Department of Electronics and Telecommunication Engineering

UG Scheme-2023 (NEP-2020)

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-VI													
23BTECL304 23BTECP304	Digital Signal Processing	PCC 9	2	1	2	5	4	10	15	50	25	25	125
23BTECL305 23BTECP305	Digital Communication	PCC 10	2	-	2	4	3	10	15	50	25	-	100
23BTECLXX 23BTECPXX	Program Elective II	PEC 2	3	-	2	5	4	10	15	50	25	-	100
23BTECLXX	Program Elective III	PEC 3	4	-	-	4	4	10	15	50	-	-	75
23BTECLXX 23BTECPXX	Vocational and Skill Enhancement Elective –IV	VSEC 4	1	-	2	3	2	10	15	-	25	-	50
23BTXXXXX	Multidisciplinary Minor	MDM 4	2	-	-	2	2	10	15	50	-	-	75
23BTSHP302	Research Ethics & Technical Writing	RM	-	-	4	4	2	-	-	-	50	-	50
TOTAL			**14**	1	**12**	**27**	**21**	**60**	**90**	**250**	**150**	**25**	**575**

Department of Electronics and Telecommunication Engineering

Course	Offered to Department	Name of Subject	Course Code
Program Elective II	ETC	System on Chip	23BTECL310 23BTECP310
		CMOS VLSI Design	23BTECL311 23BTECP311
		Advanced Embedded System	23BTECL312 23BTECP312
Program Elective III	ETC	Wireless and Mobile Communication	23BTECL313
		Audio and Speech Signal Processing	23BTECL314
		Mechatronics	23BTECL315
Vocational and Skill Enhancement Elective – IV	ETC	Introduction to JAVA Programing	23BTXXXXX
		Python for AI	23BTXXXXX
Multidisciplinary Minor (MDM 4)	Other than ETC	Introduction to Wireless Communication	23BTECL316XX

Department of Electronics and Telecommunication Engineering

Course Title: Digital Signal Processing										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 9	2	1	2	4	10	15	50	25	25
Course Code	23BTECL304 23BTECP304									
Teaching Mode	Offline	5 Hrs			Total	**75**			50	
Duration of ESE	3 Hrs					125				

Course Objectives	1. To study different types of signals and systems 2. To understand transformation tools for analysis of signals & systems 3. To learn design of various digital filters and use of DSP processor for real time applications
Course Outcomes	**Upon successful completion of this course, student will be able to:** CO1: Understand fundamentals and applications of discrete-time signals and systems CO2: Apply Z transform to discrete-time signals and systems CO3: Apply DFT and FFT to discrete-time signals and systems CO4: Design digital filters for discrete time signals for applications CO5: Understand architecture and functioning of DSP processor for real time applications

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O 2	PS O3
CO1	3	2	0	1	0	0	0	0	0	0	0	0	3	0	2
CO2	3	2	2	0	2	0	0	0	0	0	0	0	3	0	2
CO3	2	0	2	0	2	0	0	0	0	0	0	0	3	0	2
CO4	3	3	2	0	2	0	0	0	0	0	0	0	3	0	2
CO5	3	2	2	2	0	0	0	0	0	0	0	1	3	0	2

Department of Electronics and Telecommunication Engineering

Course Contents:

Unit	Contents	Hours
I	**Introduction:** Introduction to discrete signals & Systems, Operations on Discrete signals**,** Z- Transform representation, ROC, Z-transform properties, Inverse Z-Transforms Methods, applications of Z- Transform & Inverse Z-Transforms.	**8 Hrs.**
II	**Transform Analysis of LTI Systems:** Frequency analysis of discrete time signals, Discrete Time Fourier Transform and Discrete Fourier Transform, Properties, Inverse Discrete Fourier Transform, Efficient Computation of DFT using FFT algorithms, Linear Filtering approach to computation of DFT, FFT of long sequences using overlap add and overlap save method.	**8 Hrs.**
III	**Digital Systems Structures:** Structures for FIR Systems and IIR Systems, representation of Structures using Block diagram & Signal Flow Graph	**8 Hrs.**
IV	**Digital Filters:** Design of IIR filters from analog filters using Impulse Invariant Method, Bilinear Transformation, Matched Z-Transformation, Butterworth Approximation, Chebyshev, FIR filters design Methods- Windowing, Hamming & Kaiser.	**8 Hrs.**
V	**DSP Processor & Applications**: Desirable Features of DSP Processors, Types of Architectures of DSP processor, Introduction to Multirate signal processing, Adaptive filtering, Case study, Advanced topics based on course.	**8 Hrs.**

