Systems: A Practical Approach to Design, Implementation, and Management; 6th Edition; Pearson
2. Ragu Ramakrishnan, Johannes Gehrke; Database Management Systems; 3rd Edition; McGraw Hill Education
3. Kristina Chodorow, Mongo; DB The definitive guide; O'Reilly Publications, ISBN: 978-93-5110-269-4, 2nd Edition.
4. Dr. P. S. Deshpande; SQL and PL/SQL for Oracle 10g Black Book; DreamTech.

**Course Outcomes:**

The student will be able to –

1. Differentiate database systems from file systems by enumerating the features provided by database systems and describe each in both function and benefit.
2. Transform an information model into a relational database schema and to use a data definition language and/or utilities to implement the schema using a DBMS
3. Design ER diagrams for new databases and read (understand) ER diagrams.
4. Read/write - Extended Relational Algebra, Simple SQL, Embedded SQL, SQL Queries Using Embedding Operators, SQL Queries With GROUP BY, HAVING



**Course Code: EL3012**

**Course Name: Electronics Product Design**

**Credits: 4**

**Teaching Scheme: 4 Hours / Week**

**Lab 2 Hours / Week**

**Section 1:**

Product specifications, feasibility analysis, Hardware Design, Software Design

**Section 2:**

System Reliability, Aesthetics and Ergonomics of product, EMI & EMC Consideration in Product design.

**List of Practicals:**

1. Define the specifications for the given product.
2. Carryout market feasibility analysis of giving product.
3. Draw and explain ERD of the given product.
4. Draw and explain the CFD / DFD of the given product.
5. Build and test the circuit of the given product.
6. Design the enclosure for the product. Ensure aesthetic and ergonomic design.
7. Draw and explain the component layout plan of the product.
8. Draw the power supply –grounding plan of the product.
9. Develop marketing plan of the product
10. Carryout profit loss analysis of developed product.

**List of Projects:**

Design and model a Prototype for

1. Coffee making machine
2. Cruise control
3. Ticket dispensing system
4. Power Supply
5. Attendance Monitoring System etc.

**Text Books:**

1. *Kevin Otto, Kristin Wood; Product Design – Techniques in Reverse Engineering and New Product Design; Pearson.*
2. *Roger Pressman; Software Engineering – A Practitioner’s Approach; McGraw Hill.*

**Reference Books:**

1. *Karl Ulrich, Steven Eppinger; Product Design and Development; McGraw Hill.*

**Course Outcomes:**

The student will be able to –

1. Understand hardware design methodology.
2. Understand software design techniques.
3. Model a prototype of product.
4. Develop reliable products ergonomically and aesthetically under Emi / EMC constraints.

**Course Code: EL3014**

**Course Name: Data Communication and Networking**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

**Introduction to Data Communication and Networking:** Uses of Computer Networks, Network Hardware, Network Software Internet Reference Models (OSI and TCP/IP)

**Physical Layer:** Basis for Data Communication, Guided Transmission Media , Wireless Transmission Medium, Circuit Switching and Telephone Network,

**Data Link Layer and Medium Access Layer:** Data Link Layer Design Issues, Error and Flow Control, Example Data Link Protocol, Channel Allocation Problem, Multiple Access, CSMA, CSMA/CD, CSMA/CA

**Local Area Network:** Connecting devices:-Repeaters, Hub, Bridges, Switch, Router, Gateways, Ethernet, Fast Ethernet, Wireless LAN, Blue tooth

**Section 2:**

**Network Layer:** Network Layer Design Issues, Routing Algorithms, Congestion control Algorithms, Quality of Service; Network Layer Protocols

**Transport layer:** Transport Layer Service, Elements of Transport protocols, Internet protocols (UDP and TCP)

**Application Layer:** DNS- Domain Name System, Electronic Mail, World Wide Web, Multimedia **Network Security:** Cryptography, Symmetric key Algorithms (DES, AES), Public key Algorithms-RSA, Digital Signatures, Firewall

**List of Practicals (Any Six):**

1. Preparation and testing of UTP Cat6 straight through and crossover cable.
2. Implementation of any LAN topology for file/printer sharing
3. Implementation of Stop and wait or Sliding window protocol
4. Implementation of Error correction and checking method
5. Implementation of Shortest Path Finding Algorithm
6. Design a client server environment to implement a web application.
7. Design a client server environment to implement a File transfer application.
8. Implementation of Private Key algorithms
9. Implementation of Public Key - RSA algorithm
10. Simulation of Network to study addressing mechanism and routing

**Text Books:**

1. *Computer Networks by Andrew S. Tanenbaum (Fifth Edition), Pearson Education*
2. *Data Communication and Networking by Behrouz A. Forouzan (Fourth Edition), Tata McGraw Hill*

**Reference Books:**

1. *William Stallings; Data and Computer Communication*
2. *James Kurose and Keith Ross; Computer Networking; Low Price Edition.*

**Course Outcomes:**

The student will be able to –

1. Describe OSI reference Model and the components and infrastructure that form the basis for most computer networks
2. Depict physical and data link layer functions and implement data link layer protocols and medium access control protocols
3. Design Local Area Network
4. Analyze the TCP/IP Protocol
5. Implement application layer protocols
6. Illustrate network management functions and security algorithms

**Course Code: EL3002**

**Course Name: Robotics**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Introduction to robotics, Safety and economics of robots, Specifications, Robot Anatomy, Degrees of freedom, Robot Coordinate systems, Joints, workspace, Singularity, Representation of position and orientation by Homogeneous Transformation, Forward and inverse kinematics of robot, D-H convention, Jacobians and dynamics of robot. End effectors-Grippers and tools. Gripper force analysis.

**Section2:**

Path planning, Trajectory Planning, Joint space and Cartesian space trajectories. Linear function with parabolic blends, Higher order polynomials, Robot sensing and vision system. Machine vision, Robot programming: Lead through, offline; Hardware and software of robot controller, [Introduction to Robot operating system](#).

