

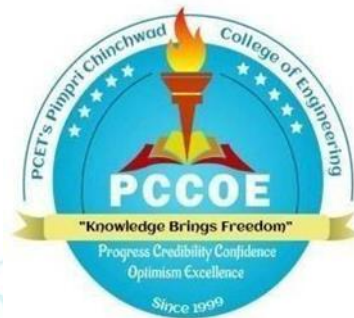
Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

DEPARTMENT OF E&TC ENGINEERING



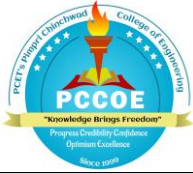
Curriculum Structure and Syllabus

of

**Third Year B. Tech. E&TC Engineering
(Regulations 2023)**



Effective from Academic Year 2026-27 with minor change



**Pimpri Chinchwad Education Trust's
Pimpri Chinchwad College of Engineering**

Course Approval Summary

A) Board of study – Department of Applied Sciences and Humanities

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1.	Not applicable	--	--	--

B) Board of study -Department of Civil Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1	Not applicable	--	--	--

C) Board of study-Department of Computer Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1.	Not applicable	--	--	--

D) Board of study-Department of CSE(AIML)

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1.	Not applicable	--	--	--

E) Board of Study- Department of E &TC

Sr. No.	Name of the Course	Course Code	Page number	Signature and stamp of BoS
1.	Communication Systems	BET25PC01	14	
2.	Communication Systems Lab	BET25PC02	16	
3.	Digital Signal Processing	BET25PC03	18	
4.	Digital Signal Processing Lab	BET25PC04	20	
5.	Advanced Microcontroller	BET25PC05	22	
6.	Advanced Microcontroller Lab	BET25PC06	23	
7.	Model Based Design Lab	BET25PC07	25	
8.	Digital Design with Verilog HDL	BET25PE01	27	

9.	Digital Design with Verilog HDL Lab	BET25PE02	28	
10.	Fiber Optic Communication	BET25PE03	30	
11.	Fiber Optic Communication Lab	BET25PE04	32	
12.	Statistical Signal Processing	BET25PE05	34	
13.	Statistical Signal Processing Lab	BET25PE06	36	
14.	Embedded System Design and RTOS	BET25PE07	38	
15.	Embedded System Design and RTOS Lab	BET25PE08	40	
16.	Power Electronics	BET25PE09	41	
17.	Power Electronics Lab	BET25PE10	43	
18.	PEC Project-1	BET25PE11	45	
19.	Computer Network and Security	BET26PC01	48	
20.	Computer Network and Security Lab	BET26PC02	50	
21.	Electromagnetics	BET26PC03	52	
22.	VLSI Design Lab	BET26PC04	54	
23.	System Design Using FPGA	BET26PE01	57	
24.	System Design Using FPGA Lab	BET26PE02	59	
25.	Information Theory and Coding	BET26PE03	61	
26.	Information Theory and Coding Lab	BET26PE04	62	
27.	Time-Frequency Analysis and Wavelets	BET26PE05	64	
28.	Time-Frequency Analysis and Wavelets Lab	BET26PE06	66	
29.	Embedded System for Connected Devices	BET26PE07	68	
30.	Embedded System for Connected Devices Lab	BET26PE08	70	
31.	Connected, Autonomous & Electric Vehicle –I	BET26PE09	72	
32.	Connected, Autonomous & Electric Vehicle –I Lab	BET26PE10	74	
33.	System Verilog for Verification	BET26PE11	75	
34.	System Verilog for Verification Lab	BET26PE12	77	
35.	Transmission Lines & Antenna	BET26PE13	79	
36.	Transmission Lines & Antenna Lab	BET26PE14	81	
37.	Digital Image Processing	BET26PE15	82	
38.	Digital Image Processing Lab	BET26PE16	84	
39.	C++ for Embedded Systems	BET26PE17	86	
40.	C++ for Embedded Systems Lab	BET26PE18	88	
41.	Embedded Automotive	BET26PE19	90	
42.	Embedded Automotive Lab	BET26PE20	92	
43.	PEC Project - 2	BET26PE21	93	
44.	Computational Tools for AIML	BET26VS01	95	

F) Board of study -Department of Information Technology Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1.	Not applicable	--	--	--

G) Board of study -Department of Mechanical Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1.	Not applicable	--	--	--

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering



Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

EOMS Policy

“We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

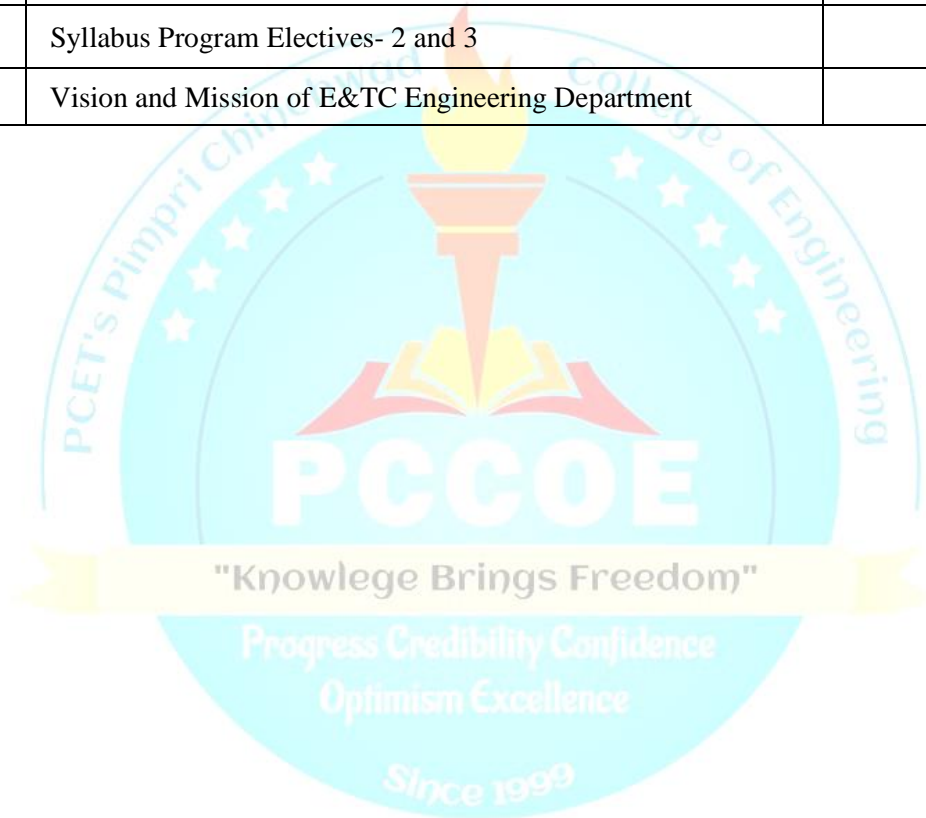
We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute’s social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS).”

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Sr. No.	Content	Page No.
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CURRICULUM FRAMEWORK
(Regulations 2023)

LIST OF ABBREVIATIONS

Sr. No.	Abbreviation	Type of Course
1	BSC	Basic Science Course
2	ESC	Engineering Science Course
3	PCC	Programme Core Course
4	PEC	Programme Elective Course
5	MDM	Multidisciplinary Minor
6	OEC	Open Elective Course
7	VSEC	Vocational and Skill Enhancement Course
8	AEC	Ability Enhancement Course
9	EEM	Entrepreneurship/Economics/Management Course
10	IKS	Indian Knowledge System
11	VEC	Value Education Course
12	ELC	Experiential Learning Courses
13	LLC	Liberal Learning Courses