Text Books	1.	Digital Signal Processing, Principles, Algorithms, and Applications, J. G. Proakis and D. G. Manolakis, Prentice Hall, 2006,4th
	2.	Theory and Applications of Digital Signal Processing. R. Rabiner, and B., Gold, Prentice Hall,2000,3rd
Reference Books	1.	Digital Signal Processing, A. V. Oppenheim and R. W. Schafer, Prentice Hall,1998
	2.	Understanding of Digital Signal Processing, Richards Lyons , Pearson, 2011, 3rd Edition
	3.	Digital Filters: Analysis Design and Application, A. Antonion, Prentice Hall,1999,
	4	Digital Signal Processing, A Computer based approach, S. K. Mitra, Mc Graw Hill, 4th edition
eBooks	1	http://electronicsforu.com/resources/cool-stuff-misc/8-free-ebooks-digital-signal-processing
	2	http://www.freebookcentre.net/Electronics/DSP-Books-Download.html
Online TL	1	https://nptel.ac.in/courses/117102060/
	2	https://freevideolectures.com/course/2499/elec3104-digital-signal-processing http://eemedia.ee.unsw.edu.au/ELEC3104/index.htm https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/study-materials/
	3	https://nptel.ac.in/courses/108/105/108105055/ in reference books /web resources

Department of Electronics and Telecommunication Engineering

S. N.	Name of Experiment	Mapping with Course Outcomes
1.	Write a MATLAB program to generate standard discrete time signals & plot them	CO1
2.	Write a MATLAB code to verify Sampling theorem.	CO1
3.	Write a MATLAB program to compute frequency response of first order system h(n)=0.8^n u(n)	CO4
4.	Write a MATLAB program to calculate Circular convolution of two sequences using DFT and IDFT	CO2
5.	Write a MALAB Program to perform Z Transform of X(Z)=1 + Z-1 + 2 Z -2 /1 - 0.25 Z-2 using partial fraction expansion method	CO1
6.	Write a MATLAB program to find N point Fast Fourier Transform (FFT) & Inverse Fast Fourier Transform (IFFT)	CO2
7.	Write a MATLAB program to design Butterworth and Chebyshev Low pass and high pass filter	CO4
8.	To Study DSP processor architecture and perform Echo generation using DSK6713 Processor	CO5
	Open Ended Experiments	
1.	To Study Code Composer Studio (CCS) and verify Linear convolution using CCS	
2.	Write a MATLAB program to verify Power Spectral Density of various mathematical signals	
	Details of online Laboratory Resource Material Instruction / Operating Manuals	
1.	https://www.iitk.ac.in/new/digital-signal-processing-laboratory	
2.	http://vlabs.iitkgp.ac.in/dsp/	
3.	http://users.ece.utexas.edu/~bevans/courses/realtime/lectures/laboratory/c6748winDSK/index.html	

Department of Electronics and Telecommunication Engineering

Course Title: Digital Communication										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 10	2	-	2	3	10	15	50	25	-
Course Code	23BTECL305 23BTECP305									
Teaching Mode	Offline	4 Hrs			Total	75			25	
Duration of ESE	3 Hrs					100				

Course Objectives	1. To understand the basic knowledge of digital communication system & Source coding techniques.
	2. To study different modulation schemes, multiple accesses, error probability for digital communication.
	3. To impart the knowledge of design, analysis & comparison of digital communication systems.
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Understand digital communication systems.
	CO2: Understand the use of various source coding techniques
	CO3: Analyze and differentiate digital modulation and demodulation techniques.
	CO4: Design channel coding and error-control coding techniques.
	CO5: Apply spread spectrum techniques for digital communication systems.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	1	2	0	0	0	2	1	0	2	1	1	2
CO2	3	1	1	2	2	0	0	0	2	2	0	2	1	1	2
CO3	3	3	3	3	3	0	0	0	2	2	0	2	2	1	2
CO4	3	3	3	3	2	0	0	0	2	2	0	2	1	1	2
CO5	2	3	3	3	2	0	0	0	2	2	0	2	3	1	2

Department of Electronics and Telecommunication Engineering

Course Content:

Unit	Contents	Hours
I	**Base band Digital Communication**: Introduction to digital communication system, Block Diagram, Formatting Textual data, messages, Line coding and spectra, Inter symbol interference	**8 Hrs.**
II	**Information Theory & Source Coding:** Introduction to information theory, Entropy and its properties, Shannon channel capacity theorem, Scrambler, Source coding Theorem, Huffman Coding, LZ Coding. Shannon- Fano Coding	**8 Hrs.**
III	**Digital Modulation and Demodulation Techniques:** BPSK, ASK, FSK, QPSK, M-array modulation Techniques. MSK,	**8 Hrs.**
IV	**Channel Coding:** Linear block codes, generator matrix and parity check matrix, cyclic codes, convolutional channel codes, Viterbi algorithm. Introduction to Turbo and LDPC code	**8 Hrs.**
V	**Spread-Spectrum methods**: Study of PN sequences, Direct sequence methods, Frequency hop methods, slow and fast frequency hop, Jamming Considerations, performance analysis, Application of spread spectrum, CDMA, Introduction to GNU Radio, Introduction to OFDM, Advance topic	**8 Hrs.**