**List of Practical:**

1. Understanding GUI of Robo Analyzer
2. Understanding coordinate frames and transformations
3. Virtual Models of Industrial Robots
4. Virtual Models of Industrial Robots with teach pendant and Blue Tooth
5. Forward kinematics of robots
6. Creating robot joint trajectories
7. Control a virtual robot using a joystick
8. Pre-processing of image- implementation of histogram, filters, Thresholding.
9. Morphological processing
10. Image segmentation

**List of Projects:**

1. Designing of gripper for cylindrical objects
2. Design of pick and place robot for a given payload capacity
3. Integration of machine vision with robot for industrial application.
4. Rubik Cube solving by Lego.
5. Writing a welding profile using virtual robot.
6. Performing "YOGA" by Humanoid robot.

**Textbooks:**

1. *Saeed Niku; Introduction to Robotics analysis, Systems, Applications; Prentice-Hall.*
2. *Mikell P. Groover; Industrial Robotics Technology Programming and Applications; McGraw Hill.*
3. *S. K. Saha; Introduction to Robotics; Tata Mcgraw Hill.*

**Reference Books:**

1. *Klafter R.D, Chmielewski T.A. and Noggins; Robot Engineering: An Integrated Approach; Prentice Hall.*
2. *Fu K.S., Gonzalez R.C., & Lee, C.S.G; Robotics control, sensing, vision and intelligence; McGraw Hill.*
3. *Craig J. J; Introduction to Robotics mechanics and control; Addison-Wesley, London.*

**Course Outcomes:**

The student will be able to –

1. Evaluate forward and inverse kinematics of robot.
2. Describe various types of robot end effectors.
3. Compute trajectories in joint and Cartesian space.
4. Familiar with robot sensing and vision system for industrial applications.

**Course Code: EL3016**

**Course Name: Digital System Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Interconnects - signal interconnect models: lumped, distributed, transmission-line, delay, crosstalk, power, clock distribution; Decomposition of a system into data and control paths - Mealy/Moore state machines, RTL descriptions, Implementation; Decomposition of the control path - Additive decomposition, Multiplicative decomposition, control synchronization, deadlocks

**Section 2:**

Parallelism and system decomposition - pipelines: control-flow and data-flow; Communication between sub-systems; Queuing models of systems, performance estimation; Resource contention; Memory sub-systems - Memory architecture, Shared memory, Data hazards, Consistency, Mutual Exclusion; Test and verification.

**List of Practical:**

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Design and simulation of an inverter chain for optimized performance.
2. Simulation of Differential and Single Ended Signal

For a given design(s) discussed in class -

Sketch proto-RTL for the given Design, Code the design using VHDL/Verilog, write a testbench to test the code, verify that the design works as expected, Synthesize the design.

Typical circuits/systems to be implemented are as follows:

1. Sequence detector Moore/Mealy Machine
2. Priority Encoder
3. Booth's Multiplier
4. Barrel Shifter
5. Queues
6. Pipelines
7. Memory – CAM, Dual port, Shared, LIFO, FIFO, etc.
8. Logic decoder

**List of Projects:**

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a

presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design a 16-entry queue with data width as 32 bits.
2. Design a system with one 32-bit data input and four 32-bit data outputs. The system is expected to broadcast the input 32-bit data to all outputs.

**Text / Reference Books:**

1. *J. M. Rabaey; Digital Integrated Circuits, A Design Perspective; Prentice Hall India.*
2. *W. J. Dally, J. W. Poulton; Digital Systems Engineering; Cambridge University Press, 1998.*
3. *S. H. Hall, G. W. Hall, J. A. McCall; High-Speed Digital System Design; John Wiley and Sons, 2000.*
4. *H. G. Cragon; Memory Systems and Pipelined Processors; Narosa, 1996.*

**Course Outcomes:**

The students will be able to

1. Identify the type of state machine
2. Calculate delay of transmission line
3. Write rtl description for a circuit/system
4. Estimate performance of queue
5. Analyze data hazards



**Course Code: EL3017**

**Course Name: Embedded System Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Types, Hardware architecture, Processor, memory, IO devices, ADC, DMA controller, Debug port, Interrupt Service Mechanism, Context switching, Software architecture, development tools. ARM architecture, nomenclature, operating modes, Exception Handling, ARM and thumb instruction set and assembly language programs, LPC 2148 feature, PLL, watch dog timer, Timer/ counter, Serial Communication, ADC, DAC

**Section 2:**

Communication protocols: CAN, Bluetooth, MODBUS, OS: Architecture, objectives and functions, Types of OS, RTOS: Characteristics, Critical section of code, race condition, Shared resource, multitasking, Task scheduling, Context switching, Intertask Communication, Mutual Exclusion, Semaphores, preemptive and non-preemptive kernel, Priority Inversion, Deadlock, memory management, ISR, Timer.  $\mu$ COS IIOS: Kernel structure, services

**List of Practical:**

1. Interfacing and programming LED with LPC 2148 using on chip timer
2. LCD interfacing
3. Keypad interfacing
4. Serial communication programming
5. ADC programming
6. DAC programming
7. PLL programming
8. external interrupt programming
9. Multitasking using RTOS
10. Resource sharing with semaphore

**List of projects**

1. Digital counter using proximity sensor
2. Wireless electronic notice board
3. Lab attendance monitoring system
4. System for communication availability/ non-availability of authority to visitor
5. Water quality measurement system

**Text Books:**

1. *Raj Kamal; Embedded Systems; TMH*
2. *Andrew Sloss; ARM system Developers Guide; Elsevier publication*

3. *Santanu Chatopadhyay; Embedded system design; Second edition,*

**Reference Books:**

1. *Dr. K.V.K.K. Prasad; Embedded / Real Time Systems; Dreamtech Publication*
2. *Iyer, Gupta; Embedded Real systems programming; Tata Mcgraw Hill Publication*
3. *Steve Heath; Embedded System Design; Newnans.*
4. *Frank Vahid; Embedded System Design.*

**Course Outcomes:**

The student will be able to –

1. Elaborate architecture of Embedded Systems & ARM
2. Experiment with ARM7
3. Compare various communication protocols used in embedded application
4. Relate RTOS kernel functions with general purpose OS functions

