Master of Science

(M.Sc.) Degree Program

ELECTRONIC SCIENCE

Outcome Based Syllabus

DEPARTMENT OF ELECTRONICS
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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 nourish and tone the legendary status in the field of Electronics by inspiring knowledge seekers to meet the challenges of evolving technology through innovative practices.

MISSION

M1 : *To strengthen technical education in Electronics for graduates by utilising the state of the art facilities and adopting latest trends in technology.*

M2 : *To impart knowledge and skills so as to kindle innovation & creativity among students leading to a progressive global career in industry & academy.*

M3 : *To facilitate best opportunities for challenging young minds fostered through interaction with leading research organizations as well as industry.*

M4 : *To develop and sustain a culture of focused work based on societal needs.*

M5 : *To provide with avenues for recognition by participation in challenging platforms, while upholding values, ethics and professionalism.*

QUALIFICATION DESCRIPTORS (QDs) :

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

QD-Mission matrix :

Mission	QD1	QD2	QD3
M1	✓	✓	
M2		✓	✓
M3	✓		✓

PROGRAMME LEARNING OUTCOMES (POs) : At the end of the program the student will be able to:

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

QD – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
QD1	✓	✓	✓	✓		
QD2	✓		✓		✓	✓
QD3				✓	✓	✓

Course Structure

Semester I

Course Code	Course	C/E	Credits
20-305-0101	Electronic Circuits	C	4
20-305-0102	Signals & Systems	C	4
20-305-0103	Digital System Design	C	4
20-305-0104	RF & Microwave Technology	C	4
20-305-0105	Programming for Embedded Systems(Lab oriented)	C	4
20-305-0106	Electronic Circuits Lab	C	1
20-305-0107	Signals & Systems Lab	C	1
	Core credits		**22**

Semester II

Course Code	Course	C/E	Credits
20-305-0201	Embedded System Design	C	4
20-305-0202	Control Systems	C	4
20-305-0203	Digital Signal Processing	C	4
20-305-0204	Seminar	C	1
20-305-0204	Embedded System Design Lab	C	1
20-305-0205	Control Systems Lab	C	1
	Core credits		**15**
	Elective I		**3**
	Total Credits		**18**

Semester III

Course Code	Course	C/E	Credits
20-305-0302	Project Part 1	C	0
20-305-0302	Communication Systems	C	4
20-305-0303	VLSI System Design	C	4
20-305-0304	Communications Lab	C	1
	Core credits		**9**
	Elective II		**3**
	Elective III		**3**
	Elective Lab		**1**
	Total Credits		**16**

Semester IV

Course Code	Course	C/E	Credits
20-305-0401	Project Part 2	C	13
	Core credits		**13**
	Elective IV		**3**
	Total Credits		**16**

List of Electives*

20-305-0X07	Machine Learning		E	3
20-305-0X08	Robotics Technology		E	3
20-305-0X09	Microwave Integrated Circuits		E	3
20-305-0X10	Data Structures		E	3
20-305-0X11	Computer Organisation		E	3
20-305-0X12	Wireless Communication		E	3
20-305-0X13	Computational Techniques		E	3
20-305-0X14	Microprocessors and Microcontrollers		E	3
20-305-0X15	Image Processing		E	3
20-305-0X16	Robotics and Intelligent Systems	20-305-0X08	E	3
20-305-0X17	Radar and Satellite Communication		E	3
20-305-0X18	Embedded Software and Real Time Systems		E	3
20-305-0X19	Antennas		E	3
20-305-0X20	Computer Architecture		E	3
20-305-0X21	Neural Networks		E	3
20-305-0X22	Machine Learning Lab	20-305-0X07	E	1
20-305-0X23	Robotics Technology Lab	20-305-0X08	E	1
20-305-0X24	Microwave Circuits Lab	20-305-0X09	E	1
20-305-0X25	Data Structures Lab	20-305-0X10	E	1
20-305-0X26	Image Processing Lab	20-305-0X15	E	1
20-305-0X27	Robotics and Intelligent Systems Lab	20-305-0X16	E	1
20-305-0X28	EM Radiation Lab	20-305-0X17	E	1
20-305-0X29	Embedded Software Lab	20-305-0X18	E	1
20-305-0X30	VLSI System Design Lab	20-305-0X19	E	1
20-305-0X31	MOOC/NPTEL Course		E	3

Total credits - 72

* Electives offered will be subject to availability of expertise in the field.
X- Semester

20-305-0101 **ELECTRONIC CIRCUITS**

L	T	P	C
4	1	0	4

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 3 : **Feedback and Stability:** Concept, Negative Feedback Loop, General Requirements of Feedback Circuits, Effect of Feedback on Amplifier, Performance, The four Basic Amplifier types, The four feedback Topologies, Effect of Feedback Connection on Amplifier Port Resistance, Examples of Real Feedback Amplifiers, Feedback Loop stability. Feedback oscillators; RC phase shift, Colpitts, Hartley, wein bridge, crystal oscillators.