Text Book and Reference Book		
Text Book	**1.**	Digital Communications (Fundamentals and applications), Bernard Sklar, Pearson Education, 2005, 2nd.
	2.	Digital Communication, Simon Haykin, Wiley Eastern, 2001, 4th.
	3.	Digital Communication, John G. Prokis, Tata Mc –Graw HILLS, 2007, 5th.
	4.	Digital Communication, J. S. Chitode, 2nd edition, Technical Publication
Reference Book	**1.**	Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University press,1999,3rd.
	2.	Communication Electronics, Roddy & Colin, PHI, Prentice-Hall TR,1981,2nd
	3.	Communication Electronics, Kennedy, Tata Mc –Graw HILLS,,2012,5th
eBooks	**1.**	Digital Communication, Communication, Multimedia, Security, Meinel, Christoph, Sack, Harald, Springer Nature, 2014. Link: https://www.springer.com/gp/book/9783642543302
	2.	Digital Communication, John R. BarryEdward A. LeeDavid G. Messerschmitt, Springer Nature, 2004, 3rd. Link: https://link.springer.com/book/10.1007/978-1-4615-0227-2
Online TL	**1.**	Modern digital communication techniques, Prof. Suvra Sekhar Das IIT Kharagpur, NPTEL. Link: https://nptel.ac.in/courses/117/105/117105144/
	2.	Principles of Digital Communication, By Prof. Abhishek Dixit , IIT Delhi, Swayam. Link: https://swayam.gov.in/nd1_noc20_ee17/preview

Department of Electronics and Telecommunication Engineering

S. N.	Name of Experiment	Mapping with Course Outcomes
1.	Write a MATLAB code to observe the performance of Return to Zero (RZ) and Non Return to Zero (NRZ) types of line codes.	CO1
2.	To observe the performance of binary ASK and implement ASK modulator and demodulator using modern tool.	CO3
3.	To observe the performance of binary PSK and implement PSK modulator and demodulator using modern tool.	CO3
4.	To observe the performance of binary FSK and implement FSK modulator and demodulator using modern tool.	CO3
5.	Develop M-ary ASK Modulator & Demodulator using modern tool.	CO3
6.	Develop M-ary FSK Modulator & Demodulator using modern tool.	CO3
7.	Develop M-ary PSK Modulator & Demodulator using modern tool.	CO3
8.	To perform Huffman coding using MATLAB tool	CO2
9.	To perform linear block coding using MATLAB tool	CO4
10.	To study different spread spectrum techniques	CO5
Open Ended Experiments		
1.	To observe the performance of QPSK and implement QPSK modulator and demodulator using modern tool.	CO3
Details of online Laboratory Resource Material Instruction / Operating Manuals		
1.	"Digital Communication Laboratory" Courseware link: https://www.mathworks.com/academia/courseware/digital-communication-laboratory.html	
2.	Digital Communications With Lab Manual, Bhat K. N. Hari, Pearson, 3rd.	
3.	Digital Communication Systems Engineering Using Software Defined Radio, by wireless innovation lab.	

Department of Electronics and Telecommunication Engineering

Program Elective-II

Department of Electronics and Telecommunication Engineering

Course Title: **System on Chip**										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	TH	TU	PR	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 2	3	-	2	4	10	15	50	25	-
Course Code	23BTECL310 23BTECP310									
Teaching Mode	Offline	5			TOTAL	75			25	
Duration of ESE	3 Hrs					100				

Course Objectives	The student will study SOC modelling and interfacing
	The student will learn SOC system design.
	SOC design, SOC prototyping, verification, testing and physical design.
	The student will able to design , implement and test SOC.
Course Outcomes	After successful completion of this course, student will be able to:
	CO-1: Understand core architectures for digital media and evaluate associated compilation techniques.
	CO-2: **Evaluate** design challenges like simulation race conditions and synthesis mismatches.
	CO-3: **Analyze** timing parameters, factors affecting delays, and techniques to ensure data integrity across clock domains.
	CO4: **Apply** MEMS concepts to solve scaling and stress-related challenges in SoC design.
	CO5: Access the use of processor and memory IPs, real-time operating systems, and peripheral interfaces in SoC designs.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	1	1	1	0	1	0	2	3	0	0
CO2	3	3	3	2	3	1	1	1	1	1	1	2	3	0	0
CO3	3	3	3	3	3	1	1	1	1	1	0	3	3	0	0
CO4	3	3	3	3	3	1	1	1	2	2	1	3	3	0	0
CO5	3	2	3	2	2	2	2	2	1	2	1	3	3	0	0

Department of Electronics and Telecommunication Engineering

Course Contents:

Unit	Contents	Hours
I	**Unit I : Introduction to SOC** Design of system on chip, Microsystems technology and applications, core architecture for digital media and the associated compilation techniques.	8
II	**Unit II : RTL Simulation** RTL Designs, RTL based chip design flow, design challenges, Simulation race, and simulation synthesis mismatch.	8
III	**Unit III : Timing Analysis and Clock Domain Crossing** Timing parameters for digital logic, factors affecting delay and slew, sequential arcs, clock domain crossing, bus synchronization, preventing data loss through FIFO.	8
IV	**Unit IV: SOC implementation** Study of processor IP, Memory IP, wrapper Design - Real-time operating system (RTOS), Peripheral interface and components, High-density FPGAs - EDA tools used for SOC design. System In Packages, Package in Package	8
V	**Unit V : MEMS** Introduction, Concepts of MEMS: Principles, application and design, Scaling Properties/Issues, Micromachining Processes: Substrates, lithography, wet/dry etching processes, deposition processes, film stress, exotic processes. Applications of SOC: Health Care, Surveillance, etc and advance topics.	8