**Course Code: EL3018      Course Name: Digital Signal Processing**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Z-Transform, analysis of LTI systems in Z domain, Discrete Fourier Transform (DFT) and its computation, Linear filtering using DFT, FFT Algorithms

**Section 2:**

FIR filter Design and Realization, IIR filter Design and Realization

**List of Practical:**

1. Verification of sampling theorem. Plot Magnitude and Phase Response of Discrete Time Signal
2. Verification of Properties of DFT
3. Implement Decimation in Time FFT Algorithm.
4. Design of FIR Filter
5. Design of IIR Filter
6. Study the effects of up sampling and down sampling in time and frequency domain
7. Verification of properties of Z Transform
8. Check stability of System using pole zero plot
9. Implement Convolution and correlation of two signals
10. Decimation and Interpolation of signal

**List of Project areas:**

1. A signal (ECG/Speech) is contaminated with power line interference noise. Design a Notch filter to remove 50Hz Notch frequency from noisy signal. Observe frequency response of designed filter and analyze the filtered signal.
2. Design of Multirate system for the given sampling rate and specifications of filter required for sound recording system to compose and mix high and low frequency signals generated from different instruments in a Recording studio.
3. A signal (ECG/Speech) is contaminated with noise. Design FIR and IIR filters for given specifications to remove noise from signal. Compare results of FIR and IIR filters. Implement using DSP Processor.
4. Project based on Multirate signal processing
5. Project based on Filter Design for noise removal
6. Project based on Transform properties

**Text Books:**

1. *Sanjit Mitra; Digital Signal Processing; TMH, 3rd edition*
2. *John Proakis, Dimitri Manolakis; Digital Signal Processing – Principles, Algorithms and*

*Applications; PHI*

**Reference Books:**

1. *Ramesh Babu; Digital Signal Processing; Scitech publications 2001.*
2. *Shalivahanan, Vallavraj, Gnanapriya C; Digital Signal Processing; TMH 2001.*

**Course Outcomes:**

The student will be able to –

1. Demonstrate use of Z Transform in analyzing LTI systems.
2. Determine DFT coefficients using FFT algorithms to minimize hardware complexity.
3. Analyze FIR filters for the given Specifications.
4. Analyze IIR filters for the given Specifications.
5. Design practical sampling rate converters.

**Course Code: EL3019**

**Course Name-Machine Learning**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Data preprocessing; Regression – simple linear, multiple linear, polynomial, decision tree, random forest; Classification – logistic regression, K-nearest neighbors, support vector machine, kernel SVM, naïve bays;evaluating regression model performance

**Section2:**

Clustering – k-means, hierarchical, Reinforcement learning; Natural language processing; Artificial neural network; Dimensionality reduction – Principal Component Analysis, Model Selection

**List of Practical:**

1. Build linear regression model.
2. Build a classifier model using logistic regression / K-NN / SVM
3. Studyofrandomforest Regression Model
- 4.Developdecisiontreetosolvetheproblem
5. Develop naïve Bayesclassifiermodel
- 6.Studyofhierarchicalclusteringapproach
- 7.Develop K-means clustering technique
8. Design and develop a model for natural language processing
- 9.Construct model using Artificial neural network
10. Build model using Principal Component Analysis

**List of Project areas:**

1. Plant disease classification
2. Prediction for commercial success
3. Restaurant recommendation system
4. Improve healthcare
5. Natural language processing

**Text Books:-**

1. *Tom Mitchell; Machine Learning; TMH, 2018*
2. *StefenMarland; Machine Learning; CRC Press, 2011*
3. *Peter Flach; Machine Learning: The Art and Science of Algorithms that make sense of Data; Cambridge University Press, 2012*
4. *T. Hastie, R. Tibshirani, J. Friedman; Introduction to Statistical Machine Learning with applications in R Springer; 2<sup>nd</sup> edition.*

**Reference Books:**

1. *EthemAlpaydin; Introduction to Machine Learning; PHI 2<sup>nd</sup> edition, 2013*
2. *Lorenza Saitta, Attilio Giordana; Phase Transitions in ML; Cambridge Press.*
3. *C. M. Bishop;Pattern Recognition and Machine Learning; Springer 1st Edition-2013*
4. *T. Hastie, R. Tibshirani, J. Friedman;the Elements of Statistical Learning; 2<sup>nd</sup> 2008.*

**Course Outcomes:**

The student will be able to –

1. Select regression model to solve business problems
2. Choose a classifier model for building applications
3. Apply clustering techniques to solve real world problems
4. Design and implement various machine learning algorithms in a range of real-world applications

**Course Code: EL3020**

**Course Name: AdHoc Networks**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1: Ad Hoc Wireless Networks**

Cellular and Ad Hoc Wireless Networks, MAC Protocols, Routing Protocols Applications, Issues,

**Section 2: Implementation and performance of Ad Hoc Networks**

Quality of service, Performance parameters, route discovery time, end to end delay, throughput, packet loss, repair time, power life issues.

**List of Practical:**

1. Installation of Linux and NS-2 network simulator.
2. Simulation of wired topology.
3. Simulation of wireless topology.
4. Generation of trace file and X-Graph
5. Measure the energy consumption and the residual energy of wireless nodes in network.
6. Measure the packet loss and packet delivery ratio in a wireless network
7. Predict link failure in a wired / wireless network.