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 :

1. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, McGraw Hill Book Company 1998.
2. Ned Mohan et.al, “Power Electronics”, John Wiley and Sons, 1989
3. Mark N. Horenstein, “Micro Electronics Circuits and Devices” (Chapter 2 & 10) PHI, 1997.
4. B. Razavi , “Fundamentals of Microelectronics”, Wiley
5. Donald A. Neamen, “Electronic Circuit Analysis and Design”, 3/e, TMH, 2006
6. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, TMH, 2010
7. Spencer and Ghausi: “Introduction to Electronic Circuit Design”, Pearson Education, 2003.
8. R. E. Boylstead and L. Nashelsky: “Electronic Devices and Circuit Theory”, 10/e, PearsonEducation, 2009.
9. Gaykward, “Operational Amplifiers”, Pearson Education, 1999
10. Coughlin R. F. and Driscoll F. F., “Operational Amplifiers and Linear Integrated Circuits”, Pearson Education 2002
11. P. S. Bimbhra, “Power Electronics”, Khanna publishers, 2012
12. Sen P. C., “Power Electronics”, Tata Mc Graw Hill,2003
13. Rashid, “Power Electronics”,Prentice Hall India,1993
14. G. K. Dubey et.al, “Thyristorised Power Controllers”, Wiley & Sons, 2001
15. Dewan and Straughen, “Power Semiconductor Circuits”, Wiley & Sons, 1984
16. Singh M. D. & Khanchandani K. B., Power Electronics, Tata Mc Graw Hill, 1998

20-305-0102 **SIGNALS & SYSTEMS**

L	T	P	C
4	1	0	4

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

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 2 : **Fourier analysis for continuous time signals and systems:** Representation of periodic signals: Continuous Time Fourier Series, convergence of Fourier series, Gibbs phenomenon, Representation of aperiodic signals: Continuous Time Fourier Transform, The Fourier Transform for periodic signals, Properties of Fourier representations, Frequency Response of systems characterized by linear constant coefficient differential 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 :

1.Alan V. Oppenheim Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”, 2nd Edition, Pearson Education India, 2015
2.Simon Haykin and Barry V. Veen, “Signals & Systems”, John Wiley, 2nd Edition, 2007
3.B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2004.
4.Taylor F. H., “Principles of Signals & Systems”, McGraw Hill, 1994
5.Lathi B. P., “Modern Digital & Analog Communication Systems”, Third edition, Oxford University Press, 2001
6.R. F. Ziemer, W. H. Tranter and D. R. Fannin, “Signals and Systems - Continuous and Discrete”, 4thedition., Prentice Hall, 1998
7.Douglas K. Lindner, "Introduction to Signals and Systems", Mc-Graw Hill International Edition,1999.
8.Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons (SEA) Private Limited, 1995.
9.M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", Tata McGraw Hill Edition, 2003

20-305-0103 **DIGITAL SYSTEM DESIGN**

L	T	P	C
4	**1**	**0**	**4**

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 1 : **Review of Digital Systems and Combinational logic design:** Number Systems and Conversion, Binary Arithmetic, Boolean Algebra - Basic operations, Expressions and Truth tables, Theorems and Laws, Min-term and Max-term Expansions, K-maps, Quine-McCluskey Methods.

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 :

1. Charles H. Roth Jr. “Fundamentals of Logic Design”, 5th edition, Cengage Learning 2009
2. Charles H. Roth Jr. Lizy Kurian John, Beyeong Kil Lee, “Digital Systems Design Using Verilog”, CL Engineering, 1st edition, 2015
3. Samir Palnitkar, “Verilog HDL”, Pearson Education, 2nd edition, 2004
4. Morris Mano, “Digital Logic Design”, Fourth Edition, Pearson Publication,2008
5. Nripendra N. Biswas “Logic Design Theory” Prentice Hall of India, 2001
6. Parag K. Lala “Digital system Design using PLD” B S Publications, 2003
7. John F. Wakerly, “Digital Design - Principles and Practices”, Pearson, 4th edition, 2008.
8. Victor P. Nelson, H. Troy Nagle, J. David Irvin, Bill D. Carol, “Digital logic Analysis and design”, 1st edition, Prentice Hall Publications

20-305-0104 **RF & MICROWAVE TECHNOLOGY**

L	T	P	C
4	1	0	4

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.	Understand
CO2	Evaluate the concept of distortion due to noise and fundamentals of antennas and propagation.	Apply
CO3	Understand the working and types of various microwave sources.	Understand
CO4	Describe the various passive components.	Understand
CO5	Describe the working and design of a microwave amplifier, an oscillator and a mixer and compare the performance of its various types.	Understand
CO6	Evaluate the design of an RF system.	Apply

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 2 : Noise and Distortion - Noise, Noise figure, Noise temperature, Dynamic range, Intermodulation distortion. Antennas & Propagation - Antenna fundamentals, Propagation, Radar equation, Communications Link equations, Satellite fundamentals

Module 3 : Microwave devices: Limitations of conventional tubes at microwave frequencies Two cavity Klystron and reflex Klystrons, Magnetron and Travelling Wave Tubes, Microwave Solid State Devices, Transferred Electron devices, Gunn effect, PIN diode, YIG Devices.

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 :

1. Microwave and RF Design of Wireless Systems, David M. Pozar, John Wiley & Sons, 2001.
2. Stephen C. C. Harsany: `Principles of Microwave Technology', Prentice Hall, 1997.
3. Peter A. Rizzi, Microwave Engineering: Passive Circuits. New Delhi : PHI, 2001.
4. Edward C. Jordan, Electromagnetic waves and Radiating Systems. 2nd Edition, Pearson, 2015.
5. Robert E. Collin, Foundations for Microwave Engineering, McGraw Hill, 1998.
6. D. M. Pozar, Microwave Engineering, 4th edition, John Wiley and Sons (ASIA), 2011.
7. Paul C. R. and S. A. Nassar, " Introduction to Electromagnetic fields ", McGraw Hill, 1987.