Text Books	1.	Sanjay Churiwala, Sapan Garg , “Principles of VLSI RTL Design A Practical Guide”, Springer
	2.	Youn-Long Steve Lin, “Essential Issues in SOC Design, Designing Complex Systems-onChip”, Springer
Reference Books	1.	Reference Books 1. Kamaran Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education
	2.	Rabey, Chandrakasan, “Digital IC Design”, Preason Publication

Department of Electronics and Telecommunication Engineering

Sr. No.	Name of Experiments	Mapping with Course Outcomes
1	Understand the Concept of System on Chip and Its Significance In Modern Electronic Devices	CO1
2	Write the VHDL code for the CPU, including the instruction set and the control unit.	CO1, CO2
3	Design the memory module for the SoC. Implement different types of memory like RAM, ROM, and cache (optional) using VHDL.	CO1, CO2
4	Write the VHDL code for the FIFO module and verify its functionality through simulation.	CO1, CO2
5	Design the peripheral module (UART) using VHDL and implement its functionalities like data transmission and reception.	CO1, CO2
6	Implement the interconnections between CPU, memory, and peripheral modules using VHDL, typically using a bus architecture.	CO1, CO2
7	Simulate the entire SoC design using the VHDL simulation software.	CO1, CO2
8	Verify the functionality of the SoC on the physical FPGA board.	CO1, CO2,CO3
	Open Ended Experiments	
9	Analyze the power consumption of the SoC during simulation and/or FPGA implementation to assess the effectiveness of the low-power techniques.	CO3
10	Evaluate the performance improvement achieved by using the co-processor for specific applications.	CO1, CO2,CO3

Department of Electronics and Telecommunication Engineering

Course Title: CMOS VLSI Design (Program Elective-II)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 2	3	-	2	4	10	15	50	25	-
Course Code	23BTECL311 23BTECP311									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	3 Hrs					100				

Course Objectives	1. To understand the characteristics of CMOS circuit construction and tradeoffs to optimize power, delay, and area.
	2. To design CMOS circuits & memories
	3. To understand delay in data path of CMOS circuits.
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Interpret the operation of MOS transistor & different parameters
	CO2: Analyze the mathematical methods and circuit in CMOS digital electronics circuits.
	CO3: Understand the effect of rise time & fall time on circuit performance.
	CO4: Analyze and implement various Complex CMOS logic circuits.
	CO5: Design various CMOS Memories and advanced logic circuits

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	3	0	3	0	0	0	1	0	0	1	0	2	1
CO2	2	2	3	0	3	0	0	0	1	0	0	1	0	2	1
CO3	2	2	3	0	3	0	0	0	1	0	0	1	0	2	1
CO4	2	3	3	0	3	0	0	0	1	0	0	1	0	2	1
CO5	2	3	3	0	3	0	0	0	1	0	0	1	0	2	1

Department of Electronics and Telecommunication Engineering

Course Content:

UNIT	Contents	Hours
I	**CMOS Structure:** Review of MOS Structure, Threshold Equation, MOSFET Current-Voltage Characteristics, Channel Length Modulation, Substrate Bias Effect, MOSFET Scaling, Short Channel Effect, MOSFET Capacitance.	**8 Hrs.**
II	**CMOS Inverter Design:** Noise Margin, Inverter with different Loads, CMOS Inverter Basics & Characteristics, Design of CMOS Inverter, Static Load MOS Inverters.	**8 Hrs.**
III	**Switching Characteristics :** Rise and Fall Time Derivation, Inverter Design with delay constraint, Interconnect Parasitic, Interconnect Delay, Switching Power Dissipation, Power Delay Product	**8 Hrs.**
IV	**CMOS VLSI Design for Power and Speed consideration:**Clocking Strategies, Clock Skew, Fan in, Fan-out, Metastability, Complex CMOS logic: Review of Combinational logic, Pass Transistor Logic, Transmission gate, Static & Dynamic logic ckts, Domino & Zipper logic,	**8 Hrs.**
V	**CMOS Memories** - Memories: DRAM, SRAM & Flash Memory, BiCMOS, RFMOS, Latchup, Stick diagram representation, Advanced Topic of the Course.	**8 Hrs.**