**List of Projects:**

8. Study the effect of mobility on throughput in a wireless network with DSR & AODV
9. Study the effect of mobility on energy consumption of a wireless network with DSR & AODV
10. Study the effect of network topology on throughput in a wireless network with DSR & AODV
11. Compare the packet loss in unicast and multicast protocols. Comment on your results
12. Queue Monitoring - Drop-Tail
13. Study the effect of data rate on energy consumption in 802.15.4 protocol

**Text Books:**

1. *C.K. Toh; Ad Hoc Mobile Wireless Networks Protocols and Systems; Pearson.*
2. *C. Siva Ram Murthy, B.S. Manoj; Ad Hoc Wireless Networks Architecture and Protocols; Pearson Education.*
3. *Sudip Misra, Isaac Woungang, Subhas Chandra Misra; Guide to Wireless Adhoc Network; Springer.*

**Reference Books:**

1. *Jagannathan Sarangpani; Wireless Ad Hoc and Sensor networks: Protocols, performance and Control; CRC Press.*
2. *Carlos De Morais Cordeiro, Dharma Prakash Agrawal; Ad Hoc and Sensor Networks: Theory and applications.*
3. *Relevant IEEE Papers.*

**Course Outcomes:**

The student will be able to –

1. Understand MAC protocols.
2. Describe routing protocols
3. Explain performance issues in Ad-hoc networks.
4. Select QoS solutions for performance improvement



**Course Code: EL3021      Course Name: Microwave Engineering**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Microwave transmission lines; Overview of Microwave communication: Microwave communication system , Advantages and applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Waveguide components and applications. Ferrite Components, Scattering matrix of microwave devices.

Microwave tubes: O type and M type classifications.

**Section 2 :**

Microwavesolid state devices: Gunn Diode , Tunnel Diode, PIN diode, Varactor diode, MASER. IMPATT and TRAPATT. Real world applications of microwave engineering in Radars, Communication, Industrial applications

Microwave Measurement – Bolometer Method. Measurement of Attenuation, Frequency, VSWR, Q of a Cavity Resonator. Impedance Measurements

**List of Practicals:**

1. Study of different Microwave components.
2. Derive the expressions for Waveguide parameters.
3. Mathematical analysis of Reflex klystron.
4. Study the characteristics of Reflex klystron.
5. Study the domain formation in Gunn diode.
6. Study V-I characteristics of Gunn diode.
7. Calculate Scattering matrix for Magic Tee.
8. Study port parameters of Magic Tee.
9. Study construction details of Circulator.
10. Calculate port parameters of Circulator. .

**List of Projects:**

1. Plot radiation pattern of different antennas.

**Text Books:**

1. *Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition*
2. *Micro Wave and Radar Engineering – M. Kulkarni, UmeshPublications*

**Reference Books:**

1. *R. Chatterjee; Elements of Microwave Engineering; Affiliated East-West Press Pvt. Ltd; New Delhi, 1988.*
2. *Peter A. Rizzi; Microwave Engineering Passive Circuits; PHI, 1999.*

**Course Outcomes:**

The student will be able to-

1. Analyze microwave channel mathematically.
2. Analyze microwave components mathematically.
3. Interpret microwave sources mathematically.
4. Describe microwave solid state devices.
5. Describe real time applications of microwave engineering.
6. Explain different microwave measurements.

**Course Code: EL3022      Course Name: Internet of Things**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1: IoT Overview**

**Introduction, IoT Architecture:** a. Node Structure B. Networking, Communication Technologies, **Industrial Network Evolution** IT-OT Manufacturing Convergence Industrial IoT TCP/IP & OSI Networking Models Fundamentals of LAN & WAN, Fundamentals of IP Addressing, **Switching-** Ethernet LAN Switching Ethernet Switch Configuration, Practical Example discussion, **Routing-** Routing Protocols-RIP, EIGRP,OSPF

**Section 2:Case studies and Implementation**

Case Study.Routing Between VLANs, Smartness,IoT Fabricator, Study of IoT Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones),

**List of Practical:**

1. Install Packet Tracer
2. Building the LAN Network
3. Smart Lamp
4. Configure routing information protocol (RIP)
5. Port Security
6. Configure the basic parameters of a CISCO router

**List of Projects:**

1. Implementation Routing Information protocol RIP on IP Network
2. Smart home
3. Smart office
4. Smart campus
5. Temperature Monitoring & Control
6. Smart garden
7. Smart industry

**Text Books:**

1. *Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann; Interconnecting Smart Objects with IP: The Next Internet.*
2. *Adrian McEwen, Hakim Cassimally; Designing the Internet of Things.*
3. *Dr. Ovidiu Vermesan, Dr. Peter Friess; Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems; River Publishers*
4. *Vijay Madisetti,ArshdeepBahga; Internet of Things (A Hands-on-Approach); 1st Edition, VPT, 2014*
5. *Zach Shelby, Carsten Bormann; 6LoWPAN: The Wireless Embedded Internet; Wiley*

6. *Daniel Minoli John; Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications; Wiley & Sons*

**Reference Books:**

1. *Francis da Costa; Rethinking the Internet of Things: A Scalable Approach to Connecting Everything; 1st Edition; Apress Publications, 2013*
2. *Cuno Pfister; Getting Started with the Internet of Things, O'Reilly Media, 2011, ISBN: 978-1-44939357-1*

**Course Outcomes:**

The student will be able to –

1. Understand the vision of IoT from a global context.
2. Use of Devices, Gateways and Data Management in IoT.
3. Building state of the art architecture in IoT.
4. Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

**Course Code: EL 3023**

**Course Name: Industrial Automation**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Automation overview, types of Automation, Hierarchical levels of automation, Plant wide control systems and Automation Strategy. PLC: Architecture, I/O module, Scan cycle, Set, Reset, Timer and counter instructions. Advanced PLC programming: Logical, math, Branching etc. Standalone and Distributed PLCs.

**Section 2:**

SCADA, HMI: Concepts, functionality and programming techniques. Introduction to DCS, Communication and networking protocols: Devise Net, Control Net, HART, Profibus PA, Field Bus H1, IEEE 1394, Introduction to EtherCAT, Condition monitoring, Intelligent control. Case Studies .

**List of Practicals:**

1. Ladder program realizing Boolean logic.
2. Sequencing operation using bit logic.
3. Performing delayed operation of lamp using PLC timers
4. Performing UP/DOWN counters with RESET instruction.
5. Program control- Jump and subroutine.
6. Sensor interfacing to PLC
7. PLC interfacing with SCADA and status read/command transfer operation.
8. Alarm annunciation using SCADA.
9. GUI development for industrial application.
10. RTU / MTU communications.