20-305-0105 **PROGRAMMING FOR EMBEDDED SYSTEMS**

L	T	P	C
4	0	2	4

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 1 : **Introduction:** Embedded Systems- Software, Processors, Programming Languages, Operating Systems, Applications. GNU/Linux OS, Architecture, GNU Compiler toolchain:- gcc, debugging, building. Introduction to C, Simple C programs, Desirable program characteristics

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, multifile 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 backwords. 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 :

1. Byron S. Gottfried, Programming with C, Schaumm’s Outline Series, McGraw Hill Education India - 4th Edition, 2018
2. Daniel W. Lewis, “Fundamentals of embedded software where C and assembly meet”, Pearson Education, 1st Edition 2001

References :

1. Brian W. Kernighan, Dennis M. Ritchie, C Programming language, Prentice Hall; 2nd edition, 1988
2. M. Tim Jones, GNU/Linux Application Programming, Charles River Media, Inc, 2008
3. Michael J Pont, Embedded C, Addison-Wesley Professional, 2002
4. Exploring C for Microcontrollers- A Hands on Approach ,Jivan S. Parab, Vinod G. Shelake, Rajanish K.Kamot, and Gourish M.Naik, Springer, 2007
5. David E. Simon, An Embedded Software Primer, Pearson Education, 2003.

20-305-0106 **ELECTRONIC CIRCUITS LAB**

L	T	P	C
0	0	4	1

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.

20-305-0107 **SIGNALS & SYSTEMS LAB**

L	T	P	C
0	**0**	**4**	**1**

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	Understand
CO2	To understand the basic signal processing operations in Octave/MATLAB/Python	Understand
CO3	To plot basic elementary signals and perform fundamental operations on signals	Understand
CO4	To implement frequency domain analysis techniques using Octave/MATLAB/Python	Apply
CO5	To analyse the stability of systems using Octave/MATLAB/Python	Apply

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.

20-305-0201 **EMBEDDED SYSTEM DESIGN**

L	T	P	C
4	1	0	4

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	Understand
CO2	Study the impact of optimizations on processor and memory affecting efficiency of embedded systems	Analyze
CO3	Program embedded system devices to implement applications	Apply
CO4	Review commercial embedded platforms and their features	Understand
CO5	Interface embedded system with external devices	Apply

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 2 : **Embedded system programming:** Compiler, cross-compiler, interpreter. Review of PIC16F88X block diagram, features & Peripherals, instruction set, timers, counters, ports, interrupts. Programming the PIC16F88X: Capture, compare, PWM Module, Power saving modes. Programming peripherals: Real Time Clock, Pulse Width Modulation, Stepper motors, LCD.

Module 3 : **Embedded Processors and Optimizations:** Evolution of Intel processors, Pentium processor architecture, Out of order execution, branch prediction, register renaming. Pipeline conflicts and Hazards. **Memory Design and Optimizations:** Caches, multi-levels, placement and replacement policies, Cache hit and miss Cache performance and prediction. Address translation, base and bound registers, paging.

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, I^2C, USB. Analog interfacing and applications, Analog to Digital Convertors: Properties, Parallel Comparator, Dual Slope and Successive Approximation methods.

References :

1. A. Silberschatz, P. B.Galvin and G. Gagne, Operating System Concepts (6th ed.), John Wiley & Sons, Inc., 2001
2. Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", McGraw HillBook, Company, 1986
3. Microchip - Microcontroller application notes / data sheets.
4. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, Second Edition, Newnes, 2009, ISBN: 978-0-12-382090-7
5. LPC User Manual: www.nxp.com/documents/user_manual/UM10375.pdf
6. LPC Datasheet: www.nxp.com/documents/data_sheet/LPC1311_13_42_43.pdf
7. Daniel W. Lewis, Fundamentals of Embedded Software, where C and assembly meet, Pearson Education 2001.
8. John B. Peatman, Design with PIC Microcontrollers, Pearson Education, 1997.
9. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Elsevier Publication 2000.
10. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide – Designing and Optimizing System Software, Elsevier Publications, 2007.

20-305-0202 **CONTROL SYSTEMS**

L	T	P	C
4	1	0	4

Prerequisites : Signals & Sytems

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 :

1. Ogata K., "Modern Control Engineering", 5th Edition, Pearson, 2010
2. Ogata K., “Discrete Time Control Systems", 2nd Edition, Prentice Hall India, 2005
3. Norman S. Nise, “Control Systems Engineering”, 6th Edition, John Wiley & Sons, Inc., 2010

4. Richard C. Dorf & Robert H. Bishop, "Modern Control Systems", 12th Edition, Prentice Hall, 2010
5. Benjamin C. Kuo, "Digital Control Systems", Second Edition, Oxford University Press, 2012
6. Nagarath I. J. & Gopal M., “Control System Engineering”, 6th Edition, New Age International Pvt. Ltd., 2018
7. M. Gopal “Control System Principles and Design” 4th Edition, McGraw Hill Education, 2012
8. A. Nagoor Kani, “Control Systems”, RBA Publications, 2017
9. A. Nagoor Kani, “Advanced Control Theory”, 2nd Edition, RBA Publications, 2009

20-305-0203 **DIGITAL SIGNAL PROCESSING**

L	T	P	C
4	1	0	4

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 :

1.John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications,” Pearson Education, 4th edition, 2007.
2.Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK", John Wiley & Sons, Inc., 2005

3.Mitra S. K., “Digital Signal Processing: A Computer Based Approach,” McGraw-Hill Publishing Company, 1998.
4.Oppenheim A. V., Schafer R. W., “Discrete-Time Signal Processing,” Prentice Hall India, 1996.
5.Chi-Tsong Chen, “Digital Signal Processing: Spectral Computation and Filter Design,” Oxford University Press, 2001.
6.Lonnie C. Ludeman, “Fundamentals of Digital Signal Processing,” John Wiley& Sons, NY, 1986.
7.R. E. Bogner, A. G. Constantinidis, (Editors), “Introduction to Digital Filtering,” John Wiley & Sons, NY, 1975.
8.Emmanuel C. Ifeacher, Barry W. Jervis, “Digital Signal Processing: A Practical Approach,” 2nd edn., Pearson Education, 2004.
9.Boaz Porat, “A Course in Digital Signal Processing,” Prentice Hall Inc, 1998.

