COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

The University’s basic philosophy and goals find eloquent expression in its Coat of Arms emblazoning the motto “Tejaswinavadhitamastu” which in essence means “may the wisdom accrued deify us both the teacher and the taught and percolate to the Universe in its totality”, which in essence means “may learning illumine us both” (the teacher and the taught).

MISSION

The University shall have the following objectives as its mission:

(i) to prosecute and promote research in applied science, technology, industry, commerce, management and social science for the advancement of knowledge and for the betterment of society;

(ii) to provide facilities and offer opportunities for graduate and post-graduate education in applied science, technology, industry, commerce, management and social science by instruction, training, research, development and extension and by such other means as the University may deem fit;

(iii) to devise and implement programmes of education in applied science, technology, industry, commerce, management and social science that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization;

(iv) to serve as a centre for fostering co-operation and exchange of ideas between the academic and research community on the one hand and industry on the other;

(v) to organise exchange programmes with other institutions of repute in India and abroad with a view to keeping abreast of the latest developments in relevant areas of teaching and research.
DEPARTMENT OF ELECTRONICS

VISION

To be recognised as an established Department for academics and research that prepares the students to address the challenges of modern electronics industry through state of art technical knowledge and innovative approaches.

MISSION

<table>
<thead>
<tr>
<th>Mission (M)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>to provide quality education using modern tools and facilities that will produce globally competence professional in the field of electronics.</td>
</tr>
<tr>
<td>M2</td>
<td>to assist students to solve interesting problems that will encourage the research activities in department.</td>
</tr>
<tr>
<td>M3</td>
<td>to promote interaction with industry and other reputed institutes for mutual benefit.</td>
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</table>

QUALIFICATION DESCRIPTORS (QDs) :

<table>
<thead>
<tr>
<th>QD</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QD1</td>
<td>Proficient in analyzing real life problems using modern engineering tools, and provide solutions which are economically and socially feasible.</td>
</tr>
<tr>
<td>QD2</td>
<td>Develop life-long learning skills for continuous professional development that can contribute to engineering and to the scientific community.</td>
</tr>
<tr>
<td>QD3</td>
<td>Demonstrate an ability to communicate effectively and practice professional ethics and social responsibility in their career.</td>
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</table>

QD-Mission matrix :

<table>
<thead>
<tr>
<th>Mission</th>
<th>QD1</th>
<th>QD2</th>
<th>QD3</th>
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</thead>
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<tr>
<td>M2</td>
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<tr>
<td>M3</td>
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**PROGRAMME LEARNING OUTCOMES (POs)**: At the end of the program the student will be able to:

<table>
<thead>
<tr>
<th>PO1</th>
<th>Enhance knowledge by understanding, experimenting and comparing information (existing and new) in the field of electronics.</th>
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</thead>
<tbody>
<tr>
<td>PO2</td>
<td>Demonstrate ability to model, simulate and evaluate the phenomenon and systems in the chosen areas of electronics.</td>
</tr>
<tr>
<td>PO3</td>
<td>Use state-of-the-art tools to design, development and analysis problems and provide timebound and economical solutions.</td>
</tr>
<tr>
<td>PO4</td>
<td>Work in collaborative manner with others in a team, contribute to the management, planning and implementations.</td>
</tr>
<tr>
<td>PO5</td>
<td>Effectively communicate technical content through written reports/design documents, and presentations.</td>
</tr>
<tr>
<td>PO6</td>
<td>Engage in lifelong learning independently to enhance knowledge and skills that can contribute to the continuous improvement of individuals and society.</td>
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</table>

**QD – PO Mapping**

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
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## Course Structure

### Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course</th>
<th>C/E</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>20-305-0101</td>
<td>Electronic Circuits</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0102</td>
<td>Signals &amp; Systems</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0103</td>
<td>Digital System Design</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0104</td>
<td>RF &amp; Microwave Technology</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0105</td>
<td>Programming for Embedded Systems(Lab oriented)</td>
<td>C</td>
<td>4</td>
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<tr>
<td>20-305-0106</td>
<td>Electronic Circuits Lab</td>
<td>C</td>
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<tr>
<td>20-305-0107</td>
<td>Signals &amp; Systems Lab</td>
<td>C</td>
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</table>

**Core credits** 22

### Semester II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course</th>
<th>C/E</th>
<th>Credits</th>
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<tbody>
<tr>
<td>20-305-0201</td>
<td>Embedded System Design</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0202</td>
<td>Control Systems</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0203</td>
<td>Digital Signal Processing</td>
<td>C</td>
<td>4</td>
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<tr>
<td>20-305-0204</td>
<td>Seminar</td>
<td>C</td>
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<tr>
<td>20-305-0204</td>
<td>Embedded System Design Lab</td>
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<tr>
<td>20-305-0205</td>
<td>Control Systems Lab</td>
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**Core credits** 15

**Elective I** 3

**Total Credits** 18

### Semester III

<table>
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<th>Course</th>
<th>C/E</th>
<th>Credits</th>
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<tbody>
<tr>
<td>20-305-0302</td>
<td>Project Part 1</td>
<td>C</td>
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<tr>
<td>20-305-0302</td>
<td>Communication Systems</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0303</td>
<td>VLSI System Design</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>20-305-0304</td>
<td>Communications Lab</td>
<td>C</td>
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**Core credits** 9

**Elective II** 3

**Elective III** 3

**Elective Lab** 1

**Total Credits** 16
### Semester IV

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<tr>
<td>20-305-0401</td>
<td>Project Part 2</td>
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#### Core credits

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#### Elective IV

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#### Total Credits

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### List of Electives*

<table>
<thead>
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<th>Course Code</th>
<th>Course</th>
<th>C/E</th>
<th>Credits</th>
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<tbody>
<tr>
<td>20-305-0001</td>
<td>Machine Learning</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0002</td>
<td>Robotics Technology</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0003</td>
<td>Microwave Integrated Circuits</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0004</td>
<td>Data Structures</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0005</td>
<td>Computer Organisation</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0006</td>
<td>Wireless Communication</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0007</td>
<td>Computational Techniques</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0008</td>
<td>Microprocessors and Microcontrollers</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>20-305-0009</td>
<td>Image Processing</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0010</td>
<td>Robotics and Intelligent Systems</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0011</td>
<td>Radar and Satellite Communication</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0012</td>
<td>Embedded Software and Real Time Systems</td>
<td>E</td>
<td>3</td>
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<tr>
<td>20-305-0013</td>
<td>Antennas</td>
<td>E</td>
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<tr>
<td>20-305-0014</td>
<td>Computer Architecture</td>
<td>E</td>
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<tr>
<td>20-305-0015</td>
<td>Neural Networks</td>
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<td>3</td>
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<tr>
<td>20-305-0016</td>
<td>Machine Learning Lab</td>
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<tr>
<td>20-305-0017</td>
<td>Robotics Technology Lab</td>
<td>E</td>
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<tr>
<td>20-305-0018</td>
<td>Microwave Circuits Lab</td>
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<tr>
<td>20-305-0019</td>
<td>Data Structures Lab</td>
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<tr>
<td>20-305-0020</td>
<td>Image Processing Lab</td>
<td>E</td>
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<tr>
<td>20-305-0021</td>
<td>Robotics and Intelligent Systems Lab</td>
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<tr>
<td>20-305-0022</td>
<td>EM Radiation Lab</td>
<td>E</td>
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<tr>
<td>20-305-0023</td>
<td>Embedded Software Lab</td>
<td>E</td>
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<tr>
<td>20-305-0024</td>
<td>VLSI System Design Lab</td>
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<tr>
<td>20-305-0025</td>
<td>MOOC/NPTEL Course</td>
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</table>

**Total credits - 72**

* Electives offered will be subject to availability of expertise in the field.
Prerequisites: A basic course in Basic Electronics.

Course Description: Study and analysis of electronic circuits using active devices. Understand the working of VCO and PLL.

Course Outcome: After the completion of the course the student will be able to

- **CO1** Understand the fundamental principles of linear electronic systems. Understand
- **CO2** Analyze electronic circuits using active devices. Analyze
- **CO3** Design the electronic circuits using linear devices. Apply
- **CO4** Understand the concept of feedback and oscillators. Understand
- **CO5** Analyze different types of power amplifiers. Analyze
- **CO6** Understand the concept of VCO and PLL. Understand

Course content:

**Module 1:** Review of active devices: Diodes, BJTs, UJTs, MOSFETs, Insulated Gate Bipolar Transistors Structure, Characteristics, Operation, specifications. Operational amplifiers: parameters and modes of operation.