**List of Projects:**

1. Simulation of conveyor belt industrial application using PLC.
2. PLC controlled robotic arm.
3. Automatic car parking system.
4. PLC, SCADA and HMI for waste water treatment and distribution plant.
5. PLC, SCADA and HMI for Building automation systems
6. Wireless SCADA application for remote Industrial plant.

**Text Books:**

1. *Frank D Petruzella; Programmable logic controller; McGraw-Hill Education.*
2. *Poppovik and Bhatkar; Distributed Computer Control for Industrial Automation; Dekkar Publication.*
3. *SCADA by Stuart a Boyer: ISA 1999*

**Reference Books:**

1. *Krishna Kant; Computer Based Process Control; Prentice Hall of India.*
2. *A. D. Rodić; Automation and Control- Theory and Practice; In Tech.*
3. *Srinivas Medida; Pocket Guide on IndustrialAutomation- For Engineers and Technicians.*

**Course Outcomes:**

The student will be able to –

1. Develop PLC programs for industrial applications.
2. Apply advanced instruction of PLC to solve complex automation applications.
3. Understand the functionality of SCADA, HMI and DCS systems.
4. Describe and apply protocols needed for industrial communication and networking.

**Course Code: EL3024**

**Course Name: VLSI Technology**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Introduction, MOSFET Fabrication for IC, Silicon Crystal Structure, Defects in Crystal, Crystal growth, Oxidation, Kinetics of Oxidation, Oxidation rate constants, Dopant Redistribution, Oxide Charges, Epitaxy, Molecular Beam Epitaxy, Diffusion, theory of Diffusion, Infinite Source, Actual Doping Profiles, typical diffusion systems, Ion Implantation Process, Annealing, Masking, Lithography.

**Section 2:**

Etching - Wet Chemical and Dry Etching, Plasma Etching, Etching of Si, SiO<sub>2</sub>, SiN and other materials, Deposition, Plasma Deposition, Metallization, Issues in Aluminum Metal contacts, Isolation, LOCOS, Issues in LOCOS, Trench isolation, BJT Fabrication and Realization of Circuits, MOSFET – Metal gate vs Self-aligned, Poly-gate, Tailoring of Device Parameters, CMOS Technology, latch up in CMOS, BICMOS Technology.

**List of Practicals:**

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session.

Typical Lab experiments as follows:

Design and simulate process flow for

1. NMOSFET
2. PMOSFET
3. Resistive NMOS Inverter
4. CMOS Inverter
5. RC Filter
6. LOCOS
7. STI
8. SOI MOSFET
9. P-N Junction
10. BJT

**List of Projects**

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a

presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design, Simulate and Optimize the performance of a FINFET
2. Design, Simulate and Optimize the performance of a FDSOI/PDSOI

**Text Books:**

1. *S. K. Gandhi ; VLSI Fabrication Principles*
2. *S. M. Sze; VLSI Technology*
3. *J. D. Plummer, M. Deal and P. D. Griffin; Silicon VLSI Technology*

Material is also referred from the relevant International Journals and Conference proceedings.

**Course Outcomes:**

The students will be able to

1. Locate the defect in Silicon crystal
2. Differentiate between deposition and ion implantation
3. Calculate thickness of oxide in oxidation process
4. Design process flow for the given structure
5. Identify the profile of etching
6. Draw the structure from process flow



**Course Code: EL4003**

**Course Name: Engineering Ethics**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Introduction to Ethical Reasoning and Engineer Ethics, Professional Practice in Engineering, Ethics as Design - Doing Justice to Moral Problems, Central Professional Responsibilities of Engineers.

**Section 2:**

Computers, Software, and Digital Information, Rights and Responsibilities Regarding Intellectual Property, Workplace Rights and Responsibilities, Responsibility for the Environment

**List of Projects:**

1. Case Study: Based on Theory of GroupThink
2. Case Study: Halting a Dangerous Project
3. Case Study: Related to Innocent comments, Late Confessions etc.
4. Case study: Related to assessment schemes, teaching methodology, EDD, lab conduction

**Text Books:**

1. *Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge.*
2. *Ethics in Engineering MW Martin and R Schinzinger MC Graw Hill Engineering Ethics and Environment P a Vesilind and AS Gunn Cambridge.*

**Reference Books:**

1. *Engineering Ethics, Concepts and Cases; Charles e. Harris, michael s. Pritchard, Michael J. Rabins, wadsworthCengage Learning*

**Course Outcomes:**

The student will be able to –

1. Perform their professional responsibilities as Engineers.
2. Recognize through ethically significant problem situations that are common in Engineering
3. Think through ethically significant problem situations
4. Evaluate the existing ethical standards for ENGINEERING Practice.

**Course Code: EL4004**

**Course Name: Renewable Energy**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1: Creating Energy**

**Conventional and Non-Conventional Energy** like Wind Power, Solar Power, Geothermal energy, Tidal/Hydro Power, Biomass, Challenges, Production, Transmission and use of energy.

**Section 2: Sustainable Energy**

Technologies to generate Energy from Wind, Solar, Hydro, Biomass. Integration of Renewable energy in the electrical Power System, Energy Storage.

**List of Practical:**

1. Collect the information about Energy Conservation Building Code.2007
2. Prepare a write up on role of Energy Manager and Energy Auditor.
3. Collect information from by market survey and prepare report on rating, luminous output, cost, list of manufacturers of various types of energy efficient luminaries (FTL, CFL, LED, Sodium Vapor, HPMV etc.)
4. Make a comparative study of energy efficient control gears and ballasts used in lighting system based on energy efficiency, cost, life, energy saving and saving in energy bill
5. Visit to any organization where energy conservation program is implemented (Hospitals, workshops, institutes, commercial building, residential building etc.
6. Using various energy audit instruments used for measurement of electrical, mechanical and thermal energy parameters, carryout energy audit and prepare a report as a case study for Residence, Small workshop, Public Library, Hospital etc.(Inclusive of Data Collection processes)
7. Visit a dealer in Electric Home Appliances to know and understand STAR Rating
8. Testing of solar cells for I-V characteristics
9. Design of Off Grid Solar System
10. Design of grid connected rooftop system