20-305-0204 **SEMINAR**

L	T	P	C
0	**0**	**2**	**1**

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

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.

20-305-0205 **Embedded Systems Design Lab**

L	T	P	C
0	**0**	**4**	**1**

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.

6. Familiarization of deployment flow ARM Development Kit, Keil Mvision IDE, Flash Programming. Flash a sample blinky program into ARM Cortex M3.

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.

20-305-0206 **CONTROL SYSTEMS LAB**

L	T	P	C
0	**0**	**4**	**1**

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	Apply
CO2	Study characteristics of control components like DC motor, compensator etc.	Understand
CO3	Analyse the stability of physical systems represented as transfer functions	Analyze
CO4	Simulate first order and second order systems and understand the performance	Understand

Sample List of Experiment* :

1 Familiarize with Matlab

2 Represent Polynomials in Matalab

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.

20-305-0301	**PROJECT PART 1**

L	T	P	C
0	**1**	**0**	**0**

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 to1) 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.

20-305-0302 **COMMUNICATION SYSTEMS**

L	T	P	C
4	1	0	4

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.	Understand
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.

Module 5 : **Digital communication systems:** Probability and random variables – stochastic processes, gaussian probability distribution, sources of noise, performance level of digital data transmission in the presence of AWGN, Optimum Receiver Filter-Matched Filter.

References :

1. B.P. Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems”, Oxford University Press, 4th Edition, ISBN 978-0-19-538493-2, 2010.

2. S. Haykin, Communication Systems, John Wiley and Sons, 4th Edition, ISBN 9788126509041, 2006.
3. R.E. Ziemer and W. H. Tranter, Principles of Communications, Wiley, 7th edition, ISN 9781118078914, 2014.
4. Herbert Taub and Donald L. Shilling, “Principles of Communication Systems”, McGraw-Hill, 3rd edition, ISBN 9780070648111, 2007.

20-305-0303 **VLSI SYSTEM DESIGN**

L	T	P	C
4	**1**	**0**	**4**

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	Understand
CO2	Understand the syntax and functionality of a given C program	Understand
CO3	Implement a basic system with controller and datapath on FPGAs	Apply
CO4	Develop embedded systems using micro blaze softcore processors	Analyze
CO5	Develop embedded systems using Zync processors	Analyze

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 SofCores - 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 :

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits – A Design Perspective", Pearson Education India, 2 nd edition, 2016
2. Charles H. Roth Jr. Lizy Kurian John, Beyeong Kil Lee, "Digital Systems Design Using Verilog", CL Engineering, 1 st edition, 2015.
3. Samir Palnitkar, "Verilog HDL", Pearson Education, 2 nd edition, 2004

References :

1. W. Wolf, "FPGA- based System Design", Pearson, 1 st edition, 2004
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization", Wiley-IEEE Press, 1 st edition, 2007.
3. John F. Wakerly, "Digital Design - Principles and Practices", Pearson, 4 th edition, 2008.
4. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Publishing, 3 rd edition, 2005.
5. Xilinx FPGA user guides and University Program Course materials

20-305-0304 **COMMUNICATION SYSTEMS LAB**

L	T	P	C
0	0	4	1

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	Understand
CO2	To familiarize communication toolbox in MATLAB/Labview	Understand
CO3	To implement basic analog and digital modulation techniques in MATLAB/Labview	Apply
CO4	To analyse the effect of noise in digital communications system	Understand
CO5	Prepare the reports and present the results correctly.	Apply

Sample List of Experiment* **:** MATLAB/Labview Implementation of

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.

20-305-0401 **PROJECT PART 2**

L	T	P	C
0	0	24	13

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 to1) 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.

20-305-0X07 **MACHINE LEARNING**

L	T	P	C
3	**2**	**0**	**3**

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 :

1. Tom Mitchell, “Machine Learning”, McGraw-Hill 1997
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, “The Elements of Statistical Learning: Data Mining, Inference, and Prediction”, Second Edition, Springer Series in Statistics, 2016
3. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer - Information Science and Statistics, 2011
4. Shai Shalev Shwartz, Shai Ben David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014
5. Ethem Alpaydin, “Introduction to Machine Learning”, Second Edition, MIT Press, 2010
6. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012
7. Simon Haykin, “Neural Networks and Learning Machines”, Pearson Education India; Third edition 2016

20-305-0X08 **ROBOTICS TECHNOLOGY**

L	T	P	C
3	**2**		**3**

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 3 : **Robot Dynamics:** Velocity Kinematics, Jacobian, Singularities, Differential motion, Euler – LaGrange Equation, Expression of Kinetic and Potential Energy, Equations of Motion. Ref:1, Chapter 3

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

Resolution. Direction of rotation, Velocity and acceleration measurements. Actuators-Hydraulic and Pneumatic, Electrical actuators: DC motors, AC motors, Stepper motors, BLDC, Solenoids. Motor drives:. PWM and H-bridges, case study L298 based drive.