COURSE WISE CREDIT DISTRIBUTION

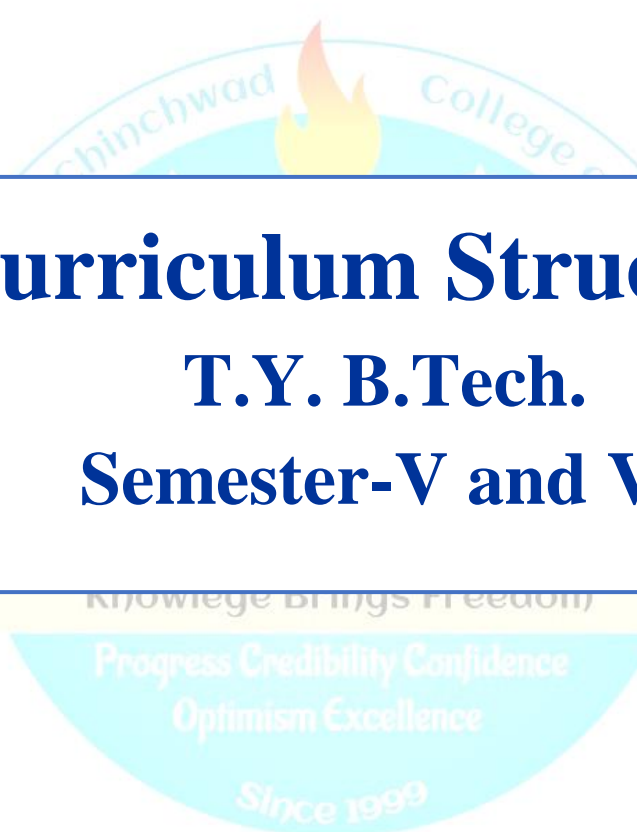
Sr. No.	Type of Course	No.of Courses	Total	
			NO.	%
1	Basic Science Course(BSC)	8	14	8.75
2	Engineering Science Course(ESC)	6	12	7.5
3	Programme Core Course (PCC)	26	46	28.75
4	Programme Elective Course(PEC)	13	20	12.5
5	Multidisciplinary Minor(MDM)	6	14	8.75
6	Open Elective(OEC)	3	6	3.75
7	Vocational and Skill Enhancement Course(VSEC)	4	8	5
8	Ability Enhancement Course(AEC)	2	4	2.5
9	Entrepreneurship/Economics/Management	2	4	2.5
10	Indian Knowledge System(IKS)	1	2	1.25
11	Value Education Course(VEC)	2	4	2.5
12	Experiential Learning Courses(ELC)	5	22	13.75
13	Liberal Learning Courses(LLC)	2	4	2.5
Total		80	160	100

SEMESTER-WISE COURSE DISTRIBUTION

Course Distribution: Semester Wise										
Sr. No.	Type of Course	No. of Courses / Semester								Total
		1	2	3	4	5	6	7	8	
1.	Basic Science Course(BSC)	4	4	-	-	-	-	-	-	8
2.	Engineering Science Course(ESC)	4	2	-	-	-	-	-	-	6
3.	Programme Core Course(PCC)	-	1	5	5	6	4	5	-	26
4.	Programme Elective Course(PEC)	-	-	-	-	3	5	5	-	13
5.	Multidisciplinary Minor(MDM)	-	-	1	1	2	1	1	-	6
6.	Open Elective(OEC)	-	-	2	1	-	-	-	-	3
7.	Vocational and Skill Enhancement Course(VSEC)	1	1	-	1	-	1	-	-	4
8.	Ability Enhancement Course(AEC)	1	-	-	1	-	-	-	-	2
9.	Entrepreneurship/Economics/Management Course(EEM)	-	-	1	1	-	-	-	-	2
10.	Indian Knowledge System(IKS)	-	1	-	-	-	-	-	-	1
11.	Value Education Course(VEC)	-	-	1	1	-	-	-	-	2
12.	Experiential Learning Courses(ELC)	-	-	1	-	-	-	-	4	5
13.	Liberal Learning Courses(LLC)	1	1	-	-	-	-	-	-	2
Total		11	10	11	11	11	11	11	4	80

SEMESTER-WISE CREDIT DISTRIBUTION

Credit Distribution: Semester Wise										
Sr. No.	Type of Course	No. of Credits / Semester								Total
		1	2	3	4	5	6	7	8	
1.	Basic Science Course(BSC)	7	7	-	-	-	-	-	-	14
2.	Engineering Science Course(ESC)	7	5	-	-	-	-	-	-	12
3.	Programme Core Course(PCC)	-	2	8	8	12	8	8	-	46
4.	Programme Elective Course(PEC)	-	-	-	-	4	8	8	-	20
5.	Multidisciplinary Minor(MDM)	-	-	2	2	4	2	4	-	14
6.	Open Elective(OEC)	-	-	4	2	-	-	-	-	6
7.	Vocational and Skill Enhancement Course(VSEC)	2	2	-	2	-	2	-	-	8
8.	Ability Enhancement Course(AEC)	2	-	-	2	-	-	-	-	4
9.	Entrepreneurship/Economics/Management Course(EEM)	-	-	2	2	-	-	-	-	4
10.	Indian Knowledge System(IKS)	-	2	-	-	-	-	-	-	2
11.	Value Education Course(VEC)	-	-	2	2	-	-	-	-	4
12.	Experiential Learning Courses(ELC)	-	-	2	-	-	-	-	20	22
13.	Liberal Learning Courses(LLC)	2	2	-	-	-	-	-	-	4
Total		20	20	20	20	20	20	20	20	160



Curriculum Structure
T.Y. B.Tech.
Semester-V and VI

CURRICULUM STRUCTURE

Third Year B.Tech. (E&TC Engineering) Semester – V (Regulation 2023)

Course Code	Course Type	Course Name	Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation Scheme and Marks						
			L	P	T	Total	L	P	T	O	FA1	FA2	SA	TW	PR	OR	Total
BET25PC01	PCC	Communication systems	2	-	-	2	2	-	-	1	10	10	30	-	-	-	50
BET25PC02	PCC	Communication systems lab	-	2	-	2	-	4	-	1	-	-	-	50	50	-	100
BET25PC03	PCC	Digital Signal Processing	3	-	-	3	3	-	-	1	20	20	60	-	-	-	100
BET25PC04	PCC	Digital Signal Processing Lab.	-	1	-	1	-	2	-	1	-	-	-	50	-	-	50
BET25PC05	PCC	Advanced Microcontroller	2	-	-	2	2	-	-	1	10	10	30	-	-	-	50
BET25PC06	PCC	Advanced Microcontroller Lab.	-	1	-	1	-	2	-	1	-	-	-	25	25	-	50
BET25PC07	PCC	Model Based Design Lab.	-	1	-	1	-	2	-	-	-	-	-	50	-	-	50
BET25PExx	PEC	PEC1	2	-	-	2	2	-	-	-	10	10	30	-	-	-	50
BET25PExx	PEC	PEC1 Lab.	-	1	-	1	-	2	-	-	-	-	-	50	-	-	50
BET25PE11	PEC	PEC Project-1	-	1	-	1	-	2	-	-	-	-	-	25	-	25	50
BET25MDxx	MDM	MDM3	3	-	-	3	3	-	-	-	20	20	60	-	-	-	100
BET25MDxx	MDM	MDM3 Lab	-	1	-	1	-	2	-	-	-	-	-	50	-	-	50
Total			12	8	0	20	12	16	0	6	70	70	210	300	75	25	750

#Refer separate booklet for Multidisciplinary Minor (MDM) courses

L-Lecture, P-Practical, T-Tutorial, O-Others, FA-Formative Assessment, SA-Summative Assessment, TW-Term Work, OR-Oral, PR-Practical

CURRICULUM STRUCTURE

Third Year B.Tech. (E&TC Engineering) Semester – VI (Regulation 2023)

Course Code	Course Type	Course Name	Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation Scheme and Marks						
			L	P	T	Total	L	P	T	O	FA1	FA2	SA	TW	PR	OR	Total
BET26PC01	PCC	Computer Network and Security	2	–	–	2	2	–	–	1	10	10	30	–	–	–	50
BET26PC02	PCC	Computer Network and Security Lab.	–	1	–	1	–	2	–	1	–	–	–	25	25	–	50
BET26PC03	PCC	Electromagnetics	2	–	1	3	2	–	1	1	10	10	30	50	–	–	100
BET26PC04	PCC	VLSI Design Lab	–	2	–	2	–	4	–	1	–	–	–	50	50	–	100
BET26PExx	PEC	PEC2	2	–	–	2	2	–	–	–	10	10	30	–	–	–	50
BET26PExx	PEC	PEC2 Lab.	–	1	–	1	–	2	–	–	–	–	–	50	–	–	50
BET26PExx	PEC	PEC3	2	–	–	2	2	–	–	–	10	10	30	–	–	–	50
BET26PExx	PEC	PEC3 Lab.	–	1	–	1	–	2	–	–	–	–	–	50	–	–	50
BET26PE21	PEC	PEC Project -2	–	2	–	2	–	4	–	–	–	–	–	50	–	50	100
BET26MDxx	MDM	MDM4	2	–	–	2	2	–	–	–	10	10	30	–	–	–	50
BET26VS01	VSEC	Computational Tools for AIML	1	1	–	2	1	2	–	–	25	25	–	50	–	–	100
Total			11	8	1	20	11	16	1	4	75	75	150	325	75	50	750

L-Lecture, P-Practical, T-Tutorial, O-Others ,FA–Formative Assessment, SA-Summative Assessment, TW-Term Work, OR-Oral, PR-Practical

Note: Exit Policy: Available as a separate document

Semester V
List of Program Elective Courses (PEC-1)

Course Code	Course Name	Remark
BET25PE01	Digital Design with Verilog HDL	Choose any one course and its associated lab.
BET25PE02	Digital Design with Verilog HDL Lab.	
BET25PE03	Fiber Optic Communication	
BET25PE04	Fiber Optic Communication Lab.	
BET25PE05	Statistical Signal Processing	
BET25PE06	Statistical Signal Processing Lab.	
BET25PE07	Embedded System Design and RTOS	
BET25PE08	Embedded System Design and RTOS Lab.	
BET25PE09	Power Electronics	
BET25PE10	Power Electronics Lab.	