**Module 2:** Operational amplifiers: Characteristics, op-amp architecture, Offset and Bias Voltages and Current, Slew Rate, Finite Frequency Response, Gain-bandwidth product, Linear op-amp circuits, Non Linear Op-amp Circuits: Open Loop Comparator, Polarity Indicator, Schmitt Trigger; astable and monostable circuits, Active filters: LPF & HPF using Sallen-Key configuration, Simulation of circuits using LTSPICE.


**Module 4:** Linear circuits: UJT relaxation oscillator, time base generators -bootstrap, miller; blocking oscillators, transient switching and characteristics., voltage regulators, VCO and emitter coupled VCO, Basic PLL topology and principle, transient response of PLL, Linear model of PLL, Major building blocks of PLL – analog and digital phase detector, VCO, filter, Applications of PLL Monolithic PLL - IC LM565 and CD4046 CMOS PLL.

**Module 5:** Amplifiers: classification - class A , class B, Class AB, Class C and class D -Transformer coupled Power amplifiers – Transformer less class AB push-pull Power amplifier - complementary symmetry power amplifier - Harmonic distortion in Power amplifiers - Transistor rating - Heat sinks.
References:
Prerequisites : Mathematics

Course Description : This course deals with the design and analysis of continuous and discrete time signals and systems

Course Outcome : After the completion of the course the student will be able to

CO1 Understand the basic properties of signals and systems
CO2 Analyze continuous time systems using Fourier series and transform
CO3 Perform frequency domain analysis using discrete time Fourier Analysis
CO4 Evaluate Laplace transform of continuous time signals
CO5 Evaluate Z-transform of discrete time signals

Course content :

Module 1 : Elements of signal theory: Signals as functions, classification of signals, elementary signals, basic operations on signals, Systems – Properties of systems – stability, causality, linearity, time invariance, memoryless, invertibility, Time-domain representation and analysis of LTI and LSI systems – Convolution sum, convolution integral and their evaluation, representation for LTI systems, Properties of LTI systems, Step response of LTI system, Systems described by differential equations and difference equations


Module 3 : Frequency domain analysis of LTI systems: Representation and determination of Discrete time Fourier series, properties of DTFS, Representation and determination of Discrete time Fourier Transform, Magnitude and Phase spectrum, Properties of DTFT, Frequency response of systems characterised by linear constant coefficient difference equation

Module 4 : Laplace transform: Definition, Laplace transform of elementary signals, Region of convergence, Properties of ROC and Laplace transform, Inverse Laplace transform, Initial and Final value theorems, Analysis and characterisation of LTI systems, causality and stability, Transfer function and differential equations.

Module 5 : Z-transform: Definition, Z-transform of elementary signals, Region of convergence, Properties of ROC and Z transform, Inverse Z-transform, Analysis and characterisation of LSI systems, causality and stability, Transfer function and difference equations.
References:
Prerequisites : Digital Electronics

Course Description : This course gives an overview of the design of digital systems. It introduces the basics of combinational and sequential circuits. It provides the concept of state machines and gives an idea of how to model real time scenarios and applications. The course also gives an idea of how to realise the digital system using hardware description language and also provides an overview of programmable logic devices.

Course Outcome : After the completion of the course the student will be able to

CO1 Minimize the logic function and implement using combinational logic circuit 
   Apply

CO2 Compare the various programmable logic devices 
   Understand

CO3 Design sequential circuits using the various design techniques 
   Apply

CO4 Describe the digital systems using hardware description language, Verilog 
   Apply

CO5 Design combinational and sequential digital system using Verilog 
   Apply

Course content : 


Module 2 : Combinational Logic Design: NAND and NOR gates, Design of Two-level and Multi-level Gate Circuits, Circuit Conversion, Review of combinational logic circuit design - design of gates with limited fan-in, Gate delays and timing diagrams, hazards, Combinational Circuits - Multiplexers, decoders, encoders, buffers, code converters, adder, subtractor, Programmable Devices - Read Only Memory, Programmable Logic Array, Programmable Array Logic, Complex Programmable Logic Devices.

Module 3 : Sequential Logic Design: Sequential Circuits, Latches, Flip-Flops, Analysis of clocked sequential circuits, Mealy and Moore Models, state reduction and assignment, design procedures, excitation tables, state-transition table, state diagram, Finite State Machine design, Registers and Counters, Counter Design using flip flops.

Module 4 : Introduction to HDL – Hardware Description Languages, Verilog, Rules and Syntax, Modules, Ports, Variables, Datatypes, Operators, Assignments, Procedural
Assignments, Always block, Delays, Dataflow modeling, Behavioral modeling, Structural modeling, Tasks and functions.

Module 5: **System Design using Verilog**: Modeling combinational and sequential circuits using verilog – arithmetic and logic circuits, registers, counters, sequential machines, tristate buffers, Mealy and Moore finite state machines, Simulation and verification - Verilog testbench, Memory, File read and write.

References:
Prerequisites: A basic course in Electromagnetic Theory

Course Description: In this course, the students are given an overview of basic concepts involved in an RF Communication system.

Course Outcome: After the completion of the course the student will be able to

CO1 Understand the basic building blocks of wireless systems and basic transmission line theory.

CO2 Evaluate the concept of distortion due to noise and fundamentals of antennas and propagation.

CO3 Understand the working and types of various microwave sources.

CO4 Describe the various passive components.

CO5 Describe the working and design of a microwave amplifier, an oscillator and a mixer and compare the performance of its various types.

CO6 Evaluate the design of an RF system.

Course content:

Module 1: Introduction to Wireless Systems - Overview of various systems and Block diagrams. Transmission lines & Network Analysis - Transmission line theory, Smith Chart, S-parameters, Impedance matching


Module 4: Passive RF Components: RF Filters, power dividers, directional couplers, switches, attenuators, circulators, phase shifters

Module 5: Active RF Components: Amplifiers- Design using S parameters, LNA, PAs. Mixers- Characteristics and types, Oscillators – types and frequency synthesizers. Receiver Design: Architecture, Dynamic range and practical receivers
References:

Prerequisites : None

Course Description : This course trains the students to program embedded systems using C programming language.

Course Outcome : After the completion of the course the student will be able to

CO1 Understand Basic Operating systems for embedded systems. Understand
CO2 Understand the syntax and functionality of a given C program Understand
CO3 Understand basic memory layout and memory management in C, given a problem identify the requirement for static and dynamic memory allocations and develop programs using pointers, functions and recursion. Analyze
CO4 Given a problem, understand the basic algorithm, determine the required program structure, and write the C program, write test cases, compile, execute and verify the program. Analyze
CO5 Write C programs and compile, link, execute and debug them Apply
CO6 Write programs for Arduino development boards and test basic functionalities Apply

Course content :


Module 2 : Basics of C Programming: Character set, Identifiers and Keywords, Data Types, Constants, Variables and Arrays, Declarations, Expressions, Statements, Symbolic constants, Operators and Expressions, Input and Output. Planning, Preparing, Running and Debugging a complete C program, Control Statements - if else, while, do-while, for, switch, break, continue, goto. Functions - prototypes, passing arguments, recursion

Module 3 : Arrays, Pointers & Structures: Arrays, Mutidimensional arrays and strings, Pointers, Passing pointers to functions, Pointers and Arrays, Operation on pointers, Array of pointers, Structures and Unions.