**List of Project areas:**

1. Case study of the biggest planned renewable energy projects in the world.
2. Testing of solar cell

**Text Books:**

1. *Solanki C. S; Solar Photovoltaics - Fundamentals, Technologies and Applications; 3rd edition; PHI.*

2. *S. Sukhatme, J Nayak;Solar Energy: Principles of Thermal Collection and Storage; 3rd edition; Mc Graw Hill.*

**Reference Books:**

1. *Michael Boxwell;The Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy: How to Design and Install Photovoltaic Solar Electric Systems 2017; internet linked.*
2. *Solanki;Renewable Energy Technologies: A Practical Guide for Beginners; PHI*

**Course Outcomes:**

The student will be able to –

1. Obtain the overview of the global energy scenario, understand need on non-conventional energy resources.
2. Global Challenges and their limited resources.
3. Calculate the potential attribution of different sources of renewable energy like wind, solar and biomass and how to integrate them in an energy system
4. Design a plan for a 100% sustainable energy system technique.

**Course Code: EL4006**

**Course Name: CMOS Mixed Signal Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Two stage amplifiers, Cascade – Folded and Telescopic, DC and AC behavior, Current and Voltage references, Current mirrors, Bandgap references, Analog and discrete-time signal processing, sampling circuits, different types of sampling switches, Sample and Hold Architectures, Open loop & closed loop architectures, switched capacitor filter, Interconnects.

**Section 2:**

Basics of data converters, Analog to digital converters (ADC), Digital to analog converters (DAC), Successive approximation ADCs, Dual slope ADCs, High-speed ADCs - flash ADC, pipeline ADC and related architectures, High-resolution ADCs - delta-sigma converters, DACs – Resistor Ladder architectures, Current steering architectures, CMOS comparator, Analog Multiplier, Phase Locked Loops (PLL), Charge Pump PLL, Delay Locked Loops.

**List of Practicals:**

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Simulation of two-stage amplifier
2. Simulation of Sample and Hold circuit
3. Measuring the performance parameters of cascade amplifier
4. Measuring the performance parameters of folded cascode amplifier
5. Simulation of OTA
6. Simulation of PLL signal generators
7. Simulation of Switch Capacitor Filter
8. Simulation of Resistor Ladder DAC
9. Simulation of basic charge pump circuit
10. Simulation of an analog multiplier

**List of Projects:**

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design of high speed CMOS comparator
2. Design of higher order Sigma Delta modulator

**Text Books:**

1. *R. Jacob Baker; CMOS mixed-signal circuit design; Wiley India, IEEE press, reprint 2008.*
2. *Behad Razavi; Design of analog CMOS integrated circuits; McGraw-Hill; 2003.*

**Reference Books:**

1. *Baker, Li, Boyce; CMOS: Circuit Design, layout and Simulation; PHI, 2000.*
2. *R. Gregorian and G. Temes; Analog MOS Integrated Circuit for signal processing; John Wiley & Sons.*

*Material is also referred from the relevant International Journals and Conference proceedings.*

**Course Outcomes:**

The students will be able to

1. Draw small signal model of an amplifier stage
2. Calculate current in current mirror circuit
3. Identify feedback loop in sample and hold circuit
4. Find quantization noise in data converter
5. Draw basic architecture of PLL
6. Differentiate various architectures of ADCs

**Course Code: EL4008 Course Name: Mobile Communication**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1: Infrastructure to develop Mobile Communication Systems**

Cellular Technology, Capacity improvement, Mobile Traffic calculation, Attributes of CDMA and GSM in cellular systems

**Section 2: Wireless Communication System and standards**

Broadcast Networks, Infrastructure based/ cellular Networks, Ad-Hoc Network, WLAN

**List of Practicals:**

1. Study of DSSS Modulation/Demodulation using an analog signal as an input.
2. Study of BPSK Modulation/Demodulation process.
3. Study of PSTN
4. Study of Mobile trainer
5. To configure servers using packet tracer.
6. Antenna Design using Simulation Software(MATLAB/HFSS)

**List of Projects:**

1. Performance analysis of wireless networks.
2. Implement a home automation system using packet tracer.
3. Antenna Design

**Textbooks:**

1. *Wireless Communication- Principle and Practice, Theodore S. Rappaport, PHI*
2. *Mobile Communication- Jochen Schiller, Pearson Education*

**Reference Books:**

1. *Radio Frequency Principles and Applications, Albert A. Smith, Universities Press*

**Course Outcomes:**

The student will be able to –

1. Understand latest trends in wireless technologies, a path towards 5G.
2. Correlate how the handsets in their hand works, what is happening on the air interfaces and how call shifts from/to 4G to 3G and then to 2G .
3. Understanding the different standards in Mobile Technology.
4. Understand Real time application of knowledge using projects with simulation software for call flow and negative events.

**Course Code: EL4013**

**Course Name: Advanced Power Electronics**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Three phase-controlled converters, Analysis for resistive and inductive load.

Effect of Source Impedance (Ls) on single phase converter operation, Single and Three Phase Dual Converter: Control Schemes and analysis.

Three phase transistorized voltage source inverter (VSI), Analysis of operational modes.

PWM Inverters: Techniques, Comparison, Harmonic Analysis, Voltage Control and Harmonic Reduction in Inverters, Power Factor Improvement techniques: PAC, SAC, EAC and PWM

**Section 2:**

Series and parallel operation of power devices, String efficiency and Derating factor, Equalizing networks, Protection circuits, Sensing & measurement of sinusoidal/ non-sinusoidal voltage & current signals.

DC motor drives: - Performance parameters, speed control and braking techniques,

AC motor drives: - Performance parameters, Speed control (Stator voltage, Frequency, V/F), Effect of non-sinusoidal supply on motor performance, Selection of drive, Protection circuits for AC/DC Motor Drives.