Semester VI
List of Program Elective Courses (PEC-2)

Course Code	Course Name	Remark
BET26PE01	System Design Using FPGA	Choose any one course and its associated lab.
BET26PE02	System Design Using FPGA Lab.	
BET26PE03	Information Theory and Coding	
BET26PE04	Information Theory and Coding Lab.	
BET26PE05	Time-Frequency Analysis and Wavelets	
BET26PE06	Time-Frequency Analysis and Wavelets Lab.	
BET26PE07	Embedded system for Connected Devices #	
BET26PE08	Embedded system for Connected Devices Lab	
BET26PE09	Connected, Autonomous & Electric Vehicle –I*	
BET26PE10	Connected, Autonomous & Electric Vehicle –I Lab	

Semester VI
List of Program Elective Courses (PEC-3)

Course Code	Course Name	Remark
BET26PE11	System Verilog for Verification, System	Choose any one course and its associated lab.
BET26PE12	System Verilog for Verification, System Lab.	
BET26PE13	Transmission Lines & Antennas	
BET26PE14	Transmission Lines & Antennas Lab.	
BET26PE15	Digital Image Processing	
BET26PE16	Digital Image Processing Lab.	
BET26PE17	C++ for Embedded system#	
BET26PE18	C++ for Embedded system Lab	
BET26PE19	Embedded Automotive	
BET26PE20	Embedded Automotive Lab.	

**Offered by MG Motors*
#Offered by HCL limited



Course Syllabus

T.Y. B.Tech.

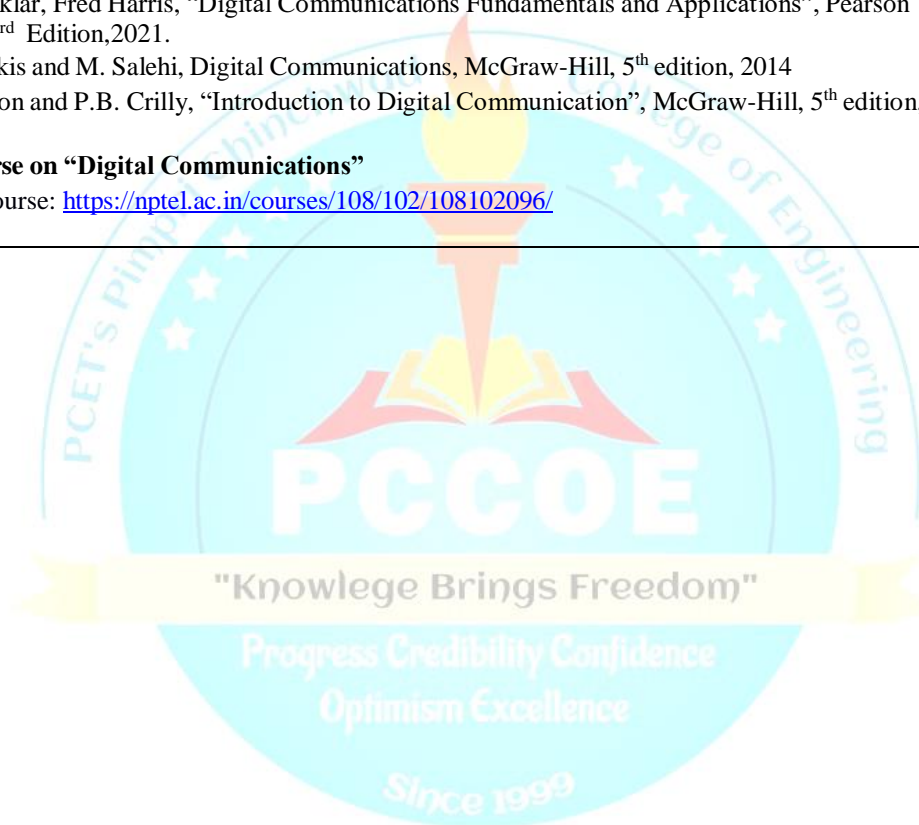
Semester-V

Optimism Excellence

Since 1999

Program:	B. Tech. (E&TC)				Semester:	V		
Course :	Communication System				Code :	BET25PC01		
Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme			
	Lecture	Practical	Tutorial	Other	FA		SA	Total
					FA1	FA2		
02	02	-	-	01	10	10	30	50
Prior knowledge of Signals and Systems, Modulation Techniques are essential								
Course Objectives: This course aims at enabling students, <ol style="list-style-type: none"> 1. Develop a strong foundation in analog and digital communication principles, including modulation techniques, multiplexing methods, noise analysis, and receiver design. 2. Explore digital modulation schemes, noise performance metrics, and emerging wireless communication standards, including IoT, AI/ML applications, and multiple access techniques used in 4G and 5G networks 								
Course Outcomes: After learning the course, the students will be able to: <ol style="list-style-type: none"> 1. Apply the fundamental principles of analog communication, including modulation techniques, noise analysis, and multiplexing methods. 2. Apply sampling theorem, pulse modulation, and line coding techniques for digital signal transmission and reconstruction. 3. Analyze the performance of various digital modulation schemes in the presence of noise using BER and SNR metrics. 4. Evaluate modern digital communication technologies, including multiple access techniques, wireless standards, AI/ML applications in wireless communication. 								
Detailed Syllabus:								
Unit	Description							Duration [Hrs]
1	Fundamentals of Analog Communication:- Introduction to Communication Systems, Amplitude Modulation (AM): Principles, Spectrum, Power Relations, Frequency Modulation (FM) and Phase Modulation (PM): Concepts and Bandwidth requirements, Superheterodyne Receiver and Demodulation Techniques, Noise in Analog Communication: Types, SNR, and Performance Analysis, Analog Multiplexing Techniques: Frequency Division Multiplexing (FDM)							08
2	Fundamentals of Digital Communication:- Advantages of Digital Communication over Analog Communication, Sampling Theorem and Signal Reconstruction, Pulse Code Modulation (PCM) and Quantization Noise, Delta Modulation (DM) and Adaptive Delta Modulation (ADM), Line Coding Techniques: NRZ, RZ, Manchester Coding, Inter-symbol Interference (ISI) and Nyquist Criterion, Digital Multiplexing: Time Division Multiplexing (TDM)							08
3	Digital Modulation Techniques and Noise Performance:- Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK) and Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation (QAM), Bit Error Rate (BER) and Performance Analysis in AWGN Channels, Signal-to-Noise Ratio (SNR) and its Impact on Digital Communication, Introduction to Spread Spectrum Techniques: DSSS, FHSS							07

4	Modern Digital Communication:- Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA, 4G and 5G Wireless Communication Standards ,Internet of Things (IoT) and Machine-to-Machine (M2M) Communication, Wireless Sensor Networks (WSN) and LPWAN Technologies,Introduction to AI and ML in Wireless Communication	07
Total		30
Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.		
Text Books:		
<ol style="list-style-type: none"> 1. Simon Haykin, Michael Moher – <i>Communication Systems</i> ,5th Edition,2024,Wiley Publication. 2. B.P. Lathi & Zhi Ding – <i>Modern Digital and Analog Communication Systems</i> ,5th Edition,2019, Oxford University Press 		
Reference Books:		
<ol style="list-style-type: none"> 1. Bernard Sklar, Fred Harris, “Digital Communications Fundamentals and Applications”, Pearson Education, 3rd Edition,2021. 2. J. G. Proakis and M. Salehi, Digital Communications, McGraw-Hill, 5th edition, 2014 3. A.B Carlson and P.B. Crilly, “Introduction to Digital Communication”, McGraw-Hill, 5th edition, 2015 		
NPTEL Course on “Digital Communications”		
Link of the Course: https://nptel.ac.in/courses/108/102/108102096/		