Text Book and Reference Book		
Text Book	**1.**	Principles of CMOS VLSI Design, Neil H. E. Weste, Kamran Eshraghian, Addison Wesley,
	2.	CMOS Digital Integrated Circuits Analysis & Design,Sung-Mo Kang & Yusuf Leblebici,Tata McGraw -Hill,2003
	3.	Digital integrated circuits: a design perspective, Second Edition,,Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic,Illustrated, Pearson Education,2003
Reference Book	**1.**	VLSI Design Techniques for Analog and Digital Circuits
	2.	R. L. Geiger, P.E. Allen, and N. R. Strader, McGraw Hills 1st Edition
eBooks	**1.**	Design of Analog CMOS Integrated Circuits,Razavi,McGraw-Hill,2001
	2.	CMOS Logic Circuit Design,John P. Uyemura,Illustrated, Springer Science & Business Media,,1999,
Online TL	**1.**	CMOS Digital VLSI Design, Prof. Sudeb Dasgupta , IIT Roorkee on Swayam/NPTEL

Department of Electronics and Telecommunication Engineering

S. N.	Name of Experiment	Mapping with Course Outcomes
1.	To design and plot the output characteristics of a 3-inverter ring oscillator using Microwind/Tanner	CO2
2.	To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS LOGIC using Tanner	CO4
3.	Design a XNOR gate using CMOS, Pass Logic, and Transmission Gate & Domino Logic.	CO4
4.	Design a 2:1 multiplexer using CMOS, Pass Logic, Transmission Gate & Domino Logic using Microwind/Tanner	CO4
5.	To design and plot the characteristics of a positive and negative latch based on multiplexers using Microwind/Tanner	CO5
6.	Design of D FF using CMOS logic using Microwind/Tanner	CO5
7.	Design of JK FF using CMOS logic using Microwind/Tanner	CO5
8.	To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers.	CO5
9.	Layout Extraction & Simulation of CMOS NAND and NOR Gate.	CO5
10.	Study of Fabrication of CMOS and Layout design rules.	CO1
Open Ended Experiments		
1.	Design and Analysis of Dynamic CMOS logic circuits	CO4
Details of online Laboratory Resource Material Instruction / Operating Manuals		
1.	Shakshat Virtual Lab , IIT Guwahati	
2.	Centre for VLSI and Embedded Systems Technology, IIT Hyderabad	

Department of Electronics and Telecommunication Engineering

Course Title: Advanced Embedded System (Program Elective-II)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 2	3	-	2	4	10	15	50	25	-
Course Code	23BTECL312 23BTECP312									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	3 Hrs					100				

Course Objectives	1. To impart the concepts and architecture of embedded systems and to make the students capable of designing Embedded systems.
	2. To understand the architecture and programming of Industry popular 32-bit Microcontroller ARM Cortex
	3. To understand the usage of the development and debugging tools.
	4. To study programming and interfacing details of building Microcontrollers based Embedded Systems.
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Understand different options for the realization of embedded systems and single board computers.
	CO2: Acquire the knowledge of ARM architecture and instruction set architecture.
	CO3: Understand and analyse architecture of ARM Cortex M3 Processor.
	CO4: Analyze and exceptions, Nested Vectored Interrupt Controller and Different Behaviour of Interrupts.
	CO5: Demonstrate and analyse architecture of ARM Cortex M3/M4 Processor Core and its integrated development environment.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	2	3	3	0	0	0	2	0	0	2	0	2	0
CO2	2	1	2	3	3	0	0	0	2	0	0	2	0	2	0
CO3	2	1	2	3	3	0	0	0	2	0	0	2	0	2	0
CO4	0	0	1	3	3	0	0	0	2	0	0	2	0	2	0
CO5	2	1	2	3	3	0	0	0	3	0	0	2	0	2	0

Department of Electronics and Telecommunication Engineering

Course Content:

UNIT	Contents	Hours
I	**Embedded Systems Concepts:** Introduction to embedded systems, Single Core, multi Core Systems. System In Package (SIP), System On Module (SOM), Package on Package (POP), Computer on Module (COM) based Embedded system, Single Board Computers.	**8 Hrs.**
II	**ARM Architecture:** Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture.	**6 Hrs.**
III	**Overview of Cortex-M3:** Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions. Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus.	**10 Hrs.**
IV	**Exceptions, NVIC and Interrupt Behavior:** Exception Types Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call. NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency	**8 Hrs.**
V	**Cortex-M3/M4 Microcontroller**: STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development & Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc. Introduction to Arduino IDE, Arduino Programming Concepts.	**8 Hrs.**

Text Book and Reference Book		
Text Book	**1.**	The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.
	2.	Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", 2006, Elsevier.
Reference Book	**1.**	Reference Books 1. Kamaran Eshraghian, "Principles of CMOS VLSI Design", Pearson Education
	2.	Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education
	3.	Cortex-M series-ARM Reference Manual

Department of Electronics and Telecommunication Engineering

Text Book and Reference Book		
	4.	Cortex-M3 Technical Reference Manual (TRM)
	5.	Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
	6.	David Seal "ARM Architecture Reference Manual", 2001 Addison Wesley, England; Morgan Kaufmann Publishers
	7.	Arnold. S. Berger, "Embedded Systems Design – An introduction to Processes, Tools and Techniques", Easwer Press