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 :

1. Fu K. S. ,et al “Robotics- Control, Sensing, Vision and Intelligence “, McGraw – Hill, 1987.
2. H. R. Everett, “Sensors for Mobile Robots – Theory and Applications”, A. K. Peteres Ltd. 1995, ISBN 1-56881-048-2.
3. Roland Siegwart, Illah R, Nourbakhsh, “Introduction to Autonomous Mobile Robots”, 2nd Edition, The MIT Press, 2011. ISBN 0-262-19502-X.
4. “Robotics and Automation Handbook”, Edited:Thomas R. Kurfees,, CRC Press 2005.
5. Selig J. M., “Introductory Robotics”,PHY(UK), 1992.
6. YoremKoren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
7. Groover M. P. et al., “Industrial Robotics – Technology, Programming & Applications”, McGraw-Hill., 2005

20-305-0X09 **MICROWAVE INTEGRATED CIRCUITS**

L	T	P	C
3	2	0	3

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 4 : **Nonreciprocal components for MICs:** Microstrip on Ferromagnetic substrates, Microstrip circulators. Isolators and phase shifters. Design of microstrip circuits – high power and low power 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 :

1. David M. Pozar, "Microwave Engineering", Wiley, 4th ed, Hoboken, NJ, ISBN 9780470631553, 2011.
2. Thomas H Lee, "Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits", Cambridge University Press, 2004.

3. Matthew M. Radmanesh, “Radio Frequency and Microwave Electronics Illustrated”, Prentice Hall, ISBN: 9780130279583, 2001.
4. R Ludwig & Bretchko, “RF Circuit Design, Theory and Applications”, Pearson Education Inc, ISBN: 9788131762189, 2011.
5. T. C. Edwards, ”Foundation for Microstrip Circuit Design,” Jone Willy & sons. 2000
6. E. H. Fooks & R. A. Zakarevicuis,” Microwave Engineering using Microstrip Circuits.” Prentice Hall. Sakti 2000
7. Hoffman R. K., “Handbook of Microwave Integrated Circuits”, Artech House, Boston, 1987.
8. Gupta K. C., and Amarjit Singh, Microwave Integrated circuits, Wiley Eastern,1974.
9. Bharathi Bhat and S. K. Koul, “Stripline-like transmission lines for microwave integrated circuits, New age international, 2007.

20-305-0X10 **DATA STRUCTURES**

L	T	P	C
3	**2**	**0**	**3**

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.

Module 4 : **Lists, Stacks & Queues & Binary Trees:** Array Based Implementation of lists, Linked Lists- Pointer Based Implementation, Stacks and Queues- Array based Implementation. Binary Tree- in-order, pre-order and post-order traversals - representation and evaluation of arithmetic expressions using binary tree.

Module 5 : **Search Trees & Graphs:** Binary Search trees - insertion, deletion and search Graphs- Directed Graphs, Adjacency-Matrix and Adjacency-List Representation, Depth First Search, Breadth First Search, Traversal and shortest path problems.

References :

1. Larry Nyhoff , “ADTs, Data Structures and Problem Solving with C++”, Second Edition, Pearson Education, 2012.

2. Sahni S., “Data Structures, Algorithms and Applications in C++”, McGraw-Hill Higher Education, 1999.
3. Yedidyah Langsam, Moshe J Augenstein, Aaron M Tenenbaum, “Data Structures Using C and C++” , Second Edition, PHI Publishers, 1996.
4. T. H. Cormen, C. E. Lieserson, R. L. Rivest, C. Stein, “Introduction to Algorithms (3/e)”, MIT Press, 2003.
5. S. Dasgupta, C. H. Papadimitriou, U. Vazirani, “Algorithms”, McGraw-Hill Higher Education, 2006.
6. A. V. Aho, J. D. Ullman and J. E. Hopcroft, “Data Structures and Algorithms”, Addison Wesley, 1983.

20-305-0X11 **COMPUTER ORGANIZATION**

L	T	P	C
3	2	0	3

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.	Understand
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.

Module 2 : Input/Output: I/O Devices, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access, I/O Channels. External Interconnection Standards – USB, SCSI, PCI Express

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

Module 3 : Datapath Design: Data Representation – Fixed Point Numbers, Floating Point Numbers, Fixed Point Arithmetic – Addition and Subtraction – Multiplication – Division – Arithmetic Logic Units – Shifters and rotators.

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.

External Memory – Magnetic disks, RAID, Solid State drives, Optical Memory, Magnetic Tape.

References :

1. Patterson D.A. & Hennessy J.L., "Computer Organization and Design", Morgan Kaufmann Publishers, 2002
2. John P. Hayes “Computer Architecture and Organization”, McGraw-Hill International Editions, Computer Science Series, 1998.
3. Morris Mano “Computer System Architecture”, Prentice-Hall India, Eastern Economy Edition, 2009
4. Carl Hamacher, Zvonko Vranesic & SafwatZaky, “Computer Organization”, Mc Graw Hill, 2001
5. Pal Choudhuri P., "Computer Organization and Design", Prentice-Hall India, 2nd Edition, 2003
6. William Stallings, "Computer Organization and Architecture", Pearson Education, 4th Edition, 2006
7. http://www.ecs.umass.edu/ece/koren/architecture/Simplescalar/
8. https://www.edumips.org/
9. https://www.hpl.hp.com/research/cacti/

20-305-0X12 **WIRELESS COMMUNICATION**

L	T	P	C
3	2	0	3

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.	Apply
CO2	Understand propagation mechanisms and path loss models.	Understand
CO3	Explain the effects of multipath on the propagation.	Understand
CO4	Understand different multiple access schemes.	Understand
CO5	Familiarizing 4G systems and latest wireless technologies.	Understand

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 2 : **Propagation and Path Loss:** Free space Propagation Model, Basic propagation mechanisms, Ground reflection Model, Knife-edge diffraction model, Radar cross section model. Path-loss Model: Log Distance Path-Loss Model.