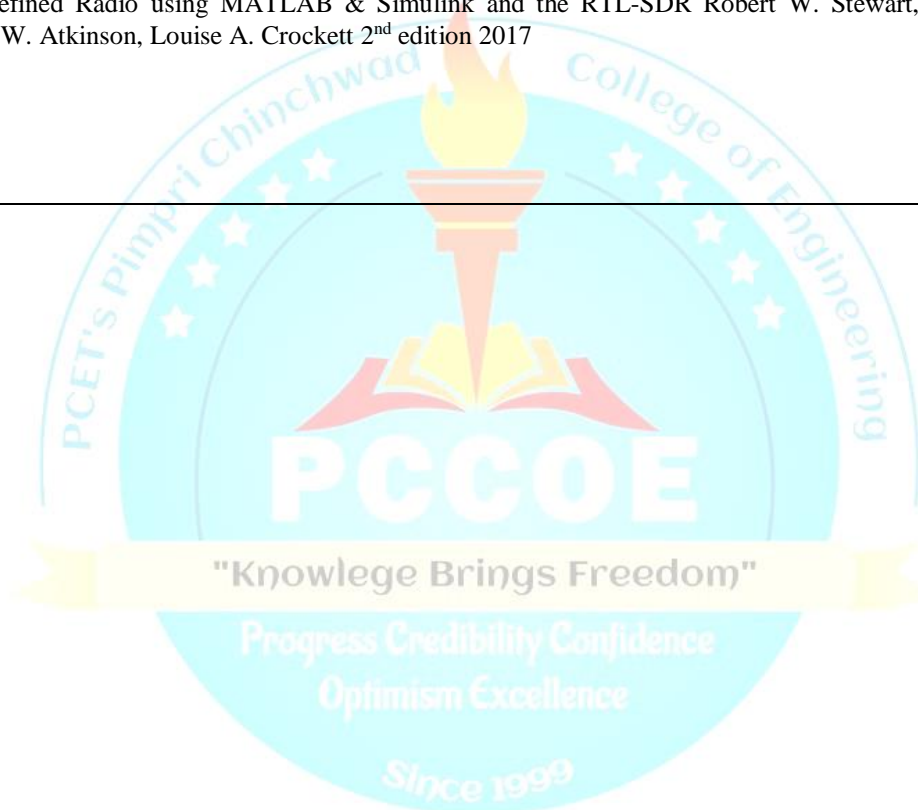
Program: B. Tech. (E&TC)					Semester		V	
Course : Communication System Lab					Code : BET25PC02			
Teaching Scheme Hrs/Week					Evaluation Scheme			
Credit	Lecture	Practical	Tutorial	Other	TW	OR	PR	Total
2	-	04	-	01	50	-	50	100
Prior knowledge of: Signals and Systems, Modulation Techniques are essential								
Course Objectives: This course aims at enabling students, <ol style="list-style-type: none"> To demonstrate Analog and Digital Bandpass modulation schemes. Develop a Practical Understanding of SDR-Based Communication Systems. Implement and Analyze Advanced Wireless Communication Technologies 								
Course Outcomes: After learning the course, the students should be able to: <ol style="list-style-type: none"> Implement and Analyze Bandpass Modulation scheme Implement and Analyze Analog and Digital Communication Techniques using SDR. Design and Evaluate Advanced Wireless Communication Systems 								
Detailed Syllabus:								
Expt. No.	List of Experiments							
1	AM Generation : Calculation of modulation index by graphical method, Power of AM Wave for different modulating signal							
2	Frequency modulator & demodulator using IC 565 (PLL based), calculation of modulation index & BW of FM							
3	Prove sampling Theorem. Reconstruct the analog signal from its samples. Observe the aliasing effect by varying sampling frequency.							
4	QPSK Generation & detection: calculation of BW, observation of constellation diagram and coherent detection							
5	DS-SS with BPSK Generation & detection :Generation of PN sequence using N-bit, calculation of processing gain and coherent detection.							
6	Understand SDR architecture, install GNU Radio/SDR software, and configure SDR receiver/transmitter.							
7	Implement AM modulation and demodulation using SDR, analyze the power spectrum and signal characteristics							
8	Generate an FM signal using SDR, receive and demodulate it, and analyze its bandwidth.							
9	Implement PCM using SDR and analyze quantization noise effects							
10	Implement and analyze TDM for multiple digital signals using SDR.							

11	Implement and analyze Digital bandpass modulation scheme using SDR.
12	Implement Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS) using SDR and analyze their benefits.
13	Measure the Bit Error Rate (BER) of different modulation schemes in an Additive White Gaussian Noise (AWGN) channel using SDR
14	Implementation and Performance Analysis of Multiple Access Techniques using SDR.
15	Design and implement a simple communication system using SDR software where students can manipulate different modulation schemes, signal parameters, and observe their effects on the received signal.

Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.

Text Books :

1. Software-Defined Radio for Engineers Travis Collins, Robin Getz, Di Pu, Alexander Wyglinski 1st edition 2018
2. Software-Defined Radio using MATLAB & Simulink and the RTL-SDR Robert W. Stewart, Kenneth W. Barlee, Dale S. W. Atkinson, Louise A. Crockett 2nd edition 2017



Program :	B. Tech. (E&TC)			Semester: V			
Course :	Digital Signal Processing			Code :	BET25PC03		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100
Prior knowledge of:							
a. Basics of signals, signal operations							
b. Basics of analog signal processing & transforms							
is essential							
Course Objectives:							
This course aims at enabling students,							
1. To provide background fundamentals of digital signals and computations of transform algorithms.							
2. To describe the design procedure of digital filters.							
Course Outcomes:							
After learning the course, the students should be able to:							
1. Explicate various stages of Digital Signal Processing.							
2. Select proper tools to evaluate systems using frequency transformation techniques like DFT, FFT.							
3. Design the FIR digital filter for given specifications.							
4. Realize the IIR digital filter using different structures							
5. Explain applications of digital signal processing algorithms to various areas like medical, speech, image							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Fundamentals of Digital Signal Processing Basic Elements of DSP and its requirements ,Sampling and Reconstruction, Definition and properties of Z Transform , Pole zero plot, System stability analysis ,correlation						09
2	Transforms: DTFT, Definition and properties of Discrete Fourier Transform (DFT), Computation of DFT using FFT (Radix-2 FFT Algorithms), Inverse DFT, Circular convolution						09
3	FIR Filter Design: Introduction, Basics of group delay & phase delay concepts, Comparison between Analog and Digital Filters, Characteristics of FIR filter, FIR filter design using Windowing methods ,Frequency sampling method, FIR Filter Structures						09
4	IIR Filter Design: IIR Filter Design by: Approximation of derivatives method, impulse invariance method, bilinear transformation method, warping effect, Design of Butterworth low pass and High pass filter, IIR Filter Structures.						10
5	DSP Applications: Speech processing, Musical sound processing, Image, Biomedical signal processing, RADAR						08
	Total						45
Text Books:							
1. Proakis & Manolakis, "Digital Signal Processing- Principles, Algorithms & Applications", 5th Edition, Pearson education, New Delhi, 2021.							
2. S Esakkirajan,t Veerakumar,Badri Narayan Subudhi Digital Signal Processing McGraw Hill 2021							

Reference Books:

1. P. Ramesh Babu, "Digital Signal Processing" Scitech Publications Pvt. Ltd. 4th edition, 2009

2. Nagoor Kani," Digital Signal Processing". Tata McGraw-Hill, Second edition, 2012

Research Papers:

1. Yan Wang a, Wei Song c, Wei Tao a, Antonio Liotta d, Dawei Yang a, Xinlei Li a, Shuyong Gao b, Yixuan Sun a, Weifeng Ge b, Wei Zhang b, Wenqiang Zhang a,b,*," A systematic review on affective computing: emotion models, databases, and recent advances," International Journal of Information Fusion, 83-84, pp. 19-52, 2022, doi: <https://10.1016/j.inffus.2022.03.009>.