Module 4 : Memory layout and Memory management: Memory layout, Stack and Heap. Static and Dynamic allocation, automatic, static and global variables, multifeile programs, library functions, Linker, Preprocessor directives, Macros. Data Representation: Fixed-Precision Binary Numbers, Binary Representation of Integers, Binary Representation of Real Numbers - Fixed-Point and Floating Point.
Module 5: **Introduction to Embedded C:** Introduction, Data types, Bit manipulation, Interfacing C with Assembly - Programming in Assembly, Instruction Sequencing, Procedure Call and Return, Parameter Passing, Input/Output Programming - Instructions, Synchronization, Transfer Rate, and Latency, Polled waiting loops. Embedded programming issues - Reentrancy, Portability, Optimizing and testing of embedded C programs.

| Sample List of Experiment* | | |
|----------------------------|--------------------------|
| 1. Write a program to compare multiple pairs of numbers and display the results. | | |
| 2. Write a program to print all prime numbers less than a given number. | | |
| 3. Write a program which reads a word and encode it into a number replacing each letter by its position in the alphabet. | | |
| 4. Write a program which reads a sentence with uppercase and lowercase letters, numbers and symbols and outputs with the case reversed. | | |
| 5. Write a program which calculates the running average of a sequence of number. The average has to be calculated and displayed every time a new number is entered. Use a separate function for average. | | |
| 6. Write a program which reads in the coefficient of a quadratic equation and outputs all the roots. | | |
| 6. Write a recursive program to print the Fibonacci series. | | |
| 7. Write a program which reads a text and counts the number of characters and words. | | |
| 8. Write a program that slows a person to play tic-tac-toe with a computer | | |
| 9. Write a program which stores n numbers in an array, sorts the array and outputs the result. | | |
| 10. Write a program which reads a sentence, stores it in an array and display it backwards. Write a separate function for reversing the array. Repeat with pointer instead of arrays. | | |
| 11. Write a C program that reads several different names and addresses into the computer, rearranges the names into alphabetical order, and then writes out the alphabetized list. Make use of structure variables within the program. | | |
| 12. Use Gcc to compile a multifile C program and debug it using gdb | | |
| 13. 8051 Programming: Blink Led | | |
| 14. 8051 Programming: Serial Communication using UART | | |
| 15. Arduino Basics: Use potentiometer to control blinking and fading of LED | | |
| 16. Arduino Basics: Send the potentiometer output to the computer and plot the graph. | | |
| 17. Arduino Basics: Control multiple LEDs using for loop and if, switch case and while statements | | |
| 18. Arduino based digital thermometer | | |

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
**Text Books:**

**References:**
Prerequisites: A basic course in Basic Electronics.

Lab Description: Simulation of analog and digital circuits using OR-CAD. Analysis of electronic circuits using active devices. Understand the working of PLL.

Course Outcome: After the completion of the lab the student will be able to

CO1 Design, implement and verify the Circuits using transistors Apply
CO2 Design, setup and verify the Circuits using Op-amps Apply
CO3 Study the OR-CAD simulator, and use it Apply
CO4 Analysis of PLL Apply
CO5 Design and analyze Circuits using 555 IC Apply

Sample List of Experiments*

- Multivibrators, Filters
- Circuits using op-amp(Adder, Subtractor, integrator, differentiator, inverting and non inverting amplifiers, square wave generator and triangular wave generator, Filters..)
- OR-CAD simulation of Power supply, Amplifiers, digital counters, Amplitude Modulation
- Find lock range and capture range of NE 565 PLL
- Multivibrators using 555 IC

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites: Signals & Systems

Lab Description: Implementation of basic signal processing techniques in Octave/MATLAB/Python

Course Outcome: After the completion of the lab the student will be able to

- **CO1** To familiarize basic programming environment for signal processing in Octave/MATLAB/Python
- **CO2** To understand the basic signal processing operations in Octave/MATLAB/Python
- **CO3** To plot basic elementary signals and perform fundamental operations on signals
- **CO4** To implement frequency domain analysis techniques using Octave/MATLAB/Python
- **CO5** To analyse the stability of systems using Octave/MATLAB/Python

Sample List of Experiment*: OCTAVE/MATLAB/Python Implementation of

- Basic Matrix and Linear Algebra operations
- Generation of Elementary Signals
- Checking of Linearity and Time Invariance of any given system
- Find linear convolution of two given signals
- Find the magnitude and phase spectrum of given signals

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites : None

Course Description : This course educates students on designing embedded systems to interface with peripherals for performing various functionalities.

Course Outcome : After the completion of the course the student will be able to

CO1  Familiarize with embedded system components

CO2  Study the impact of optimizations on processor and memory affecting efficiency of embedded systems

CO3  Program embedded system devices to implement applications

CO4  Review commercial embedded platforms and their features

CO5  Interface embedded system with external devices

Course content :

Module 1 : Embedded system concepts: Microprocessors and microcontrollers, General purpose computer and Embedded Systems. Components of embedded systems, processor, memory, etc. Performance and power of processors, Amdahl’s law, Moore’s law. RISC vs. CISC, Review of Intel and ARM processors. Mobile embedded platforms.


Module 4 : Commercial Embedded platforms: Development and interfacing with evaluation boards: Texas Instruments, Arduino, Galileo, Raspberry Pi,
etc. Mobile Embedded Platforms: iOS, Android, etc. Popular ARM architectures, Registers, Current Program Status Register (CPSR), Processor modes, Register organization, Interrupts, ARM Cortex M3, Memory system, processor and memory organization, ARM bus (AMBA).

Module 5: **Embedded System Interfacing:** Sensors and Transducers for interfacing. Interfacing standards, SPI, I²C, USB. Analog interfacing and applications, Analog to Digital Convertors: Properties, Parallel Comparator, Dual Slope and Successive Approximation methods.

References:

5. LPC User Manual:
6. LPC Datasheet:
Prerequisites : Signals & Systems

Course Description : This course deals with analysis and modeling of continuous time and discrete time control systems

Course Outcome : After the completion of the course the student will be able to

CO1 Model control systems using block diagrams and signal flow graphs Analyse
CO2 Compare various techniques for analysis of control systems Analyse
CO3 Discuss the need for sampled data systems Understand
CO4 Analyse the stability of discrete time systems Analyse
CO5 Explain the concepts of state space representation Analyse

Course content :

Module 1 : Mathematical modeling of control systems - open loop and closed loop systems, concept of feedback, modeling of continuous time systems, Review of Laplace transform, transfer function, block diagrams, signal flow graph, Mason's gain formula - block diagram reduction using direct techniques and signal flow graphs - examples - derivation of transfer function of simple systems from physical relations - low pass RC filter - RLC series network - spring mass damper

Module 2 : Analysis of continuous time systems - time domain solution of first order systems, time constant, time domain solution of second order systems, determination of response for standard inputs using transfer functions, steady state error, concept of stability, Routh-Hurwitz techniques, construction of bode diagrams, phase margin, gain margin, construction of root locus, polar plots and theory of Nyquist criterion, theory of lag, lead and lag-lead compensators

Module 3 : Basic elements of a discrete time control system – sampling, sample and hold, Examples of sampled data systems, pulse transfer function, Review of Z-transforms, system function, mapping between s plane and z plane

Module 4 : Analysis of discrete time systems – Stability, Jury's criterion, bilinear transformation, stability analysis after bilinear transformation, Routh-Hurwitz techniques, construction of bode diagrams, phase margin, gain margin

Module 5 : State space analysis - state space models, state space equations, phase variable and diagonal forms from time domain - diagonalization - solution of state equations

References :
Prerequisites: Signals & Systems

Course Description: This course deals with analysis and design of various digital filters, various finite word length issues associated with DSPs and DSP processor architecture.

Course Outcome: After the completion of the course the student will be able to:

- **CO1**: Compute linear and circular convolution. 
  - Apply

- **CO2**: Evaluate DFT of discrete signals. 
  - Apply

- **CO3**: Design a digital filter. 
  - Analyse

- **CO4**: Understand the architecture of a DSP processor. 
  - Understand

- **CO5**: Explain the basic concepts of multirate signal processing. 
  - Understand

Course content:

**Module 1:** Fourier analysis of discrete-time signals and systems: Discrete Fourier Series, Discrete Time Fourier Transform, Convolution; Linear and circular convolution, Practical implementation, Overlap-save and overlap-add methods.

**Module 2:** Discrete Fourier Transform - Properties; Approximation of Fourier transform through DFT, Fast algorithms for DFT - The FFT algorithm – DIT & DIF algorithms, inverse DFT using FFT.

**Module 3:** Digital filter design: FIR Filters: Impulse response, Transfer function, Linear phase properties, Design: window-based design, frequency sampling design. IIR Filters: Impulse response, Transfer function, Pole-zero representation, Butterworth, Chebyshev, elliptic filter concepts, Approximation problem for IIR filter design - Impulse in variance method, bilinear transform method, matched z-transform method. Frequency transformations, Realization structures: Direct form 1 and 2, parallel and cascade.

**Module 4:** Digital Signal Processors: Introduction, TMS320C6x Architecture, Functional units, Linear and circular addressing modes, TMS320C6x instruction set.

**Module 5:** Multi-rate signal processing: Changing the sampling rate using discrete time processing, Sampling rate reduction by an integer factor, Compressor, Time and frequency domain relations, Sampling rate increase by an integer factor, Expander, Time and frequency domain relations, Changing the sampling rate by a rational factor.