Power Quality: -Types, Sources, measurement and preventive techniques of power line disturbances

**List of Practical:**

1. Study of 3 Phase Inverter with Load
2. Study of Stator Voltage Control of 3 Phase IM
3. Speed Control of DC Drive (Controlled Converter/ Chopper Based)
4. Study of Protection Circuits for Drives (OV/ OC)
5. Study of Protection Circuits for Drives (Soft start/ Soft stop)
6. Study of Voltage/ Frequency Control of 3 Phase IM
7. Study of Power Factor Improvement Technique (SAC/ PAC)
8. Simulation of three Phase Controlled Converter with R, RL Load
9. Simulation of three Phase Inverter with R, RL Load
10. Simulation of dual converter with suitable Load

**List of Projects:**

1. Switching circuit for a power device for 3 phase power conversion systems (SCR / power BJT / power MOSFET / IGBT)
2. PWM generation for device switching

Develop a 3-phase power converter for utility applications as listed below (Any one). Source available is AC Mains/ DC battery.

3. UPS
4. Speed control of DC Motor
5. Speed control of AC Motor
6. Develop sensing and protection circuit for converter/ AC or DC drive (over voltage/ over current/ soft start and soft stop)
7. Dual converter (switching circuit)
8. Solid state relay/ Programmable Ac power control
9. Verify, through simulation, the performance of 3 phase AC-DC power conversion systems for suitable load. Comment on the results.
10. Verify, through simulation, the performance of 3 phase DC-AC power conversion systems for suitable load. Comment on the results.

**Text Books:**

1. *M D Singh, K B Khanchandani; Power Electronics; 2 nd Edition, TMH.*
2. *M. H. Rashid; Power Electronics Circuits, Devices and Applications; 3 rd Edition, PHI.*

**Reference Books:**

1. *N. Mohan, T. M. Undeland and W P Robbins; Power Electronics: Converters, Applications, and Design; 3 rd edition, John Willey and Sons, Singapore.*
2. *Dubey, Doralda, Joshi and Sinha; Thyristorised Power Controllers; New Age International.*
3. *P. C. Sen; Thyristor DC Drives; John Wiley.*
4. *B. K. Bose; Modern Power Electronics and AC Drives; Pearson Education, 2002.*

**Course Outcomes:**

The student will be able to –

1. Analyze three phase AC-DC/ DC-AC power converters in terms of performance parameters.
2. Analyze power factor in AC/DC converters.
3. Describe series and parallel connection of power devices.
4. Describe the role of converters in speed control DC & AC motors.



**Course Code: EL4014**

**Course Name: Artificial Neural Networks**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Introduction to ANN: History of Neural networks, Neural net architecture, Neural learning, Evaluation of networks, Implementation. Supervised Learning: Perceptions, Linear separability, perceptron training algorithms, modifications, Support vector machines, multilevel discrimination, back propagation algorithm. Adaptive multilayer networks, predication networks, Polynomial Networks.

**Section 2:**

Unsupervised & Associative Learning: Winner-Takes All network, learning vector quantization, counter propagation networks, Adaptive Resonance theory, Topological Organized networks, Distance based learning, Max Net, Competitive Net, Principal Component Analysis, Associative Learning: Associative non-iterative procedures for association, hop field networks, Optimization, Learning using Hopfield networks, Introduction to Fuzzy logic.

**List of Practical:**

1. To study the neural network tool box.
2. To study how to train the database.
3. Design the support vector machine.
4. Design the support probabilistic networks.
5. Write down the algorithms and implement back propagation algorithm.
6. Write down the algorithms and implement predication network algorithm.
7. Design and simulate the probabilistic network.
8. Design and simulate the Max Net.
9. Design and simulate the Competitive Net.
- 10 Design and simulate the Hopfield networks.

**List of Projects:**

1. Study the relevant IEEE papers based on the Principal Component Analysis and implement it for any of the application.
2. Study the relevant IEEE papers based on the Support Vector Machine and implement it for any of the application.

**Text Books:**

- 1 *Kishan Malhotra, Chilukurik. Mohan, Sanjay Ranka; Elements of Artificial Neural Networks; Second edition; Penram International Publishing (India) Pvt. Ltd.*
- 2 *John Yen, Reza Langari; Fuzzy Logic; First edition; Pearson Educations.*

**Reference Books:**

1. *Bart Kosko, John c. Burgess; Neural Network and Fuzzy system.*
2. *M.H. Hassoun; Fundamental of Artificial Neural Networks.*
3. *M Zurada; Introduction to Artificial Neural Network system.*
4. *Relevant IEEE Papers*

**Course Objectives:**

The student will be able to –

1. Study architecture of different Neural algorithms
2. Solve problems using unsupervised, associative learning techniques.
3. Solve problems using associative learning techniques.
4. Provide an understanding of the basics of fuzzy logic

**Course Code: EL4015**

**Course Name: Antenna Theory**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Fundamental Concepts: Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop. Aperture Antennas: Huygens Principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts.

**Section 2:**

Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas. Microstrip Antennas: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas, .Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays. And basic concepts of Smart antennas.

**List of Practical:**

1. Study the Friis transmission formula.
2. Design and simulate the circular loop antenna.
3. Design and simulate the dipole for mobile.
4. Design and simulate the antenna for the specific microwave frequency.
5. Study and design the reflector and director for the Yagi Uda antenna.
6. Study and design the patch antenna.
7. Study and design the circular patch antenna.
8. Study and design the Log Periodic antenna.
9. Simulate Microstrip antenna
10. Study antenna radiation pattern.

**List of Projects:**

- 1 Project based on the loop Antenna
2. Project based on the Rectangular Patch antenna

**Text Books:**

*Constantine A. Balanis; Antenna Theory: Analysis and Design, 3rd Edition; John Wiley, 2005 (or 2nd Ed.).*

**Reference Books:**

1. *W. L. Stutzman, and G.A. Thiele; Antenna Theory and Design; 2nd Edition; John Wiley & Sons., 1998.*
2. *R.S. Elliot; Antenna Theory and Design; Revised edition; Wiley-IEEE Press., 2003.*

**Course Outcomes:**

Students will be able to

1. Understand standard antenna characterization parameters.
- 2 Explore electromagnetic radiation mechanisms for common antenna structures.
3. Design simple antennas for specified performance.
4. Design antenna arrays with required radiation pattern characteristics.