2.G. H. MOHMAD DAR1 AND RADHAKRISHNAN DELHIBABU, " Speech Databases, Speech Features, and Classifiers in Speech Emotion Recognition: A Review "IEEE access, volume 12, pp. 151122-151152, 2024 doi : 10.1109/ACCESS.2024.3476960

NPTEL Link:

1. <https://nptel.ac.in/courses/117102060>
2. <https://nptel.ac.in/courses/108106151>



Program: B. Tech. (E&TC)					Semester : V			
Course : Digital Signal Processing Lab					Code : BET25PC04			
Teaching Scheme Hrs/Week					Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	Other	T W	OR	P R	Total
01	-	02	-	01	50	-	-	50
Prior knowledge of: Basic Signal Transforms, 1D signal linear algebra is essential								
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> To inculcate mathematical skills to solve problems involving convolution and sampling To demonstrate the representation of signals in the frequency domain. To make students aware of different types of filters and their implementations To familiarize the students with various AI based applications of DSP. 								
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> Evaluate system response using open source/MATLAB programming and frequency transformation techniques, FFT. Design IIR and FIR Filters for real world signals 								
Guidelines: Any Six Experiments is to be performed to meet the above outcomes. Term work: <ol style="list-style-type: none"> Term Work for 50 Marks For Term Work assessment only Project is mandatory. High performance computing concepts should be added 								
Detailed Syllabus:								
Expt. No.	List of Experiments							
1	Introduction to DSP Software Tools : Overview of MATLAB for DSP , Signal operations (shifting, scaling, addition, multiplication).							
2	Verification of Sampling Theorem. 2A. Generate Sinusoidal signal consist of three frequencies 1Hz, 10Hz, etc. Sample it using four sampling Frequencies 5Hz, 25Hz, 50Hz & 100Hz , Plot the signal & comment on result 2B Hearing Aliasing							
3	Write a MATLAB program to find the linear and circular convolution of two sequences. Compare the result 3A) Without Aliasing 3B) With Aliasing							
4	Frequency domain analysis of the signal: Analyze how the signal's energy is distributed over a range of frequencies.							
5	Z-Transform and System Analysis : Computation of Z-transform and inverse Z-transform Pole-zero plot of a given system Stability analysis using Z-transform							
6	Implementation of Digital Filters : To study the effect of different windows on FIR filter (LPF, HPF) response.							
7	Implementation of Digital Filters Design Butterworth filter using Bilinear transformation method for LPF and write a program to draw the frequency response of the filter.							
8	Mini Project/Open Ended Project 1. Design of an Audio Signal Filter for Speech and Music Separation Using FFT & FIR/IIR Filters							

	<p>Record your own voice with background instrumental music, then implement a digital filter using FFT, FIR, and IIR filtering techniques to separate speech and instrumental components.</p> <ol style="list-style-type: none"> 2. Secure Audio Communication Using DSP-Based Encryption & Decryption with FFT Analysis: Record an audio message, then encrypt and decrypt it using FFT-based spectral analysis to enable secure transmission. 3. Voice-Controlled DC Motor Speed Regulation Using FIR/IIR Filters <p>Record different voice commands (e.g., slow, fast, stop) and process them using FIR/IIR filtering techniques to control the speed of a DC motor for robotics applications</p> <ol style="list-style-type: none"> 4. Speech-Activated Home Automation System with FFT-Based Feature Extraction <p>Record voice commands and develop a DSP system that extracts speech features using FFT to recognize commands for controlling home appliances.</p> <ol style="list-style-type: none"> 5. Speaker Recognition System for Biometric Authentication Using FFT & Digital Filtering <p>Record multiple samples of your voice and implement a speaker recognition system using FFT for frequency domain analysis and FIR/IIR filters for noise reduction.</p> <ol style="list-style-type: none"> 6. Analog to Digital Conversion (ADC) Process Implementation with Signal Reconstruction Record an analog voice sample, convert it to digital using sampling, quantization, and encoding techniques, and then apply FFT-based signal analysis and reconstruction techniques 7. Real-Time Noise Cancellation System Using Adaptive FIR/IIR Filters <p>Record an audio signal with background noise, then implement adaptive FIR/IIR filtering to remove the noise and enhance speech clarity.</p> <ol style="list-style-type: none"> 8. ECG Signal Processing for Biomedical Diagnosis Using FFT & Digital Filters <p>Capture an own ECG signal (or use a simulated ECG signal) and apply FFT-based analysis and FIR/IIR filtering for noise suppression and feature extraction.</p> <ol style="list-style-type: none"> 9. DTMF-Based Signal Processing for Remote Control Applications Using FFT <p>Record DTMF tone signals (e.g., from a telephone keypad) and implement a DTMF tone detection system using FFT and FIR filtering techniques</p> <ol style="list-style-type: none"> 10. Motion Detection and Intruder Alarm System Using FIR Filtering <p>Capture an image/video signal and develop a motion detection system using FIR filtering techniques to analyze motion signals for security applications.</p> <ol style="list-style-type: none"> 11. Audio Watermarking for Digital Rights Protection Using FFT & Signal Modulation <p>Record an audio clip, then embed a hidden watermark (e.g., text or ID) using FFT-based signal modulation techniques for copyright protection.</p> <ol style="list-style-type: none"> 12. Speech Signal Denoising and Compression Using FFT & Adaptive Filters <p>Record a speech signal with background noise, then apply FFT-based noise reduction and compression for efficient storage and transmission.</p> <ol style="list-style-type: none"> 13. Digital Strain Gauge System for Stress Measurement with FIR/IIR Filtering <p>Capture an analog strain signal, process it using FIR and IIR digital filtering techniques, and output an 8-bit digital signal for measurement.</p> <ol style="list-style-type: none"> 14. Emotion Recognition from Speech Signals Using FFT-Based Feature Extraction <p>Record multiple voice samples expressing different emotions (happy, sad, angry, etc.), then analyze them using FFT-based feature extraction and filtering techniques to classify emotions.</p> <ol style="list-style-type: none"> 15. Music Genre Classification Using Audio Signal Processing with FFT & Filter Banks <p>Record short clips of different music genres, then implement a music classification system using FFT for spectral feature extraction and FIR/IIR filter banks for frequency-based analysis.</p>
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Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.

References:

1. S Esakkirajan,t Veerakumar,Badri Narayan Subudhi :Digital Signal Processing ,McGraw Hill 2021
2. R. Ansoerge, Programming in Parallel with CUDA: A Practical Guide, CambridgeUniversity Press 2022
3. S.Salivahanan, A. Vallavaraj and C.Gnanapriya, “Digital Signal Processing”, Tata McGraw-Hill, First edition 2009
4. <https://cupy.dev> (for CuPy)

Program:	B. Tech. (E&TC)			Semester:	V		
Course:	Advanced Microcontroller			Code:	BET25PC05		
Credits	Teaching Scheme(Hr/Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA1	FA2	SA	Total
2	2	-	-	10	10	30	50
Prior Knowledge of:							
1. Microcontroller is essential.							
Course Objectives:							
1. To make students understand architecture and applications of ARM processors in embedded systems.							
2. To introduce recent trends in microcontroller architectures.							
3. To explore students with interfacing of real world input and output devices.							
Course Outcomes:							
After completion of this course students will be able to							
1. Compare the different ARM processors.							
2. Illustrate the features of ARM based microcontrollers.							
3. Develop embedded systems using peripherals.							
4. Apply ARM Cortex and STM32 architectural concepts to develop embedded systems.							
Detailed Syllabus:							
Unit	Description						Duration (Hrs)
1.	INTRODUCTION TO ARM PROCESSORS AND ITS VERSIONS ARM7, ARM9 & ARM11 features, advantages & suitability in embedded application ARM7 registers, CPSR, SPSR, ARM and RISC design philosophy, ARM7 data flow model, programmer's model, modes of operations						7
2.	ARM7 BASED MICROCONTROLLER LPC2148 Features, Architecture (Block Diagram and Its Description), System Control Block (PLL and VPB divider), Memory Map, GPIO, Pin Connect Block, Timer, simple LPC2148 GPIO Programming examples using timers of LPC2148 to generate delay						8
3	ARM REAL WORLD INTERFACING PART I Interrupt structure of LPC2148, Interfacing with LED, LCD, GLCD, KEYPAD, simple LPC2148 UART Programming, on-chip ADC, Waveform generation using DAC Study of protocols I2C, SPI, EEPROM with I2C, All programs in embedded C.						8
4.	RECENT TRENDS IN MICROCONTROLLER ARCHITECTURES Introduction to ARM cortex series, CORTEX A, R, M processors, Introduction to STM32: Evolution, Features, Architecture, STM32 Programming Firmware development using CMSIS Standard.						7
	Total						30
Text Books:							
1. Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide – Designing and Optimizing System Software, 1 st edition, ELSEVIER, 2004.							
References:							
1. Steve Furber, ARM System on Chip Architecture, 2 nd edition, Addison-Wesley, March 2000.							
2. LPC 214x User manual (UM10139) :- www.nxp.com							
3. ARM architecture reference manual : - www.arm.com							
4. STM32 Reference Manual							
5. STM32 User Manual							