References:

SEMILTPC

Prerequisites : NIL

Course Outcome : After the completion of the course the student will be able to

CO1 Survey the literature on new research areas and compile findings on a particular topic

CO2 Organize and illustrate technical documentation with scientific rigor and adequate literal standards on the chosen topic strictly abiding by professional ethics while reporting results and stating claims.

CO3 Demonstrate communication skills in conveying the technical documentation via oral presentations using modern presentation tools.

The objective of the seminar is to impart training to the students in collecting materials on a specific topic in the broad domain of Engineering/Science from books, journals and other sources, compressing and organizing them in a logical sequence, and presenting the matter effectively both orally and as a technical report. The topic should not be a replica of what is contained in the syllabi of various courses of the M.Sc program. The topic chosen by the student shall be approved by the Faculty-in-Charge of the seminar. The seminar evaluation committee shall evaluate the presentation of students. A seminar report duly certified by the Faculty-in-Charge of the seminar in the prescribed form shall be submitted to the department after the approval from the committee.
Prerequisites : None

Lab Description : This lab will involve working on programming embedded devices, communicating with peripherals.

Course Outcome : After the completion of the lab the student will be able to

CO1 Familiarize with different embedded boards and their capabilities Understand

CO2 Learn and use software tools for multiple development boards for testing functionalities. Apply

CO3 Solve specific problems which come under interface categories such as display, counter, motor drive, etc. Apply

CO4 Acquire debugging skills by communicating to development board via console, LEDs, ports, etc. Analyze

CO5 Propose and design solutions for real world problems using embedded systems Apply

Sample List of Experiment* :

1. Interface a 16x2 LCD to PIC16F887 microcontroller and display an English word and a Malayalam word.

2. Interface a keypad to PIC16F887 microcontroller and display a key switch being pressed in the board.

3. Interface built-in DS1307 real time clock chip and display the time, day and date.

4. Use PIC16F887 to perform Compare, Capture and PWM operations.

5. Familiarization with Arduino board and Raspberry Pi. Flashing sample programs and detection of output via LED and Console.

7. Write a program to display hello world on terminal. Interface 4X4 Matrix Keypad and display in LCD.

8. Design project: Define a problem statement that can be solved by an embedded system. Design and implement an embedded system for solving this problem statement. It is required to have a computation unit, interfacing with a peripheral and a wireless communication protocol.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites

Lab Description: This lab aims to familiarize with the modeling of dynamical systems and the characteristics of control components like dc motor, Compensator etc. To model, simulate and analyze systems using MATLAB software.

Course Outcome: After the completion of the lab the student will be able to

CO1 Represent physical systems as transfer functions and derive open loop and closed loop transfer functions

CO2 Study characteristics of control components like DC motor, Compensator etc.

CO3 Analyse the stability of physical systems represented as transfer functions

CO4 Simulate first order and second order systems and understand the performance

Sample List of Experiment*

1. Familiarize with Matlab
2. Represent Polynomials in Matlab
3. Functions and Flow control in Matlab
4. Model physical systems like Mass-Spring system using transfer functions
5. Block diagram representation of physical systems using SIMULINK
6. Model and Simulate LTI Systems
7. Block Diagram Reduction
8. PD, PI and PID Controllers
9. Design a passive RC lead, lag and lag-lead compensating network for the given specifications and to obtain its frequency response
10. DC motor characteristics

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites : NIL

Course Outcome : After the completion of the course the student will be able to

CO1 Develop aptitude for research and independent learning.

CO2 Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3 Gain the expertise to use new tools and techniques for the design and development.

CO4 Acquire the knowledge and awareness to carry out cost-effective and environment friendly designs

The major project in the fourth semester offers the opportunity to apply and extend knowledge acquired in the first year of the M. Sc. program. The major project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of Communication Engineering under the supervision of a faculty from the Department or in R & D institutes/Industry. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. Students will be required to 1) perform a literature search to review current knowledge and developments in the chosen technical area; 2) undertake detailed technical work in the chosen area using one or more of the following:

- Analytical models
- Computer simulations
- Hardware implementation

The emphasis of major project shall be on facilitating student learning in technical, project management and presentation spheres.

Project work will be carried out individually. The students can register with supervising faculty and update their status regularly.

Minimum Contact hours : 15 hrs

NOTE : Those who are planning to carry out their projects in industries/ external R & D institutions can register for the MOOC course to be credited in the 4th Semester.
Prerequisites : A basic course in Signals and System

Course Description : This course gives the basic concepts in the design of a communication system, the signals and its transmission. Various modulation schemes in the analog and digital domain is also analysed.

Course Outcome : After the completion of the course the student will be able to

CO1 Understand the fundamental principles, quantities and limits involved in communication system design.

CO2 Analyse signals and its transmission. Analyse

CO3 Employ analog modulation schemes in a communication scenario. Apply

CO4 Employ the various base band and pass band digital modulation schemes. Apply

CO5 Describe the significance of probability and random process in digital communications. Understand

CO6 Understand the effect of noise on the different modulation schemes and describe an optimum receiver. Understand

Course content :

Module 1 : Introduction to communication systems: Analog vs. digital communication systems, fundamental quantities and limits (signal-to-noise ratio, channel bandwidth, Shannon's capacity), modulation, multiplexing.

Module 2 : Review of signals and linear systems: Fourier series and transform, impulse response, convolution, frequency response/transfer function, filters, energy and power spectral densities.

Module 3 : Analog communication systems: Amplitude modulation (DSB, AM, QAM, SSB, VSB), super heterodyne receiver, frequency and phase modulation (FM and PM), bandwidth of FM signals, FM receivers.

Module 4 : Digital modulation: Sampling theorem, pulse code modulation, differential pulse code modulation, delta modulation, line coding, multiplexing, power spectral density, eye diagrams and bit error rates; digital carrier systems –ASK, PSK, binary PSK, FSK, QPSK, digital I/Q modulation, M-ary signaling and bandwidth efficiency.

References:

Prerequisites : None

Course Description : This course trains the students to program embedded systems using C programming language.

Course Outcome : After the completion of the course the student will be able to

CO1 Explain the basic complementary CMOS circuits and their fabrication
CO2 Understand the syntax and functionality of a given C program
CO3 Implement a basic system with controller and datapath on FPGAs
CO4 Develop embedded systems using micro blaze softcore processors
CO5 Develop embedded systems using Zync processors

Course content :

Module 1 : CMOS Technology: MOS transistors, Ideal I-V Characteristics, Complementary MOS Logic - Inverter, Combinational Logic, NAND/NOR gates, Complementary CMOS design - Pull up and Pull Down Networks, Propagation delay, Fabrication Process

Module 2 : Sequential Circuits: Timing Metrics, Classification of Memory Elements, CMOS based static Latches and Registers, Dynamic Latches and Registers, Pipelining, Sequential timing, Timing Metrics, Setup time, Hold time.

Module 3 : Design Flow: ASIC Design flow - Custom, Semicustom and Structured-array design approaches, Cell based design methodology, Semicustom design flow, Array based design flow, Field programmable gate arrays - Architectures of Commercial FPGAs Xilinx, Intel - Altera and Atmel, Carry Chains and Cascade chains, Logic Blocks, Dedicated memories and ALUs, HDL specification, Logic synthesis, Mapping, Placement and Routing, Timing and Pin constraints.

Module 4 : System Design: Top down approach to design, Data path, Control path, Controller behaviour and Design, Memories and IP Blocks, Design Case Studies - BCD adder, Traffic light controller, Binary multiplier and Divider.

Module 5 : FPGA based Embedded SOCs: Embedded SoCores - High Level Synthesis, Hardware Software co-design, System Design using Microblaze softcore processor and Xilinx Embedded Design Kit (EDK), peripherals, developing software applications on microblaze. Embedded hard cores - Xilinx Zynq SOCs, Programmable Logic and Processor Systems, High Level Synthesis using Xilinx Vivado HLS, Creating a complete system using built-in ARM Cortex processor and an IP block in PL.
**Text Books:**


**References:**

5. Xilinx FPGA user guides and University Program Course materials
Prerequisites: Signals and Systems

Lab Description: Implementation of basic analog and digital communication techniques in MATLAB/Labview

Course Outcome: After the completion of the lab the student will be able to

CO1 To familiarize basic programming environment for communication in MATLAB/Labview

CO2 To familiarize communication toolbox in MATLAB/Labview

CO3 To implement basic analog and digital modulation techniques in MATLAB/Labview

CO4 To analyse the effect of noise in digital communications system

CO5 Prepare the reports and present the results correctly.