S. N.	Name of Experiment	Mapping with Course Outcomes
1.	Analysis of Embedded Systems & Single Board Computer (SBC) Realization	CO1
2.	Write ARM assembly to perform the following array assignment in C: for (i = 0; i <= 10; i++) {a[i] = b[i] + c;} 34 /97 Assume that r3 contains i, r4 contains c, the starting address of array a is in r1, and the starting address of array b is in r2.	CO2
3.	Write a program to read the analog input connected to ADC and compare with threshold so as to control the Digital outputs (LEDs). Use standard peripheral library and interrupt method.	CO2
4.	Transmit a string "Programming with ARM Cortex" to PC by using standard peripheral library with the help of USART3. Use polling method.	CO2
5.	Embedded C Programming on ARM Cortex M3/M4 Microcontroller	CO3
6.	Generation of PWM signal for motor control using LPC1768	CO4
7.	Design of a real-time data acquisition & control system using the STM32Lxx ARM Cortex M3 Microcontroller	CO5
8.	Case Studies: Interfacing TFT display, CAN protocol, ETHERNET to ARM Cortex M3/M4	CO5
9.	Interface Arduino uno with NeoRGB strip and write program in Arduino IDE for dynamic RGB light sequencing.	CO5
10.	Open Ended Experiment:	
11.	V-Lab Experiment:	

Department of Electronics and Telecommunication Engineering

Program Elective-III

Department of Electronics and Telecommunication Engineering

Course Title: Wireless and Mobile Communication (Program Elective-III)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 3	4	-	-	4	10	15	50	-	-
Course Code	23BTECL313									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	3 Hrs					75				

Course Objectives	1. To study the evolution of Mobile and wireless Communication Techniques
	2. To study the concept of 2G ,3G,4G,5G communication
	3. To study Wireless Networking concept.
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Understand generation of cellular communication system.
	CO2: Understand the concept of Global System for Mobile
	CO3: Remembering the concept of 3G and beyond 3G
	CO4: Apply the concept of wireless Networking
	CO5: Understand the concept of MIMO for 5G

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	0	1	0	0	0	0	0	0	0	0	3	0	0
CO2	3	2	2	2	2	0	0	0	0	0	0	0	3	0	0
CO3	3	2	2	2	2	0	0	0	0	0	0	0	3	0	0
CO4	3	2	2	2	2	1	0	1	1	1	0	0	3	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	2	3	0	0

Department of Electronics and Telecommunication Engineering

Course Content:

UNIT	Contents	Hours
I	Introduction to Mobile communication: Introduction to Wireless Mobile Communication systems, Overview of Mobile Networks, evolution of cellular wireless communication 1G,2G,3G,4G, Specification, Frequency Reuse, Channel assignment and Handoff strategies	**8 Hrs.**
II	Introduction to GSM: Interference and system capacity, , Frame structure , GSM Channels, Modulation Techniques Signal Processing in GSM, Equalizers in Communication Receiver , Diversity Techniques, FDMA, TDMA, CDMA and SDMA techniques	**8 Hrs.**
III	Introduction to 3G and beyond : Introduction, Architecture, Challenges of Wide band code division multiple access (WCDMA), Specification, EDGE, GPRS, UMTS, OFDM, UWB, and LTE.	**8 Hrs.**
IV	Wireless Networking: OSI ,TCP/IP Model ,Wireless Routing ,IEEE 802.11 Wi-fi family ,physical security, authentication and access control, Hardware Selection and configuration	**8 Hrs.**
V	5G Networking : MIMO, MIMO Channel Capacity, SVD and Eigen modes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MIMO Beam forming – MRT, MIMO -OFDM. Advance topic based on the course.	**8 Hrs.**

Text Book and Reference Book		
Text Book	**1.**	David Tse and Pramod Viswanath ,Fundamentals of Wireless Communication, 2005
	2.	Andrea Goldsmith,Wireless Communications,
	3.	Theodore Rappaport, Wireless Communication ,Pearson publication 2nd edition
Reference Book	**1.**	Gary J. Mullett Wireless Telecommunications Systems and Networks
	2.	Savo Glisic ,Advanced Wireless Communication 4G Technologies
eBooks	**1.**	Wireless Networking in the developing world: https://textbookequity.org/Textbooks/wndw3-wireless%20networking_developing_world.pdf
Online TL	**1.**	Evolution of Air Interface towards 5G, Dr. Suvra Sekhar Das https://onlinecourses.nptel.ac.in/noc19_ee16/preview

Department of Electronics and Telecommunication Engineering

Course Title Audio and Speech Signal Processing (Program Elective-III)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 3	4	-	-	4	10	15	50	-	-
Course Code	23BTECL314									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	3 Hrs					75				

Course Objectives	1. To study the basic concepts of speech and audio.
	2. To study the analysis of various M-band filter banks for audio coding
	3. To learn various transform coders for audio coding.
	4. To study the speech processing methods in time and frequency domain
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Comprehend the speech production and hearing models.
	CO2: Design and apply models for speech and audio signal processing.
	CO3: Understanding different pitch estimation methods.
	CO4: Understanding the concept of speech coding.
	CO5: Implement the methods for speech enhancement, speech coding and speech recognition