Program:	B. Tech. (E&TC)			Semester : V			
Course :	Advanced Microcontrollers Lab			Code : BET25PC06			
Teaching Scheme (Hrs/Week)				Evaluation Scheme and marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	25	-	25	50
Prior knowledge of: a. Microcontrollers and Embedded C Programming is essential.							
Course Objectives: 1. To introduce the architecture, features, and programming of LPC2148 and STM32F controllers. 2. To demonstrate real-world interfacing using peripherals.							
Course Outcomes: After completion of this course, students will be able to: 1. Demonstrate the use of hardware and software tools. 2. Design, interface and implement embedded systems using LPC2148 3. Develop STM32 controller based real-world applications.							
Guidelines: <ul style="list-style-type: none"> Any 5 experiments from Group A and Any 3 experiments from Group B are to be performed. Two turns can be utilized for Mid Term and End Term evaluation. 							
Detailed Syllabus:							
Expt. No.	List of Experiments						
Group A: ARM LPC2148 BASED EXPERIMENTS							
1	LED Blinking using TIMER						
2	Square waveform Generation using Timer Interrupt						
3	KEYPAD & LCD interfacing						
4	Using UART of LPC2148 for serial reception and transmission from/to computer.						
5	Interfacing EEPROM to LPC2148 using I2C protocol						
6	Using built-in ADC of LPC2148 for displaying its values (Programming built-in ADC with interrupt and without interrupt)						
7	Waveform Generation using DAC						
Group B: STM32 BASED EXPERIMENTS							
8	LED Blinking using STM32 at a fixed interval using GPIO programming						
9	Establish Serial Communication between STM32 and a PC using UART (RS485 physical layer)						
10	Implement Interrupt-Driven UART Communication in STM32						
11	Implement Basic CAN Bus Communication between Two STM32 Boards						
12	Implement a USB Virtual COM Port (CDC) using STM32						

References:

1. Andrew Sloss ARM System Developer's Guide by ELSEVIER
2. LPC 214x User manual (UM10139) :- www.nxp.com
3. ARM architecture reference manual : - www.arm.com
4. STM32 Reference Manual
5. STM32 User Manual



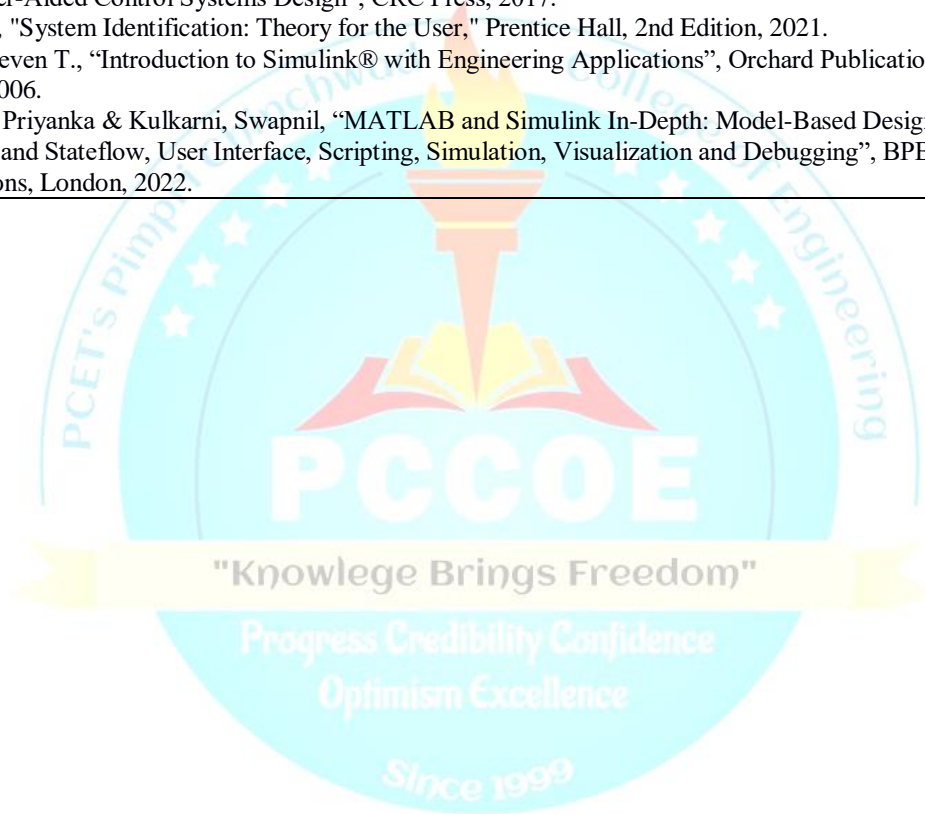
Program: B. Tech. (E&TC)				Semester: V			
Course: Model Based Design Lab				Code: BET25PC07			
Teaching Scheme Hrs./Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of: Basic Programming Concepts ,Control Systems is essential.							
Course Objectives: The objective of this laboratory is to provide the student with: <ul style="list-style-type: none"> • Hands-on experience using EDA Tools for modeling and simulation. • Practical knowledge of state machines and control strategies. • Skills to design and simulate real-world systems. • Ability to generate code from models for hardware implementation. 							
Course Outcomes: After completing the course, the students should be able to: <ul style="list-style-type: none"> • Apply Model-Based Design using EDA Tools for system simulation and control. • Create optimized models and generate code for real-time systems. 							
Guidelines: For the Term Work Assessment, students are required to complete 6 experiments from Part A and a Mini Project from Part B.							
Detailed Syllabus:							
PART:A							
Expt. No.	List of Experiments						
1	Introduction to EDA Tools (Proprietary/ Open source): Creating Your First Model						
2	Design and simulate a mass-spring-damper system model using EDA Tools.						
3	Design a PID Controller for Speed Control Using EDA Tools Function Blocks						
4	Model and Simulate a Water Tank System Using Subsystems						
5	Model and simulate state machines using Stateflow flowcharts.						
6	Apply optimization algorithms to improve system design performance.						
7	Generate C code from Simulink models and validate its functionality.						
8	Implement and simulate event-driven systems using Stateflow.						
9	Create reusable Simulink components and apply masking techniques for user-friendly interfaces.						
10	Implement a Simulink model for real-time data logging and visualize the signals during simulation.						
PART:B							
Mini Project: Design and Simulate a Model-Based Control System							
Develop and simulate a model-based control system for a real-world application using EDA Tools, aligning with at least one Sustainable Development Goal (SDG) of the institute. The mini project is self-learning-based, encouraging students to explore and implement concepts beyond the syllabus.							

Tasks:

- Choose a real-world system to model (e.g., robotic arm, autonomous vehicle, temperature control, etc.).
- Design and simulate the system, incorporating state management techniques.
- Implement a control strategy (e.g., PID, state machine).
- Optimize the system's performance based on key criteria (e.g., time response, energy efficiency).
- Generate and test the code for potential hardware implementation (optional).
- Present and document the final project with a detailed analysis and results.

References:

1. Jain, Shailendra & Kapshe, Sanjeevan, "Modeling and Simulation Using MATLAB - Simulink: For ECE", Wiley, 1st edition, 2016.
2. Bhattacharya, S. K., "Control Systems Engineering", Pearson India, 3rd edition, 2013. Chin, Cheng Siong, "Computer-Aided Control Systems Design", CRC Press, 2017.
3. Ljung, L., "System Identification: Theory for the User," Prentice Hall, 2nd Edition, 2021.
4. Karris, Steven T., "Introduction to Simulink® with Engineering Applications", Orchard Publications, 1st edition, 2006.
5. Patankar, Priyanka & Kulkarni, Swapnil, "MATLAB and Simulink In-Depth: Model-Based Design with Simulink and Stateflow, User Interface, Scripting, Simulation, Visualization and Debugging", BPB Publications, London, 2022.