Sample List of Experiment:

1. Signal Sampling and reconstruction
2. Time Division Multiplexing
3. AM Modulator and Demodulator
4. FM Modulator and Demodulator
5. Pulse Code Modulation and Demodulation
6. Delta Modulation and Demodulation
7. Signal constellations of BPSK, QPSK and QAM
8. Eye Diagram
9. FSK, PSK and DPSK schemes
10. Communication link simulation

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites  :  NIL

Course Outcome  :  After the completion of the course the student will be able to

CO1  Develop aptitude for research and independent learning.

CO2  Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3  Gain the expertise to use new tools and techniques for the design and development.

CO4  Acquire the knowledge and awareness to carry out cost-effective and environment friendly designs

CO5  Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

The major project in the fourth semesters offer the opportunity to apply and extend knowledge acquired in the 3 semesters of the M. Sc. program. The major project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of electronics under the supervision of a faculty from the electronics Department or in R & D institutes/Industry. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. Students will be required to 1) perform a literature search to review current knowledge and developments in the chosen technical area; 2) undertake detailed technical work in the chosen area using one or more of the following:

- Analytical models
- Computer simulations
- Hardware implementation

The emphasis of major project shall be on facilitating student learning in technical, project management and presentation spheres. Project work will be carried out individually. The M. Sc. project evaluation committee of the department shall evaluate the project work during the fourth semester in two phases. The first evaluation shall be conducted in the middle of the semester. This should be followed by the end semester evaluation. By the time of the first evaluation, students are expected to complete the literature review, have a clear idea of the work to be done, and have learnt the analytical / software / hardware tools. By the time of the second evaluation, they are expected to present the results of their progress in the chosen topic, write technical report of the study and results. They are expected to communicate their innovative ideas and results in reputed conferences and/or journals.
20-305-0001  MACHINE LEARNING

Prerequisites: Mathematics

Course Description: This course provides a broad introduction to machine learning and how to apply learning algorithms

Course Outcome: After the completion of the course the student will be able to

CO1 Design linear, nonlinear regression and logistic regression models Apply
CO2 Use ANN for solving ML problems Apply
CO3 Use SVM for solving ML problems Apply
CO4 Use unsupervised learning methods like clustering algorithms and dimensionality reduction algorithms Apply
CO5 Design ML system suitable to the type of data and evaluate the model performance Analyse

Course content:

Module 1: **Introduction**: Concept of learning models, Supervised Learning, Unsupervised Learning, Reinforcement Learning. Linear Regression with One Variable - idea of cost function, and gradient descent method for learning. Linear Regression with Multiple Variables- Multiple Features, Gradient Descent for Multiple Variables, Feature Scaling, Learning Rate, Normal Equation, Non-invertibility, Polynomial Regression, Logistic Regression-classification, hypothesis representation, decision boundary, cost function, optimization, multiclass classification.

Module 2: **ANN**: Introduction, mathematical model of neuron, activation functions, network architectures, Learning-cost function, gradient descent, optimisation, XOR problem, multilayer perceptron, back propagation algorithm, differentiability, feature scaling, initialization, stopping criteria.

Module 3: **SVM**: introduction, optimization objective, large margin classification, support vectors, Separating hyperplane approaches, support vector machine formulation, SVMs for Linearly Non Separable Data, SVM Kernels, Hinge Loss formulation

Module 4: **Unsupervised Learning**: Clustering: Introduction, k-means algorithm, optimization, random initialization, clustering. Dimensionality Reduction: Data compression, visualization, principal component analysis algorithm, reconstruction from compressed representation

Module 5: **ML System Design and Evaluation Measures**: Learning with large datasets, stochastic gradient descent, batch and mini-batch gradient descent. Evaluating a Hypothesis, Model Selection, Regularisation, Training Validation Testing, Diagnosing Bias vs. Variance. Two Class Evaluation Measures, Confusion Matrix, Precision Recall curve, ROC Curve, Area Under Curve(AUC)
References:

7. Simon Haykin, “Neural Networks and Learning Machines”, Pearson Education India; Third edition 2016
Prerequisites : None

Course Description : This course provides an overview of Robot mechanisms, Kinematics, dynamics, programming, control and Basics of Mobile Robots. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, controller design, actuators and sensors; embedded controller design

Course Outcome : After the completion of the course the student will be able to

CO1  Discuss the basic classification and structure of a robot. Understand

CO2  Use DH representation on a manipulator and determine the kinematic equation of the manipulator. Apply

CO3  Illustrate the concept of singularity by calculating Jacobian of a manipulator. Apply

CO4  Derive kinetic and potential energy in a robot manipulator using Euler–LaGrange Equation Understand

CO5  Explain the working and applications of various sensors and actuators used in robotics. Understand

CO6  Compare various programming and controlling techniques used in robotics. Understand

Course content :

Module 1 : **Introduction**: Definition, Robot Classifications – Cartesian, Cylindrical, Spherical Work Envelope, Types of joints, Prismatic, Revolute, Ball and socket, Number of Axes, Degree of freedom, Joint variables, Grippers - Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers

Module 2 : **Kinematics**: World frame, joint frame, end-effectors frame, Rotation Matrix, composite rotation matrix, Homogeneous Matrix, Link Coordinate, Denavit-Hartenberg representation, Arm equation, Tool Configuration. Ref:1, Chapter 2.


Module 4 : **Sensors and Actuators**: Potentiometric, Optical sensors - Optical Encoders, Absolute, Incremental, Quadrature decoding Encoder

**Module 5 :**

**Robot Programming & Robot Controllers:** Teach-in, Teach-Through, High-Level languages –robot talk, Comparison of teaching and programming methods, Software speedup, Robot Controllers – essential components, joint actuation and Sensing, Overload, Over current and stall detection methods, Position, Speed and Direction Sensing.

**References :**

Prerequisites: A basic course in Electromagnetic Theory and Transmission Line Theory Fundamentals

Course Description: In this course the basics of planar RF and microwave circuits are covered along with the various microwave integrated circuits components and fundamentals of monolithic microwave integrated circuits technology.

Course Outcome: After the completion of the course the student will be able to

CO1 Design of planar transmission line components. Apply
CO2 Explain the behaviour of microwave passive components. Understand
CO3 Describe the working of lumped elements in MICs. Understand
CO4 Explain the behaviour of non-reciprocal components in MICs. Understand
CO5 Appreciate the MMIC technology, fabrication and implementation. Understand

Course content:

Module 1: Planar Transmission lines: Strip line, Microstrip line, coplanar line, quasi-static models of microstrip line, effective permittivity, characteristic impedance, dielectric and conductor losses, substrates for MIC, slot line and coplanar waveguide.

Module 2: Microstrip Passive Components: Discontinuities in Microstrip lines and coplanar lines, step, bent, T-junction, Hybrid line coupler, parallel coupled line and directional couplers, Even and odd mode analysis, Branch line couplers, impedance transformers.

Module 3: Lumped Elements for MICs: Design and fabrication of lumped elements, circuits using lumped elements. Filters, Lumped constant Microstrip circuits


Module 5: MMIC Technology – Thick film and Thin film technology. Hybrid MIC’s. Monolithic MIC technology, fabrication process, testing methods, encapsulation and mounting of devices.

References:
Prerequisites : Basic C programming

Course Description : This course introduces object oriented programming using C++. It also discusses various data structures like stacks, queues, lists, trees and graphs. Various sorting and searching algorithms are also discussed.

Course Outcome : After the completion of the course the student will be able to

CO1 Develop programs with the concept of pointers and dynamic memory allocation. Apply
CO2 Develop object oriented programs for problems using C++. Apply
CO3 Compare the various sorting algorithms. Understand
CO4 Understand the various implementations of stacks, queues and lists. Understand
CO5 Understand various search strategies for trees and graphs. Understand

Course content :

Module 1 : Programming in C++: C++ Data Types, Simple data types, Programmer defined data types, Functions and Parameters, Pointers, Dynamic memory allocation, Static and Dynamic arrays, Structures, Pointers to structures, Input and Output, Classes, Constructors and Destructors, Copy operation.

Module 2 : Object oriented programming: Overloading operators, Overloading I/O operators, Encapsulation, Inheritance and Operator oriented design, Building derived classes, Polymorphism and Dynamic binding, Virtual Functions, Standard template Libraries, Case Study.

Module 3 : Searching and Sorting: Algorithm Efficiency, Searching: Linear and Binary search implementation Sorting: Bubble Sort, Selection Sort, Insertion Sort, Heap sort, Quick sort and Merge sort, Time and space complexity for sorting algorithms.