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	3	3	1	0	0	0	0	0	1	3	0	0	0
CO2	2	1	3	3	2	0	0	0	0	0	1	3	2	0	0
CO3	2	1	3	3	1	0	0	0	0	0	1	3	2	0	0
CO4	2	1	3	3	2	0	0	0	0	0	1	3	0	0	0
CO5	1	1	2	3	2	0	0	0	0	0	1	3	1	0	0

Department of Electronics and Telecommunication Engineering

Course Contents:

Unit	Contents	Hours
I	**Introduction:** Introduction, Anatomy and physiology of speech production, categorization of speech sounds, Prosody, Parameters of Speech: Pitch and Formants.	8 Hrs
II	**Analysis and Synthesis of Speech and Audio signals:** Spectral Analysis Models, Linear Predictive Coding Model, Modulation Models, The autocorrelation method, The covariance method, Short-Time Fourier Transform Analysis and Synthesis	8 Hrs
III	**Pitch Estimation Methods:** A correlation-based Pitch Estimator, Pitch Estimation based on Comb Filter, Pitch Estimation based on a Harmonic Sine wave Model.	6 Hrs
IV	**Speech Coding:** Vector Quantization, Frequency-Domain Coding, Transform based Approach. Audio Compression techniques	8 Hrs
V	**Enhancement of Speech and Audio Signals:** Spectral subtraction, Cepstral Mean Subtraction, Wiener Filtering, **Speaker Recognition:** Spectral Features required for Speaker Recognition, Minimum Distance classifier, Gaussian Mixture Model. Applications / Case studies,	10 Hrs

Text Books	1.	T.F. Quartieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall.
	2.	L. R. Rabiner, R. W. Schafer, Theory and Applications of Digital Speech Processing, Prentice Hall
Reference Books	1.	B. Gold, N. Morgan, D. Ellis, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley-Blackwell
	2.	T. Dutoit, F. Marqués, L.R. Rabiner, Applied signal processing: a MATLAB-based Proof of Concept, Springer
	3.	Ian Vince Mcloughlin. Speech and Audio Processing: A MATLAB-based Approach, Cambridge University Press
	4.	A. K. Jain," Fundamentals of Digital Image Processing", PHI,1995

Department of Electronics and Telecommunication Engineering

Course Title : Mechatronics (Program Elective-III)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 3	4	-	-	4	10	15	50	-	-
Course Code	23BTECL315									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	3 Hrs					75				

Course Objectives	1. Understand the key elements of mechatronics,
	2. Understand the concept of Sensors and Transducers and their characteristics
	3. Understand various hydraulic and pneumatic Systems
	4. Understand the principle and operation of Electrical and Electromechanical Actuators
Course Outcomes	**Upon successful completion of this course, student will be able to:**
	CO1: Understand and apply the key elements of mechatronics in automation,
	CO2: Apply the principle of sensor and Transducers and their characteristics in industry applications
	CO3: Understand and analyse the principles of hydraulic systems in complex engineering applications
	CO4: Understand and analyse the principles of pneumatic systems.
	CO5: Apply and evaluate the applications of Electrical Actuators and Electro-Mechanical Actuators

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	2	1	1	0	0	0	1	2	1	0	0
CO2	3	2	1	2	1	2	1	0	0	0	2	3	1	0	0
CO3	2	3	2	2	1	1	1	0	0	0	1	3	1	0	0
CO4	2	3	2	1	1	2	1	0	0	0	1	2	1	0	0
CO5	3	2	1	1	1	0	0	1	0	0	2	2	1	0	0

Department of Electronics and Telecommunication Engineering

Course Content:

UNIT	Contents	Hours
I	**Unit I : Introduction to Mechatronics** Basics of Mechatronics Systems: Definition of Mechatronics, Key elements of Mechatronics Systems, Levels of mechatronics systems, Measurement Characteristics, Mechatronics design process, phases of mechatronics design process, integrated design approach. Mechanical Components and Servo Mechanism: Servomechanism (Concepts and Theory, Problems).	**8 Hrs.**
II	**Unit II: Signal Conditioning:** Introduction to Data Acquisition system, Sensors, Micro sensors, Transducers, Signal Conditioning, Relays, Contactors and Timers, Introduction to PLCs. Basic Robot drive systems: Hydraulic, Pneumatic and Electric drive systems	**8 Hrs.**
III	**Unit III : Hydraulic Systems** Introduction to Hydraulic Actuators Fluid Power systems: Concept of Actuators, Classification of Actuators: Pneumatic, Hydraulic and Electrical Actuators, Fluid Power systems Hydraulic Systems: Physical Components of a Hydraulic systems, Hydraulic Pumps (e.g. Gear Pumps, Piston Pumps), Filters and Pressure Regulation, Relief Valve, Accumulator.	**8 Hrs.**
IV	**Unit IV : Pneumatic Systems** Introduction to Pneumatic an Actuators Physical Components of a Pneumatic Systems, Pneumatic Cylinders, Pneumatic Actuators (e.g. Spring Actuator and Spring Actuator with positioner), Air compressor, Air Receiver, Air Dryer Air Service Treatment: Air Filter, air regulator and Gauge, Air Lubricator and Pressure regulation Intake and Air Filter. Case study of Robotic Pick and Place robots	**8 Hrs.**
V	**Unit V : Electrical Actuators, Electron-Mechanical Actuators** Electrical-Actuation system: Selection criteria and specifications of stepper motors, solenoid valves, relay (Solid State relays and Electromechanical relays). Selection Criterion of control valve, Single acting and Double acting Cylinders. Electro-Pneumatic: Pneumatic Motors, Valves: Electro Hydraulic: 3/2 Valves, Cables: Power cable and Signal cables	**8 Hrs.**