Program :	B. Tech. (E&TC)			Semester: V			
Course :	Digital Design with Verilog HDL			Code :	BET25PE01		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of Digital logic design is essential							
Course Objectives:							
This course aims at enabling students,							
<ol style="list-style-type: none"> To introduce students to the fundamentals of digital system design using Verilog HDL. To provide a deep understanding of Verilog coding styles, including Gate-Level, Dataflow, and Behavioural Modelling. To enable students to design, simulate, and implement digital circuits using Verilog HDL. To develop the ability to write testbenches for functional verification of digital circuits. 							
Course Outcomes:							
After learning the course, the students should be able to:							
<ol style="list-style-type: none"> Elaborate the fundamentals of Verilog HDL, its evolution, and its role in digital system design. Apply Gate-Level and Dataflow modelling techniques to describe combinational and sequential circuits. Develop digital circuits using Behavioural modelling, incorporating procedural statements and control structures. Design and implement testbenches for functional verification of digital circuits. 							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Fundamentals of Verilog HDL, Evolution, and Role in Digital System Design: VLSI design flow in detail. Verilog as HDL, levels of design description, simulation and synthesis, Top-down and Bottom up design methodology Basic Verilog program , Verilog primitive gates. Gate-Level Modelling: Description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays						08
2	Gate-Level Modelling: Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in Gate-level Modelling. Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in dataflow model .						07
3	Modelling of sequential and combinational logic: Procedural Assignments, Initial and always blocks, blocking and non-blocking statements, delay control, conditional statements, Multiway branching, loops, sequential and parallel blocks, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in Behavioral model						07
4	Testbench Design for Functional Verification: Introduction to Testbenches, Need for Testbenches in Digital Design, Types of Testbenches (Self-Checking, Golden Model- Based). Writing Basic Testbenches: Using \$monitor, \$display, \$finish, and \$time Statements, Defining Test Stimulus Using initial and always Blocks Testbenches for Combinational Circuits: Verification of Multiplexer, ALU, and Adders, Testbenches for Sequential Circuits: Testbench for Flip-Flops, Counters, FSMs.						08
	Total						30
Text Books:							
1. Taraate, Vaibhav. Digital Logic Design Using Verilog. Springer Singapore, Edition 1st . 2022.							
Reference Books:							
1. Palnitkar, Samir. <i>Verilog HDL: a guide to digital design and synthesis</i> . Vol. 1. Prentice Hall Professional, 2003.							
2. Stephen Brown and Zvonko Vranesic, “Fundamentals of Logic Design with Verilog”, TMH publications, 2007.							
3. J. Bhaskar, “A Verilog Primer”, BSP, 2nd edition 2003.							
e-sources:							
http://vol.verilog.com							
https://www.mooc-list.com/tags/verilog							

Program: B. Tech. (E&TC)				Semester : V			
Course : Digital Design with Verilog HDL Lab.				Code : BET25PE02			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	100
Prior knowledge of:							
a. Digital logic design is essential							
Course Objectives:							
This course aims to enable students,							
<ol style="list-style-type: none"> To introduce students to the fundamentals of digital system design using Verilog HDL. To provide a deep understanding of Verilog coding styles, including Gate-Level, Dataflow, and Behavioral Modeling. To enable students to design, simulate, and implement digital circuits using Verilog HDL. 							
To develop the ability to write test benches for functional verification of digital circuits.							
Course Outcomes:							
After learning the course, the students should be able to:							
<ol style="list-style-type: none"> Model combinational and sequential circuits using Verilog HDL Design and implement testbenches for functional verification of digital circuits.. 							
Guidelines: All assignments are compulsory							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Introduction to Front end design flow and PLDs(FPGA)						
2	Modelling of adder Adder – Half/Full a. Model an adder in dataflow and structural modeling. b. Perform synthesis and verify using a test bench.						
3	Modeling of ALU for any 8 arithmetic and logical operations. a. Model ALU as a multiplexer using behavioral meddling b. Perform synthesis and verify using a test bench.						
4	Modeling of n:1 Multiplexer using behavioral meddling b. Perform synthesis and verify using test bench.						
5	Modeling of n: 2n decode, BCD to 7 seg decoder. using behavioral meddling b. Perform synthesis and verify using a test bench.						
6	4x4 Multiplier using Behavioral always block						
7	Modeling a Flip Flop and shift register using Verilog in behavioral modeling. a. Model an Active low asynchronous reset and active high synchronous reset b. Perform synthesis and verify using a test bench						
8	Modelling a counter. a. Model a counter using behavioral meddling b. Perform synthesis and verify using a test bench.						
9	Write Verilog Description for sequence detector FSM (Moore and Melay machine) to detect alternate 1's and 0's till 4 bits.						
10	Write Verilog Description for RAM						

References:

1. Fundamentals of Digital Logic with Verilog Design - Stephen Brown,ZvonkocVranesic, TMH, 2nd Edition.2010
2. Advanced Digital Logic Design using Verilog, State Machines & Synthesis for FPGA - Sunggu Lee, Cengage Learning, 2012.
3. Verilog HDL - Samir Palnitkar, 2nd Edition, Pearson Education, 2009.
4. Advanced Digital Design with Verilog HDL - Michel D. Ciletti, PHI,2009



Program :	B. Tech. (E&TC)			Semester: V			
Course :	Fiber Optic Communication			Code :	BET25PE03		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50
Prior knowledge of Physics and digital communication is essential.							
Course Objectives: This course aims at enabling students, 1.To introduce students to basic elements of optical fiber and essential parameters. 2.To make students to learn various optical sources and detectors and their characteristics. 3.To expose the students to link design and contemporary issues like DWDM,Amplifiers, passive components,FSP,VLC and AI.							
Course Outcomes: After learning the course, the students should be able to: 1. Apply the concept of optics to optical fiber characterization. 2. Examine optical sources, detectors, and their performance characteristics. 3. Design the optical link for link power and rise time. 4. Explore recent advancements in fiber optic technology, including optical amplifiers, FSO, and VLC etc.							
Detailed Syllabus							
Unit	Description						Duration [Hrs]
1	Optical fiber characteristics Key elements of optical fiber system-Ray optics, Mode theory, Geometrical-Optics Description, Fiber Types - specialty fibers. Attenuation-Absorption, Scattering, Bending losses, Dispersion-Material, Waveguide Dispersion, Polarization Mode Dispersion, Intermodal dispersion, Mode Transit time,Dispersion-Induced Limitations, Nonlinear Optical Effects- SRS, SBS, SPM, CPM, FWM.						08
2	Optical Sources and Detectors Light Emitting Diodes (LEDs), Types , Construction and Operation of LED's and LASERS, Characteristics of LED'S and LASERS, Optical Detectors: Construction and working principle of Photo Detectors, Types of Photo Detectors . Performance characteristics: Noise , Quantum Efficiency.						08
3	Optical Link Design : Digital links: Point-to-Point Links-System Consideration-Link power budget-Rise time budget,System performance- Attenuation, Dispersion measurements-OTDR. Optical Coherent Communication & OFDM in Optical Networks						06
4	Optical Network Components & Multiplexing Optical Fiber Couplers & Splitters ,Optical Amplifiers (EDFA, Raman, SOA), Wavelength Division Multiplexing (WDM, DWDM, CWDM),Optical Filters & Switches (AWG, MEMS, Liquid Crystal, Mach-Zehnder),ROADM (Reconfigurable Optical Add-Drop Multiplexers) Free-Space Optics (FSO) & Visible Light Communication (VLC) , Use cases FTTH,Optical Technologies in 6G & AI-driven Optical Networks						08
Total						30	
Text Books: 1. G. Keiser, Optical Fiber Communications, 5th ed. New York, NY, USA: McGraw-Hill, 2020. 2. J. Senior and M. Jamro, Optical Fiber Communications: Principles and Practice, 3rd ed. Pearson India , 2009.							