Prerequisites : None

Course Description : Understand the basic concepts of Computer Organization, and understand the key skills of constructing cost effective computer systems

Course Outcome : After the completion of the course the student will be able to

CO1 Describe the basic structure and function various components of a processor.

CO2 Design control path for a simple processor. Apply

CO3 Design various components in the data path for a processor. Apply

CO4 Analyse the different levels of memory in the processor. Apply

Course content :

Module 1 : Basic Structure of Computers: Stored program organization, Functional units of a computer, Software, Instructions set- formats, types and assembly language, Execution of an instruction- instruction cycle, data path and control path. Illustration of instruction execution using tools like EduMIPS64.


Control Design : Basic Concepts –Introduction – Hardwired Control, Microprogrammed Control, Design Example of a CPU Control unit.


Module 4 : Semiconductor Memories - RAM and ROM, Speed, Size and Cost - Using CACTI Model, Memory hierarchy in processors,

Cache Memory : Associative Mapping, Direct Mapping and Set Associative Mapping,

Study the effect of memory hierarchy using simulators like SimpleScalar.
Module 5: Main memory - Memory Address Map, Memory Connection to CPU, Virtual Memory – Segmentation, Address translation and protection, Memory management by Operating.

References:
8. https://www.edumips.org/
Prerequisites : None

Course Description : This course gives an overview of cellular communications. It provides details of the propagation mechanisms and difficulties faced in the channel during propagation. It gives an idea about the different multiple access techniques. The course also goes through the 4G systems and the latest wireless technologies.

Course Outcome : After the completion of the course the student will be able to

CO1 Apply the concepts in communication to understand cellular communication design.

CO2 Understand propagation mechanisms and path loss models.

CO3 Explain the effects of multipath on the propagation.

CO4 Understand different multiple access schemes.

CO5 Familiarizing 4G systems and latest wireless technologies.

Course content :

Module 1 : Cellular Networks: Introduction – Concepts of cell- Frequency Reuse – Channel Assignment Strategies, Handoff strategies – Interference and System Capacity, Trunking and Grade of Service- Improving capacity- Cell splitting and Sectoring. GSM, CDMA UMTS, LTE standards and specifications,


Module 3 : Multipath and Fading: Small Scale Multipath propagation, Impulse response Model, Parameters of Multipath Channel, Types of Small scale fading: due to multipath time delay spread and Doppler spread.


References:
Prerequisites: None

Course Description: This course deals with the basic numerical techniques and C-programming approach to implement the numerical techniques.

Course Outcome: After the completion of the course the student will be able to

CO1 Develop programs using arrays, pointers & structures Apply
CO2 Understand various numerical interpolation techniques Understand
CO3 Solve linear system of equations using numerical methods Apply
CO4 Perform integration and differentiation using numerical techniques Understand
CO5 Solve partial differential equation using numerical techniques Apply

Course content:


Module 5: **Boundary value problems:** Numerical solution of boundary value of problems, methods of finite differences, Partial Differential equations, solution of Elliptic, parabolic and hyperbolic PDE.

References:
Prerequisites : None

Course Description : This course deals with the basic overview of X86 family of microprocessor. It will discuss also include discussion of architecture, programming and interfacing of 8051 microcontroller.

Course Outcome : After the completion of the course the student will be able to

CO1 Discuss a basic computer system using 8086 microprocessor. Understand
CO2 Identify the various features in microprocessors from x86 family Understand
CO3 Explain the basic architecture of 8051. Understand
CO4 Write assembly language programs for 8051 microcontroller. Apply
CO5 Interface various input and output devices to design embedded systems using 8051 microcontroller. Analyse

Course content :

Module 1 : 8086 Microprocessor : History of microprocessors –Basics of computer architecture, the architecture of 8086, buses, memory/I/O mapping, Interrupt system, addressing modes, Introduction to programming the 8086, 8086 Computer System

Module 2 : x86 Microprocessor Family : Multiuser/Multitasking Operating System Concepts, Intel- 80286, 80386 and 80486 microprocessors.


Module 4 : Assembly Language Programming: Program status word - register banks - Addressing modes - instruction set –Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions, IO port programming, Assembly language program examples, programming using - timers, serial ports and interrupts.

Module 5 : System Design: Input Interfacing-key switches, ADC, sensors etc. , Output Interfacing- LED - 7 segment displays - LCD – relay interface –Stepper motor, programming and flowcharts (using assembly language).
References:


Prerequisites: Calculus and Matrices

Course Description: This course deals with digital images and processing of digital images for various applications like Image Enhancement, Image Restoration, Image Compression, Image Segmentation, Morphological Image Processing, Image Representation & Description.

Course Outcome: After the completion of the course the student will be able to

CO1. Apply basic image enhancement algorithms in practical applications
CO2. Evaluate basic 2D transforms needed for image processing
CO3. Identify basic problems of image degradation
CO4. Explain various image compression algorithms
CO5. Discuss basic image segmentation and representation strategies

Course content:

Module 1: Fundamentals of 2D Signals & Systems: 2D signals and Systems, separable and periodic sequence, Classification of 2D systems, 2D z-transform, 2D convolution through z-transform and matrix method, 2D correlation, 2D DFT and properties.

Module 2: Fundamentals of Digital Image Processing: Types of images – black & white, gray scale and color images, Basic relationship between pixels, Intensity transformations, Histogram processing, Spatial filtering, frequency domain filtering


Module 5: Image Segmentation: Classification of Image segmentation techniques, Thresholding, Edge based segmentation, Classification of Edges, Edge Detection, Edge Linking, Hough Transform, Region based image segmentation

References:
Prerequisites : 20-305-0002

Course Description : This course is aimed at learning basic and advanced techniques necessary for Robot motion planning, different Localization schemes, basics of Robot vision systems. Topics include Motion planning, Navigation techniques, Localization and mapping and robot vision.

Course Outcome : After the completion of the course the student will be able to

- **CO1** Discuss various locomotion techniques in mobile robot. Understand
- **CO2** Describe the various aspects of robot motion control. Understand
- **CO3** Understand challenges in robot motion planning and navigation. Understand
- **CO4** Use various Localization methods to locate a mobile robot. Apply
- **CO5** Analyse the various techniques involved in robot vision. Understand

Course content :

**Module 1 :** **Mobile Robots:** Introduction to Wheeled Robots, Classification of wheels, Fixed wheel, Centered Oriented Wheel, Off-centered oriented wheel, Swedish wheel, Mobile robot locomotion, Differential Wheel, Tricycle, Synchronous drive, Omni-directional, Ackerman Steering, Kinematics models of WMR.

**Module 2 :** **Robot Motion Control:** Robot Motion Planning, Path Planning, Geometric path, Obstacle avoidance, shortest path, Trajectory planning, The boundary conditions, Control Methods- Conventional Joint PID control, Computed torque, Nonlinear feedback, Adaptive Control, Variable Structure Control.

**Module 3 :** **Motion planning and Navigation:** Basics, Configuration Space, Obstacles, Motion Planning Methods, Roadmap Approaches, Visibility graphs, Voronoi diagram, Cell Decomposition, Trapezoidal Decomposition, Potential Fields, Bug Algorithms, RRT.


**References**

Prerequisites: A basic course in communication and microwave.

Course Description: The fundamental aspects of RF communication systems, Radar and GPS systems is covered in this course.

Course Outcome: After the completion of the course the student will be able to understand the fundamentals of RF propagation and methods to improve its quality; different types of radars; and the basics of satellite communication and GPS.

CO1: Understand the fundamental principles of RF propagation and methods to improve its quality.

CO2: Understand Radar fundamentals and analysis of range ambiguities.

CO3: Analyze Radar Signal characteristics

CO4: Understand different special purpose Radars

CO5: Understand the concept of Satellite communication

CO6: Understand the concept of GPS

Course content:

Module 1: RF propagation: Loss in free space; Atmospheric effects on propagations and diffraction effects, Various Fadings, Path Analysis: Unfaded signal level, Thermal noise Threshold: Frequency deviation. Antenna gain, Noise on FM radio link: Sources of noise, FM improvement threshold, Noise power ratio.


Module 4: Special purpose radars: Synthetic aperture radar, HF and over the horizon radar, Air surveillance radar, Height finder, Bistatic radar, Radar Beacons, Radar Jamming and Electronic Counter measures.
Module 5: Satellite Communication: Communication Satellites, INS, Trilateration, Hyperbolic navigation, Transit, GPS; principle of operation, architecture, operating frequencies, orbits, Keplerian elements. Solar and Sidereal days, GPS and UTC Time.