Text Book and Reference Book		
Text Book	**1.**	W. Boltan -Mechatronics: Electronic Control Systems in Mechanical and
	2.	Electrical Engineering, 6th Edition, Pearson Education, 2016
	3.	David Alciatore and MaichaelB Histand, -Introduction to Mechatronics and Measurement Systems‖,4th Edition, Tata McGraw Hill 2013.
Reference Book	**1.**	Nitaigour P. Mahalik, ‖ Mechatronics-Principles, Concepts and Applications‖, Tata McGraw Hill, Eleventh reprint 2011.
	2.	DevdasShetty and Richard A.Kolk, -Mechatronics System Design‖, Thomson India Edition 2007.HMT Limited, - Mechatronics‖, Tata McGraw-Hill Publishing House.

Department of Electronics and Telecommunication Engineering

Multidisciplinary Minor (MDM 4)

Department of Electronics and Telecommunication Engineering

Course Title: Introduction to Wireless Communication (Multidisciplinary Minor)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM4	2	-	-	2	10	15	50	-	-
Course Code	23BTECL316XX									
Teaching Mode	Offline	2 Hrs			Total	75			-	
Duration of ESE	3 Hrs					75				

Course Objectives	1. To understand the basic concept of wireless communication
	2.To understand the cellular concept in wireless communication
	3. To understand GSM architecture & recent trends in Wireless communication.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Explain the evolution, types, and generational progression (1G to 5G) of wireless communication systems.
	CO2: Analyze the structure of cellular systems, including frequency reuse, interference calculations, and handoff strategies.
	CO3: Compare various multiple access methods such as TDMA, FDMA, CDMA, OFDM, and CSMA in terms of efficiency and application.
	CO4: Describe the architecture and key features of GSM, CDMA (IS-95), and GPRS systems, including security and spread spectrum.
	CO5: Evaluate emerging wireless technologies and identify security challenges in contemporary wireless networks.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	-	2	2	2	3	-	-	-	-	-	-	-	2	-	-
CO2	-	2	2	2	3	-	-	-	-	-	-	-	2	-	-
CO3	-	2	2	2	3	-	-	-	-	-	-	-	2	-	-
CO4	-	2	2	2	3	-	-	-	-	-	-	-	2	-	-
CO5	-	2	2	2	3	-	-	-	-	-	-	-	2	-	-

Department of Electronics and Telecommunication Engineering

Course Content:

Unit	Contents	Hours
I	**Introduction to Wireless Communication System:** Evolution of mobile communications, Types of Wireless communication System, Introduction to First generation, Second generation Cellular Networks, Third Generation (3G) Wireless Networks, 4G & 5G networks.	8
II	**The Cellular Concept**: System Design Fundamentals: Cellular system, Hexagonal geometry cell and concept of frequency reuse, Channel Assignment Strategies, Adjacent Channel & co-channel interference, Handoff Strategies.	6
III	**Multiple Access Techniques:** Introduction, Comparisons of multiple Access Strategies TDMA, CDMA, FDMA, OFDM, CSMA Protocols.	6
IV	**Wireless Systems:** GSM system architecture, GSM speech coding, Concept of spread spectrum, Architecture of IS-95 CDMA system, GPRS system architecture.	4
V	Recent Trends: Introduction to IoT in Wireless Communication, Key features required for IoT Applications, Protocols for IoT Wireless Communication- Wi-Fi, WiMAX, Bluetooth & ZigBee Networks, UWB Radio, Wireless Adhoc Network and Mobile Portability, Security issues and challenges in a Wireless network.	6

Text Books	1.	Wireless Communication, Theodore S. Rappaport, Prentice hall of India
	2	Wireless Communications and Networking, Vijay Garg, Elsevier
	3	Wireless digital communication, Kamilo Feher, PHI
	4	Mobile Communications Engineering, William C. Y. Lee, Mc Graw Hill Publications
Reference Books	1.	Mobile and personal Communication system and services by Rajpandya, IEEE press (PHI).
	2.	Wireless Communications-T.L.Singh-TMH
	3.	Adhoc Mobile Wireless network, C.K. Toh Pearson.
E-Books	1.	https://onlinelibrary.wiley.com/doi/book/10.1002/9781119419204
Online TL Material	1.	https://archive.nptel.ac.in/courses/117/102/117102062