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.

Module 4 : **Multiple Access Techniques:** Introduction, FDMA, TDMA, Spread Spectrum Multiple Access: FHMA, CDMA, Hybrid Technique, SDMA. Packet Radio Protocols- Pure and Slotted ALOHA, CSMA. Capacity of CDMA networks.

Module 5 : **Fourth Generation Systems and Wireless Technologies:** Introduction – 4G Features and Challenges, Applications of 4G – 4G Technologies: MultiCarrier Modulation, Smart Antenna Techniques, OFDM MIMO systems, Adaptive modulation and coding with time slot scheduler, BLAST system, Software Defined Radio, Cognitive Radio.

References :

1. Theodore S. Rappaport, “Wireless Communications: Principles & Practice”, Second Edition, Prentice Hall of India Pvt. Ltd. (Low Priced Edition – Pearson Education Asia), 2002.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University press.
3. William C.Y. Lee, “Mobile Communication Engineering: Theory & Applications”, Second Edition, McGraw Hill, 1998.
4. Gordon L. Stuber, “Principles of Mobile Communications”, Kluwer Academic Press,1996.
5. John G. Proakis, “Digital Communications”, Fourth Edition, McGraw Hill, 2001.
6. Jochan Schiller, “Mobile communications”, Addison-Wesley (Low Priced Edition – Pearson Education Asia), 2002.
7. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Pearson Education.
8. A. J. Viterbi, “CDMA- Principles of Spread Spectrum”,AddisonWesley, 1995.
9. Jerry R. Hampton, “Introduction to MIMO Communications”, Cambridge University Press, 2014
10. Vijay K. Garg, “Wireless Communications and Networking”, First Edition, Morgan Kaufmann Publications, 2007

20-305-0X13 **COMPUTATIONAL TECHNIQUES**

L	T	P	C
3	2		3

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 1 : **Pointers and Arrays**: Single and multidimensional arrays - Pointers and arrays – address arithmetic - Passing pointers to functions. Structures and Unions: Basics of structures, Structures and functions – Arrays of Structures – Pointers to structures – self referential structures – Type definitions – Unions. Input and Output: Standard input and output – Formatted output – variable length argument list – file access.

Module 2 : **Numerical Analysis**: Numerical Computations, sources of errors, Numerical solution of algebraic and transcendental equations, bisection method, Newton – Raphson method, iteration methods, polynomial interpolation: Lagrange interpolation polynomial, divided differences, Newton's divided differences interpolation polynomial.

Module 3 : **Solution of linear system of algebraic equations**: Gauss – Siedel iteration method, Gauss elimination method, Gauss-Jordan method. LU decomposition method. Error equations. Matrix inversion and Eigen value problems.

Module 4 : **Numerical integration and differentiation**: Trapeziodal rule. Romberg integration, Simpsons rule, numerical differentiation, finite difference methods. Numerical solution of ordinary differential equations: Initial value problems: Euler methods, Modified Euler methods, Runge-Kutta methods. Solution of simultaneous ODE.

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 :

1. M. K. Jain, S. R. K. Iyengar, R. K. Jain, "Numerical methods for Scientific and Engineering Computation", Wiley Eastern Ltd., 1993.
2. P. Kandaswamy, K. Thilagavathy,“Numerical Methods”, S. Chand & Co. 1996
3. M. L. James, G. M. smith and J. C. Walford, "Applied Numerical methods Digital computation", Herper & Tow, 1983.
4. E. V. Krishnamurthy, S. K. Sen, “Numerical Algorithms”, Affiliated East West/1001.

20-305-0X14 **MICROPROCESSORS & MICROCONTROLLERS**

L	T	P	C
3	**2**		**3**

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 3 : Intel 8051 microcontroller: architecture, features - internal block schematic – pin descriptions, I/O ports, registers. Memory organization – on chip peripherals, External Memory (ROM & RAM) interfacing, Structure & function of interrupts.

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 :

1. Douglas V Hall, Microprocessors and Interfacing, Tata McGraw-Hill 3rd edition, 2012
2. Muhammad Ali Mazidi, The 8051 Microcontroller and embedded sytems, Pearson Education 2nd edition, 2006
3. Kenneth J. Ayala, The 8051 Microcontroller, Penram International, 3rd edition 2007
4. Lyla B. Das, The x86 Microprocessors , Pearson Education, 2010
5. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Second Edition, 2008, Pearson Education.

20-305-0X15	**IMAGE PROCESSING**

L	T	P	C
3	**2**	**0**	**3**

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	Apply
CO2	Evaluate basic 2D transforms needed for image processing	Evaluate
CO3	Identify basic problems of image degradation	Understand
CO4	Explain various image compression algorithms	Analyze
CO5	Discuss basic image segmentation and representation strategies	Understand

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 3 : **Image Restoration:** Degradation Models, Noise models, Restoration in the presence of noise only, Periodic noise reduction by frequency domain filtering, Estimating the degradation functions, Inverse Filtering.

Module 4 : **Image Compression:** Coding redundancy, spatial and temporal redundancy, measuring image information, image compression models, Image compression standards, Image compression methods – Huffman coding, Arithmetic coding, LZW Coding, Run-length coding, Bit-plane coding.