References:
1. Freeman, "Radio system Design for telecommunications", Wiley 1997
Prerequisites:

Course Description: This course provides an understanding to the students in the various aspects of embedded software and real time systems. It covers factors affecting embedded software along with methodologies in task scheduling, communication and resource management.

Course Outcome: After the completion of the course the student will be able to

CO1 Discuss factors influencing embedded software. Understand

CO2 Solve Resource and priority management issues faced in an embedded system Apply

CO3 Provide an understanding of Real Time Operating Systems and its scheduling algorithms Understand

CO4 Discuss the major task scheduling and communication algorithms Understand

CO5 Make feasible schedules using various scheduling algorithms Analyze

Course content:

Module 1: Factors influencing Embedded system design: CPU and memory types, Direct memory access, Interrupt basics, interrupt latency, disabling and masking interrupts, Shared data problems, atomicity, critical section.


Module 4: Communication and resource management: Message queue, mailbox, pipes. Inter-task communication, Blocking and non-blocking task synchronization. Nested interrupts, resource management, deadlock, starvation, pre-emption, priority inversion, priority inheritance, priority ceiling protocol.

Module 5: Embedded software development tools: Host and target machines, cross compilers, Linker, locator, emulators, in-circuit emulators, monitors. The IEEE POSIX standard for programming, POSIX Threads, POSIX semaphores and shared memory.
References:

1. An Embedded Software Primer - David E. Simon, Pearson Education.
Prerequisites: A basic course in Electromagnetics

Course Description: This course gives the student the basic principles of radiation and its different parameters. An overview on the operation of different standard antennas, arrays, printed structures and smart antenna concepts are further explored.

Course Outcome: After the completion of the course the student will be able to

CO1 Understand the fundamental principles of antenna radiation and its parameters.
CO2 Understand different antenna types and their designs.
CO3 Employ antenna array principles and design antenna arrays.
CO4 Design antennas for a given set of parameters.
CO5 Describe the operation of planar antennas.
CO6 Understand the concept of smart antennas.

Course content:

Module 1: Radiation of EM waves: Radiation mechanism, Theories of radiation, Antenna parameters, Image theory, Polarisation, Friis transmission formula, Effective aperture, EIRP, Antenna Measurements.

Module 2: Antenna structures: Wire antennas and Aperture antennas, dipoles, loops, helical antenna, horns, lens and reflector antennas, log periodic antennas.

Module 3: Antenna Arrays: Arrays of two isotropic point sources, Uniform N element array, Array factor, Pattern multiplication, Linear arrays, Uniform and Non uniform amplitude distribution, Binomial, Chebyshev and Taylor’s distributions.

Module 4: Printed antennas: Rectangular and circular patch antenna design, Feeding techniques for micro strip antennas, Printed antenna arrays, Band width enhancement techniques.

References:

Prerequisites: 20-305-0005 Computer Organization

Course Description: The course involves discussion of various modern processor architectures such as Superscalar, Multiprocessor, Vector and GPUs. It also includes a brief overview of domain specific architecture for Deep Neural Networks.

Course Outcome: After the completion of the course the student will be able to

CO1 Analyse the various optimization techniques based on instruction level parallelism in modern Superscalar processors. Apply

CO2 Illustrate the architecture of processors that exploit thread level parallelism to improve performance. Understand

CO3 Discuss the architecture of vector processors and GPUs that exploits data level parallelism to improve performance. Understand

Course content:

Module 1: Classes of Computers, Parallelism and Parallel Architectures, Instruction Level Parallelism (ILP) – Pipelining-hazards, implementation, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs Branch Prediction, Illustration of pipelining using tools like EduMIPS64.

Module 2: Instruction Level Parallelism: Dynamic Scheduling: Examples and the Algorithm, Hardware-Based Speculation, Multiple Issue processors - Static Scheduling, Dynamic Scheduling with Speculation.


Module 4: Data Level Parallelism in Vector Processor – Vector Architecture RV64V, Vector Execution Time, Multiple lane execution, Vector length registers, Memory Banks to supply bandwidth, Handling - Multidimensional Arrays and Sparse Matrices, Programming Vector Architectures.

Module 5: Data Level Parallelism in GPU – Programming the GPU, NVIDIA GPU Computational Structures, Instruction Set, Conditional Branching in GPU, Memory Structures, Example program – Parallel Matrix Multiplication on GPU.
References

2. https://www.edumips.org/
Prerequisites : Mathematics

Course Description : This course provides a broad overview to neural networks and its design approaches.

Course Outcome : After the completion of the course the student will be able to

CO1 Mathematically model a neuron Understand
CO2 Model a linear regressor/classifier using a perceptron model Apply
CO3 Solve non-linear problems using multi-layer neural network Apply
CO4 Implement better training algorithms for neural network Analyse
CO5 Model RBFN networks to solve non-linear problems with kernel functions Understand

Course content :


Module 3 : Multilayer Perceptron: Batch learning and Online learning, Back propagation algorithm, XOR problem, heuristics for making the back-propagation algorithm perform better, activation functions, differentiability, symmetric, feature scaling, initialization, stopping criteria.


Module 5 : Kernel Methods and Radial-Basis Function networks: Cover’s theorem on the separability of patterns, the interpolation problem, radial-basis-function networks, k-means clustering, recursive least-squares estimation of the weight vector, hybrid learning procedure for RBF networks

Prerequisites : Mathematics

Lab Description : This lab provides experiments to implement machine learning algorithms using Python with the help of open source libraries such as TensorFlow, Keras, etc.

Course Outcome : After the completion of the lab the student will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Design linear, nonlinear regression and logistic regression models</th>
<th>Apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Use ANN for solving ML problems</td>
<td>Apply</td>
</tr>
<tr>
<td>CO3</td>
<td>Use SVM for solving ML problems</td>
<td>Apply</td>
</tr>
<tr>
<td>CO4</td>
<td>Use unsupervised learning methods like clustering algorithms and dimensionality reduction algorithms</td>
<td>Apply</td>
</tr>
<tr>
<td>CO5</td>
<td>Design ML system suitable to the type of data and evaluate the model performance</td>
<td>Analyse</td>
</tr>
</tbody>
</table>

Sample List of Experiment* :

1. Python and Jupyter notebook familiarisation
2. Implement the Linear and Logistic Regression model with gradient descent optimisation
3. Implement an artificial neural network models and optimise using back propagation algorithm.
5. Solution proposal for a real world problem, model a neural network, pre-process the data, train the model and evaluate the performance and improve the learning through parameter tuning.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites: None

Lab Description: This lab provides students with the skill to design simple microcontroller based robots.

Course Outcome: After the completion of the lab the student will be able to

CO1 Interface different kinds of motors and sensors with a microcontroller. Apply

CO2 Design a robot joint using DC motor controlled by a closed loop system. Analyse

CO3 Design simple microcontroller based robot for required application. Analyse

Sample List of Experiment*

- Design, construct a DC motor driver using L298 with speed, overload and direction control.
- Design, construct and study a quadrature encoder for a given DC motor.
- Implement a closed loop control system for DC motor that maintains a constant speed of rotation (with 1%) different loads.
- Design and implement a simple line follower robot.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites :  RF & Microwave Systems

Lab Description : This lab familiarizes the student with the experimental set up for carrying out microwave measurements followed by characterising the various Microwave/RF components. In addition, this lab includes design/characterisation of various planar, passive and active microwave circuits using computer aided design tools.

Course Outcome : After the completion of the lab the student will be able to

CO1   Setup a X band microwave bench and carry out measurements using a slotted line.

CO2   Using an X band microwave bench characterize the various waveguide components and sources.

CO3   Familiarization of measurement with Network Analyzer.

CO4   Computer aided design of transmission lines, microwave filters, couplers & dividers and amplifier design.

CO5   Prepare the reports and present the results correctly.

COs to POs Mapping :

Sample List of Experiment*:

1. The Slotted Line (waveguide hardware, measurement of SWR, λg, impedance).
2. The Vector Network Analyzer (one-and two-port network analysis, frequency response).
3. The Gunn Diode and Klystron source (the spectrum analyzer, power meter, V/I curve).
4. Impedance Matching and Tuning (stub tuner, λ/4 transformer, network analyzer).
5. Cavity Resonators (resonant frequency, Q, frequency counter).
7. Computer Aided Design and Testing of
   - Planar Transmission Lines
   - Planar Filters
   - Amplifiers
   - Oscillators
* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites : 

Lab Description : The objective of this lab is to introduce object oriented programming in C++ and implement various data structures in C++.