**Course Code: EL4016**

**Course Name: Advanced DSP**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Random Signals, Time Averages for DT Random Process, Multirate DSP- Decimation, Interpolation, Design of Practical Sampling Rate Conversion, Adaptive Filters LMS, RLS.

**Section 2:**

Linear Prediction and Optimum Linear Filters, Wiener Filter for Filtering and Prediction, Power Spectrum Estimation, Wavelet Transform and Applications- Multiresolution Analysis, Denoising Using DWT, Signal Compression, Signal Filtering, Sampling Rate Conversion.

**List of Practical:**

1. Record an audio signal with and without noise. Display time and frequency domain representation
2. Study the effects of up sampling and down sampling in time and frequency domain
3. write a program to design Adaptive filter for Noise cancellation
4. Implement Linear prediction algorithm
5. Power spectrum estimation of Vowels of a speech signal
6. Sub band filtering of signal using Wavelet Transform
7. Design and implement Sampling rate converters
8. Implement Weiner Filter
9. Study random signal and study its power spectrum estimation
10. Implement signal compression using Wavelet Transform.

**List of Project areas:**

1. Design of Multirate system for the given sampling rate and specifications of filter required for sound recording system to compose and mix high and low frequency signals generated from different instruments in a Recording studio.
2. Design and implement Adaptive filter for reverberation/echo cancellation /speech signal and audio signal processing / image processing
3. Collect Speech/ECG signal which is contaminated with noise. Apply Wavelet transform for denoising, compression, feature extraction and Analysis of signal.
4. Project based on Adaptive filters
5. Project based on Multirate signal processing
6. Project based on prediction algorithm

**Text Books:**

1. *E C Ifleachor and B W Jervis; Digital Signal Processing – A practical approach; 2nd Edition, Pearson Education*

2. *John G Proakis, Monolakis; Digital Signal Processing – Principles, Algorithms and Applications; Pearson education*

**Reference Books:**

1. *P Vaidyanathan; Multirate Systems and Filter Banks; PHI*
2. *B Venkatramani, M Bhaskar; Digital Signal Processors, Architecture, Programming and Applications; TMH*
3. *Simon Haykin; Adaptive Filter Theory; 4th Edition Pearson Education*

**Course Outcomes:**

The student will be able to –

1. Explain random signals and random processes.
2. Demonstrate decimation and interpolation of signals
3. Apply the concept of adaptive filtering.
4. Implement the principles of linear prediction
5. Estimate spectral density
6. Use wavelet transform for signal processing

**Course Code: EL4018**

**Course Name: RF Integrated Circuit Design**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

Basic concepts in RF Engineering: Architecture, noise, nonlinear effects, sensitivity and dynamic range; Transmission media reflections, Maximum Power Transfer, Matching, Passive Components, Transmission lines, High Frequency Amplifier, MOSFET device review, MOS Capacitances.

**Section 2:**

Noise – Various sources, Noise in MOSFET; Low Noise Amplifier – Design, Various topologies; Mixers; Oscillators; RF Power Amplifiers.

**List of Practicals:**

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session.

Typical Lab experiments as follows:

1. Semiconductor Devices at High/Radio Frequencies.
2. RF-gain enhancement by inductor or by LC tank.
3. Design of CE and CS tuned amplifiers.
4. Design of CB and CD tuned amplifiers.
5. Stability problems in tuned amplifiers and Neutralization.
6. RF Power Amplifiers in Class A, B and C
7. First and second order Filters.
8. Basic topology of CG LNA
9. CS emitter degenerated LNA
10. Reflection coefficients of transmission line.

**List of Projects:**

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design of 2 - 5 GHz LNA with variable gain
2. Design of Double Cross-Coupled VCO with AGC

**Text Books:**

1. *Behzad Razavi; RF Microelectronics; 2nd Ed; Pearson, 2012.*
2. *Thomas H. Lee; The design of CMOS radio-frequency integrated circuits; 2nd Ed; Cambridge University Press, 2004.*

**Course Outcomes:**

1. Understand the basic concepts of RF engineering.
2. Describe the behavior of components at RF.
3. Design low noise devices
4. Design low noise circuits.



**Course Code: EL4019**

**Course Name: Real Time Operating Systems**

**Credits: 4**

**Teaching Scheme: 3 Hours / Week**

**Lab: 2 Hours / Week**

**Section 1:**

OS: Architecture, Objectives and functions, types of OS, Real-Time kernel concepts uC/OS blocks, Task Management

**Section 2:**

µC/OS-II'S Services, Inter task Communication and Synchronization, semaphores, message mailboxes and message queues, Memory Management

**List of Practical:**

1. Programming to interface LEDs, 7 Segment Display
2. Programming to interface Text LCD
3. Programming to demonstrate Task Scheduling using Task Management
4. Programming to demonstrate Task Scheduling using Time Management
5. Programming to demonstrate multitasking using Task management.
6. Programming for demonstrating resource sharing using Semaphores
7. Programming for demonstrating resource sharing using Mutex
8. Programming for demonstrating Inter-process communication using Mailbox.
9. Programming for demonstrating Inter-process communication using Message Queues
10. Porting UCOS-II based applications on Embedded targets (ARM)

**List of Project areas:**

1. Design RTOS based Embedded System for Bar Code Scanner

**Text Books:**

1. *Jean J. Labrosse; µC/OS, The Real-Time Kernel; Paul Temme 2002*
2. *Linux Device Drivers (Nutshell Handbook); O'Reilly Publishers 2000*
3. *Craig Hollabaugh; Embedded Linux: Hardware, Software, and Interfacing; Addison Wesley 2002*

**Reference Books:**

1. *Sreekrishnan Venkateswaran; Essential Linux Device Drivers; Prentice Hall 2008*
2. *Christopher Hallinan; Embedded Linux Primer: A Practical, Real-World Approach; Prentice Hall, 2006. µC/OS-II User Manual*

**Course Outcomes:**

The student will be able to –

1. Explain RTOS Architecture.
2. Understand task management
3. Develop Multitasking Embedded System using RTOS services.
4. Understand synchronization and communication in RTOS