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 :

1.Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing” - Pearson India Education Services Pvt. Ltd, 2018

2.Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall India Learning Private Limited, 1995

3.B. Chanda and D. Dutta Majumder, “Digital Image Processing & Analysis”, Prentice Hall of India, 2001

4.S. Jayaraman, S. Esakkirajan & T. Veerakumar," Digital Image Processing", Mcgraw Hill, 2015
5.Alan C. Bovik, "Handbook of Image and Video Processing", Academic Press, 2010.
6.Kenneth R. Castleman, "Digital Image Processing", Pearson, 1995
7.Bernd Jahne, "Digital Image Processing", 6th Edition, Springer, 2005
8.William K. Pratt, "Digital Image Processing", 4th Edition, Wiley Interscience, 2007.

20-305-0X16 **ROBOTICS AND INTELLIGENT SYSTEMS**

L	T	P	C
3	2	0	3

Prerequisites : 20-305-0X08

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.

Module 4 : **Localization and Mapping:** Introduction to localization – challenges in localization – localization and navigation, Mapping: map representation, Indoor and outdoor mapping, SLAM, Bayes rule, Passive and active Beacons sensors. Global Positioning System, DGPS, Laser Range Scanner.

Module 5 : **Robot Vision:** Introduction, Image acquisition, Illumination Techniques, Image Conversion, Frame Buffers and Grabbers, Image sampling and Quantization, Basic Relationship between pixels, Image enhancement in Spatial and Frequency domain, Image Processing and Analysis Data Reduction: Edge detection, Feature Extraction and Object Recognition Algorithm and its applications.

References :

1. Fu,K.S. ,et al "Robotics- Control, Sensing, Vision and Intelligence ", McGraw – Hill,1987.
2. H.R.Everett, "Sensors for Mobile Robots – Theory and Applications", A.K.Peteres Ltd. 1995. ISBN 1-56881-048-2.
3. Roland Siegwart, Illah R, Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2004. ISBN 0-262-19502-X.
4. "Robotics and Automation Handbook", Edited: Thomas R. Kurfees,, CRC Press 2005.
5. "Where am I? Sensors and Methods for Mobile Robot Positioning", J. Borenstein, et al., The University of Michigan, 1996.
6. "Applying Machine Vision", Zuech, Nello, John Wiley and Sons, 1988.
7. "Robotics and Image Processing", Janakiraman P.A, Tata McGraw-Hill, 1995

20-305-0X17 **RADAR AND SATELLITE COMMUNICATION**

L	T	P	C
3	**2**	**0**	**3**

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.	Understand
CO2	Understand Radar fundamentals and analysis of range ambiguities.	Analyze
CO3	Analyze Radar Signal characteristics	Analyze
CO4	Understand different special purpose Radars	Understand
CO5	Understand the concept of Satellite communication	Understand
CO6	Understand the concept of GPS	Understand

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 2 : Radar Fundamentals: Introduction, Radar Equation, Block diagram, Radar frequencies, Applications, Pulsed Radar, Range ambiguities, Displays-Duplexers, Radar Cross Section.

Module 3 : Radar Signal Characteristics: Radar pulse considerations, Minimum detectable signal, Receiver noise, Integration of radar pulses, FM-CW radar, MTI, pulse compression Radar.

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 41
2. MerrilI Skolnik, Radar Handbook, McGraw Hill Publishers, 1990
3. MerrilI Skolnik," Radar systems", McGraw Hill Publishers, 2005
4. B. Hofmann Wollenhof, H. Lichtenegger and J. Collins, "GPS Theory and Practice", Springer Wien, new York, 2000
5. J. C. Toomay, Paul Hannen "Radar Principles for the Non-Specialist", SolTech Pub. 2004

20-305-0X18 **EMBEDDED SOFTWARE AND REAL TIME SYSTEMS**

L	T	P	C
3	2	0	3

Prerequisites : Basic course on embedded systems

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 scheuling 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 2 : **Software Architectures for Embedded System**: Round Robin approach, Round-Robin with interrupts, Real Time Operating Systems, soft and hard real time OS, tasks and task states, scheduler, reentrancy, semaphores, signaling, semaphore problems.

Module 3 : **Tasks Scheduling:** Interrupt driven systems, pre-emptive priority systems, hybrid systems, task control block model. Process scheduling, Fixed priority scheduling – Rate Monotonic approach, Dynamic priority Scheduling- Earliest Deadline First approach.

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.
2. Embedded Systems - Raj Kamal, Tata McGraw Hill.
3. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
4. Shibu K V "Introduction to Embedded Systems", Tata McGraw Hill, 2010
5. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Elsevier 2000.
6. Real- Time Systems Design and Analysis – Philip A. Laplante, Wiley & Sons.

20-305-0X19 **ANTENNAS**

L	T	P	C
3	2	0	3

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

Course content :

Module 1 : **Radiation of EM waves**: Radiation mechanism, Theories of radiation, Antenna parameters, Image theory, Polarisation, Friss 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.

Module 5 : **Introduction to Smart Antennas** : Spatial processing for wireless systems, Fixed beam forming networks, Switched beam systems, Adaptive Antenna Systems, Wide band Smart Antennas, Antenna synthesis Techniques.

References :

1. Constantine Balanis A., Antenna Theory-Analysis and Design, John Wiley, 2005.
2. John D. Kraus, Ronald J. Marhefka, Ahmed S. Khan, Antennas and Wave Propagation, 4th Edition, McGraw hill Education, 2006.
3. James J. R. Hall P. S. Wood C., Micro strip Antenna-Theory and Design, IET Electromagnetic Wave series, 1985.
4. Bahl I. J., and Bhartia, Microstrip Antennas, Artech House, 1982.