Course Outcome : After the completion of the lab the student will be able to

CO1 Develop object oriented programs in C++ for real life problems Analyze
CO2 Study programs with dynamic memory allocation and understand the concept of memory leaks Understand
CO3 Implement the various sorting algorithms for large arrays with C++ and compare the execution time Apply
CO4 Implement linked lists, stacks and queues, bst with C++ and use these implementations for practical problems. Analyze

Sample List of Experiment* : 

1 Arrays: Write a program to add and multiply two large integers with more than 100 digits. The numbers are stored in arrays with each element storing a block of digits.
2 Structures: Write a program to store and manage the details of all students in a class.
3 C++ Procedural Program: Develop a procedural program to implement a Time datatype.
4 Class: Develop an object oriented program to implement a Time datatype.
5 Class, Operator Overloading: Implement a class for complex numbers with methods for input and output, add, subtract, multiply, modulus, conjugate operators.
6 Inheritance: Develop an object oriented program for managing payroll in a company.
7 Study programs with Out of range indices for arrays, pointers and pointer dereferencing, memory allocation failures
8 Bubble sort, Insertion sort, merge sort and quick sort for large arrays
9 Linked list for storing student records
10 Evaluating post fix expressions using stacks
11 BST inorder, preorder and post order traversals.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites : Image Processing

Lab Description : Implementation of basic image processing algorithms in Octave/MATLAB/Python

Course Outcome : After the completion of the lab the student will be able to

CO1 To familiarize basic programming environment for image processing Understand in OCTAVE/MATLAB/Python

CO2 To familiarize image processing toolbox available in Understand OCTAVE/MATLAB/Python

CO3 To implement basic image enhancement algorithms in spatial domain Apply

CO4 To implement 2D filters for image enhancement in frequency domain Apply

CO5 To analyse the images for high frequency contents Apply

Sample List of Experiment* : OCTAVE/MATLAB/Python Implementation of

- Basic image manipulation operations
- Image enhancement in spatial domain
- 2D filters for frequency domain image enhancement
- Edge detection algorithms
- Image segmentation methods

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites: None

Lab Description: The lab includes experiments using SCARA robot. This lab provides students with the skill to design robots specific applications like range finding and obstacle detection.

Course Outcome: After the completion of the lab the student will be able to

- **CO1** Program SCARA robot to perform tasks. Apply
- **CO2** Interface Ultrasonic, Doppler, Lidar range finder module to a microcontroller. Apply
- **CO3** Design simple robots using the various interface. Apply

Sample List of Experiment*:

1. Find the accuracy, repeatability and work envelop of SCARA robot.
2. Program the SCARA robot for transfer of a stack of objects from one position to another.
3. Interface the given Lidar range finder to a microcontroller to find the range and display the same on LCD.
4. Interface a standard Ultrasonic module to a microcontroller to find the range and display the same on an LCD.
5. Interface the given Doppler radar module to find an obstacle and plot the waveform in a PC.
6. Interface the given Inertial Measurement Unit to a microcontroller and find the 3-axis acceleration and orientation.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites: None

Lab Description: This lab familiarizes the student with the simulation and experimental set up for carrying out antenna measurements followed by characterising the various standard antennas. It also familiarises the student with the significance of EMI EMC and their impact in RF circuit design using appropriate experiments and simulation studies.

Course Outcome: After the completion of the lab the student will be able to

CO1 Understand the principle of radiation, describe its parameters and measure them.

CO2 Design and Simulation of different antennas using CAD tools Apply

CO3 Analyse the simulated and measured results with inference. Analyse

CO4 Understand the impact of undesired radiation in electronics circuit design Understand

CO5 Understand the impact of crosstalk, placement of components etc. on EMI. Apply

CO6 Prepare the reports and present the results correctly. Apply

Sample List of Experiment*:

1. Familiarization with antenna measurement setup.

2. Computer aided design, simulation and analysis of basic antenna types: Dipole, Horn (different types), Patch (various types of feed and different polarizations).

3. Measurement of antenna characteristics from the radiation patterns of standard antennas: Horn, Dipole, Vivaldi, Spiral etc.

4. To measure radiated emission from mobile tower and mobile phone.

5. To measure the Shielding Effectiveness of different types of conducting materials against radiated emissions in electronic circuit boards.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites: Embedded System Laboratory

Lab Description: This lab will involve working on software tools and programming software for real time systems.

Course Outcome: After the completion of the lab the student will be able to

CO1 Familiarize with parallel programming primitives and deadlock situations
CO2 Implement thread safe programs for parallel threaded environments
CO3 Porting an open source RTOS into development boards for demonstrating real world scenarios
CO4 Modify and customize operation of an RTOS to desired specifications
CO5 Propose and design solutions for real world problems using Real Time Operating Systems

Sample List of Experiment*:

1. Implement a parallel program demonstrating dining philosopher problem, which can result in a deadlock. Apply thread protection using semaphores to avoid deadlock situations.

2. Write a POSIX thread program with 25 threads generating a random number in them. The main thread should find the sum of all random numbers and the sum of all thread ids. Display these sums and end the child threads safely.

3. Write a POSIX program to design a producer consumer example with buffer of size 10 between them. There should be checks in place using semaphores to avoid writing to full buffer and to prevent reading from empty buffer.

4. Port FreeRTOS into Arudino board and write a program to blink LED for a fixed duration.

5. Port FreeRTOS into XILINX Zybo board containing ARM processor using VIVADO. Flash sample program to blink LEF for a fixed duration.

6. Demonstrate multi-level queue scheduling with pre-emption in FreeRTOS using a custom program.
7. Design project: Define a real time system, which requires an RTOS schedule as a solution. Implement it using FreeRTOS and demonstrate in a board of your choice.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
Prerequisites

Lab Description: This lab has two parts. The first part deals with the simulation, characterisation and layouts of basic complementary CMOS combinational and sequential circuits. The second part deals with implementation of embedded systems on FPGAs.

Course Outcome: After the completion of the lab the student will be able to

CO1 Study the delay and power dissipation of various CMOS combinational logic styles.

CO2 Study the various timing parameters like setup time and hold time for CMOS sequential logic families.

CO3 Implement embedded systems consisting of programmable logic and microblaze softcore processors.

CO4 Implement embedded systems on Zync FPGAs using programmable logic and processor system.

Sample List of Experiment*:

1. Study the characteristics of NMOS and PMOS transistors with varying length and width
2. Simulate basic complementary CMOS NAND and NOR gates and characterize for delay and power
3. Simulate and characterize past transistor and transmission gate logic functions and compare with complementary CMOS gates
4. Draw the layout for basic gates like NAND, NOR, transmission gate based XOR gate etc., extract the parasitics and characterize for delay and power
5. Simulate static and dynamic sequential circuits and study setup and hold time
6. Implement a UART interface using microblaze and transfer data between PC and FPGA board
7. Implement an ALU in programmable logic, interface with microblaze and test using UART interface
8. Implement an ALU in programmable logic, interface with the processor system (PS) in ZYNC FPGA and verify the functionality using UART.

* The list is not exhaustive. Additional experiments or project based on the experiments can be included in the laboratory activity.
National Programme on Technology Enhanced Learning (NPTEL) is a project of MHRD initiated by seven Indian Institutes of Technology (Bombay, Delhi, Kanpur, Kharagpur, Madras, Guwahati and Roorkee) along with the Indian Institute of Science, Bangalore in 2003, to provide quality education to anyone interested in learning from IITs. The main goal was to create web and video courses in all major branches of engineering and physical sciences at the undergraduate and postgraduate levels and management courses at the postgraduate level. It is the largest online repository in the world of courses in engineering, basic sciences, and selected humanities and social sciences subjects, Online web portal http://nptel.ac.in.

Since 2013, through an online portal, 4-, 8-, or 12-week online courses, typically on topics relevant to students in all years of higher education along with basic core courses in sciences and humanities with exposure to relevant tools and technologies, are being offered. An in-person, proctored certification exam and a certificate is provided through the participating institutions and industry, when applicable.

Massive Open Online Courses (MOOCs) are free online courses available for anyone to enroll. MOOCs provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale.

The students have to complete a minimum 8 week duration course which will yield them a credit of 3. The selection of the course should be approved by the committee constituted for the same.