20-305-0X20 **COMPUTER ARCHITECTURE**

L	T	P	C
3	2	0	3

Prerequisites : 20-305-0X11

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 3 : Thread Level Parallelism in Uniprocessors - Course grained and Fine grained. Thread Level Parallelism through Multiprocessor Architectures – Challenges of parallel processing, Centralized Shared-Memory Architectures. Example program – Parallel Matrix multiplication in C/C++.

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 :

1. Hennessy J.L & Patterson D.A., “Computer Architecture : A Quantitative Approach, Sixth Edition , Morgan Kaufmann Publishers, 2017
2. https://www.edumips.org/
3. David Culler, Jaswinder Pal Singh, Anoop Gupta , Parallel Computer Architecture: A Hardware/Software Approach, Elsevier, 2003

20-305-0X21 **NEURAL NETWORKS**

L	T	P	C
3	**2**	**0**	**3**

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 1 : **Introduction:** Motivation from Human Brain, mathematical model of a neuron, basic computational unit, Activation Functions, Neural networks viewed as Directed Graphs, Feedback, Network Architectures, Knowledge Representation. Learning Process–Supervised, Unsupervised and Reinforcement learning, Learning Tasks-Pattern Association, recognition, function approximation, control, beamforming.

Module 2 : **Perceptron**: Perceptron convergence theorem, batch perceptron algorithm. Model building through regression- linear regression model, Cost Function, gradient descent algorithm, chain rule, optimization, Local minima, Global Minima.

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 4 : **Learning**: back propagation and differentiation, Hessian matrix, optimal annealing and adaptive control of the learning rate, Approximations of function, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning.

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

References :

1. Simon Haykin, "Neural Networks and Learning Machines", Pearson Education India; Third edition 2016

2. Martin T Hagan, Howard B Demuth, Mark H Beale, Orlando De Jesús, "Neural Network Design", Cengage Learning,2nd Edition, 2014
3. S. Haykin, “Neural Networks: A Comprehensive Foundation”, 2nd edition, (Prentice Hall, 1999)
4. Philip D. Wasserman, “Neural Computing: Theory and Practice”, Coriolis Group, 1989
5. B.Vegnanarayana, “Artificial neural networks”, Prentice Hall of India, 2005
6. James. A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications and. Programming Techniques ", Pearson Education, 2002

20-305-0X22 **MACHINE LEARNING LAB**

L	T	P	C
0	**0**	**4**	**1**

Prerequisites : 20-305-0X07

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

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

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.
4. Model Support Vector Machines for classification tasks for linear and non-linear data.
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.

20-305-0X23 **ROBOTICS TECHNOLOGY LAB**

L	T	P	C
0	0	4	1

Prerequisites : 20-305-0X08

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.

20-305-0X24 **MICROWAVE CIRCUITS LAB**

L	T	P	C
0	0	4	1

Prerequisites : 20-305-0X09

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.	Apply
CO2	Using an X band microwave bench characterize the various waveguide components and sources.	Apply
CO3	Familiarization of measurement with Network Analyzer.	Apply
CO4	Computer aided design of transmission lines, microwave filters, couplers & dividers and amplifier design.	Analyse
CO5	Prepare the reports and present the results correctly.	Apply

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).

6 Directional Couplers, Circulators, Waveguide Tees, Isolators, Attenuators (insertion loss, coupling, directivity).

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.

20-305-0X25 **DATA STRUCTURES LABORATORY**

L	T	P	C
0	0	4	1

Prerequisites : 20-305-0X10

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.

20-305-0X26 **IMAGE PROCESSING LAB**

L	T	P	C
0	**0**	**4**	**1**

Prerequisites : 20-305-0X15

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

20-305-0X27 **ROBOTICS AND INTELLIGENT SYSTEMS LAB**

L	T	P	C
0	**0**	**4**	**1**

Prerequisites : 20-305-0X16

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.	Analyse

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 give 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.

20-305-0X28 **EM RADIATION LAB**

L	T	P	C
0	0	4	1

Prerequisites : 20-305-0X17

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.	Understand
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.

20-305-0X29 **EMBEDDED SOFTWARE LABORATORY**

L	T	P	C
0	0	4	1

Prerequisites	:	20-305-0X18
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	Analyze
CO2	Implement thread safe programs for parallel threaded environments	Apply
CO3	Porting an open source RTOS into development boards for demonstrating real world scenarios	Apply
CO4	Modify and customize operation of an RTOS to desired specifications	Apply
CO5	Propose and design solutions for real world problems using Real Time Operating Systems	Apply

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.

20-305-0X30 **VLSI SYSTEM DESIGN LAB**

L	T	P	C
0	0	4	1

Prerequisites : 20-305-0X19

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.	Understand
CO2	Study the various timing parameters like setup time and hold time for CMOS sequential logic families.	Understand
CO3	Implement embedded systems consisting of programmable logic and micro blaze softcore processors.	Apply
CO4	Implement embedded systems on Zync FPGAs using programmable logic and processor system.	Apply

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.

20-305-0X31 **NPTEL COURSE/MOOC**

L	T	P	C
3	0	0	3

Prerequisites : NIL

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

CO1 Develop aptitude for independent learning.

CO2 Flexible way to learn new skills, advance career and deliver quality educational experiences at scale

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 the 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.

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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.**