Reference Books:

1. G.P Agrawal, Fiber Optic Communication Systems, Wiley, 2011, 2nd Edition
2. B.Mukerjee, Optical WDM Networks (Optical Networks), 2006, Springer

MOOC Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee42/preview
2. https://onlinecourses.nptel.ac.in/noc20_ee79/preview



Program: B. Tech. (E&TC)				Semester : V			
Course : Fiber Optic Communication Lab				Code : BET25PE04			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of: Physics and Digital Communication is essential.							
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> To make students to use simulation software in fiber optic domain To make students to design and simulate various aspects of trends in fiber optics communication. 							
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> Analyze fiber attenuation, dispersion, and optical losses to evaluate the performance of optical communication systems. Design optical fiber communication links, including WDM, OTDM, and optical amplifiers, to optimize data transmission efficiency. Implement advanced optical communication techniques such as coherent detection (QPSK) and Free-Space Optical (FSO) communication under real-world conditions. 							
Guidelines: A list of fiber optic communication experiments to be implemented in a suitable simulation software 1. Perform any 10 experiments from 1-12. 2. Item No. 13 –Field visit is compulsory.							
Detailed Syllabus							
Expt. No.	List of Experiments						
1.	Fiber Attenuation Measurement and Fiber Dispersion Analysis						
2.	Numerical Aperture and Acceptance Angle						
3.	Visualization of Mode Propagation in Fibers						
4.	LED and Laser Diode Characteristics						
5.	Photo detector(Photodiode and APD) Response						
6.	To design a point-to-point optical fiber link and analyze bit error rate (BER).						
7.	Simulate a WDM system with multiple channels and analyze crosstalk						
8.	Simulate OTDM Systems and analyze the effects of timing jitter						
9.	To study the performance of optical amplifiers in fiber optic networks.						
10.	To analyze Fiber Bragg Gratings (FBG) as optical filters in WDM systems.						

11.	To simulate coherent optical detection using QPSK modulation.
12.	To simulate an FSO system under different atmospheric conditions.
13.	Field visit to study optical sources, detectors, fibers for telecommunication, mux demux, filters, isolators, circulators, couplers, connectors, optical amplifiers etc and the field instruments such as optical power meter, OTDR, splicing machine etc.(Prepare a short report)

References:

1. Wolf, Helmut F., "Optical Waveguides", Handbook of Fiber Optics.H. F. Wolf, Ed., Garland STPM Press, New York, 1979
2. Sandbank, C. P , Editor, Optical Fibre Communication Systems,John Wiley and Sons, Chichester2010
3. Virtual LAB Links:<http://vlabs.iitb.ac.in/vlabs-dev/labs/physics-basics/labs/numerical-aperturemeasurement-iitk/index.html>
4. <https://github.com/edsonportosilva/OptiCommPy>



Program:	B. Tech. (E&TC)			Semester: V			
Course:	Statistical Signal Processing			Code:	BET25PE05		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior Knowledge of: <ol style="list-style-type: none"> 1. Probability and Random theory 2. Linear algebra 3. Signals & Systems are essential.							
Course Objectives: This course aims at enabling students, <ol style="list-style-type: none"> 1. Establish a foundation in probability theory and random processes. 2. Learn estimation and detection techniques for noisy signals. 3. Explore adaptive filtering and spectral estimation for signal enhancement. 4. Apply statistical methods in real-world multimedia and image processing. 							
Course Outcomes: After learning the course, the students should be able to: <ol style="list-style-type: none"> 1. Analyze signals using probability theory and random process models. 2. Implement techniques like Wiener and Kalman filtering, Bayesian estimation, and Matched filtering. 3. Design adaptive filters and spectral estimation models. 4. Apply statistical tools to image denoising, video tracking, and multimedia signal processing. 							
Detailed Syllabus:							
Unit	Description						Duration [Hrs.]
1	Fundamentals of Statistical Signal Processing: Review of Probability Theory and Random Processes, Signal Modeling: Stochastic vs. Deterministic Signals, Power Spectral Density and Autocorrelation, Estimation of Statistical Parameters (Mean, Variance, Covariance), White Noise and Colored Noise, Applications: Noise Modeling in Communication						08
2	Estimation & Detection Theory: Bayesian and Maximum Likelihood Estimation, Wiener & Kalman Filters for Signal Estimation, Matched Filtering & Hypothesis Testing, Signal Detection in Noise (Neyman-Pearson Criterion), Applications: Target Detection in Radar.						08
3	Adaptive Signal processing: Adaptive Filters: Least Mean Squares (LMS) and Recursive Least Squares (RLS), Spectral Estimation: Parametric (AR, MA, ARMA) and Non-Parametric Methods (Periodogram, Welch's Method), Blind Source Separation for Audio signals.						08
4	Statistical Methods in Image and Multimedia Processing: Stochastic Models in Image Processing, Bayesian Estimation for Image Denoising, Kalman and Particle Filtering for Video Tracking.						06
	Total						30

Text Books:

1.M. H. Hayes, *Statistical Digital Signal Processing and Modeling*, Reprint ed., Hoboken, NJ, USA: John Wiley & Sons, Mar. 2008

Reference Books:

1. Steven. M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, volume 1, Pearson Education India ,2010
2. Robert. M. Gray and Davisson. L. D., *An Introduction to Statistical Signal Processing*, Cambridge University Press, 2007.
3. Dimitris Manolakis, Vinay Ingle, Stephen Kogon, *Statistical and Adaptive Signal Processing*, Tata McGraw Hill. 2012.

Online or MOOC/ Video Lectures available:**NPTEL Course:**

1.NPTEL Course “*Statistical Signal Processing*” Link of the Course: <https://nptel.ac.in/courses/108103158>

MathWorks Course:

1.Course name: “*Statistics Onramp*”

Link of the Course: <https://matlabacademy.mathworks.com/details/statistics-onramp/orst>

2. Course name: “*Curve Fitting Onramp*”

Link of the Course: <https://matlabacademy.mathworks.com/details/curve-fitting-onramp/orcf>



Program: B. Tech. (E&TC)				Semester: V			
Course: Statistical Signal Processing Lab				Code: BET25PE06			
Teaching Scheme Hrs./Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	T W	O R	P R	Total
0 1	-	02	-	50	-	-	50
Prior knowledge of: 1. Probability and Random theory 2. Linear algebra 3. Fundamentals of Programming is essential.							
Course Objectives: The objective of this laboratory is to: <ol style="list-style-type: none"> 1. Provide hands-on experience with random signal generation and statistical parameter analysis using MATLAB/Python. 2. Develop skills in implementing estimation techniques like Bayesian, MAP, and MVUE for signal enhancement. 3. Introduce adaptive filtering methods such as LMS and Kalman filters for noise suppression and signal tracking. 4. Enable students to apply spectral estimation and statistical models in real-world tasks including image denoising and video analysis. 							
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> 1. Develop practical skills in generating and analyzing random processes and computing key statistical parameters using MATLAB/Python. 2. Implement statistical estimation techniques such as Bayesian, MAP, and MVUE for signal enhancement and noise suppression. 3. Design and evaluate adaptive filters (like LMS and Kalman) and spectral estimation methods using real-world signals. 4. Apply statistical signal processing techniques in multimedia and image processing applications, including image denoising and video tracking. 							
Guidelines: Eight Experiments are to be performed. Any Seven Experiments are to be performed from Part A and Part B is compulsory							
Detailed Syllabus:							
Part A: Any Seven from List of Experiment							
Expt. No.	List of Experiments						
1	Generate and visualize Gaussian, Poisson, and Uniform random processes in MATLAB/Python.						
2	Compute and analyze the mean, variance, and autocorrelation of the generated signals.						
3	Implement basic functions of the MATLAB Toolbox for Bayesian Estimation						
4	Implement and compare non-parametric spectral estimation techniques.						
5	Apply Wiener filters for noise reduction in a given signal and evaluate filtering performance using SNR improvement.						
6	Demonstrate the Minimum Variance Unbiased Estimator (MVUE) algorithm.						
7	Realizes an adaptive FIR filter using the Least Mean Squares (LMS) algorithm						

8	Implement Maximum A Posteriori (MAP) estimation for image denoising.
9	Implement the Autoregressive Moving Average (ARMA) model in MATLAB
10	Implement a Kalman filter for tracking moving objects in a video.
Part B: Any one Case Study / Mini Project	
	<p>Suggested Case Study/Mini-Project Topics that can be implemented using MATLAB or Python:</p> <ol style="list-style-type: none"> 1. Speech Signal Denoising using Wiener and Kalman Filters 2. Real-Time Target Detection Using Matched Filter in Noisy Radar Signals 3. MVUE-Based Temperature Sensor Calibration 4. Adaptive Echo Cancellation using LMS Algorithm 5. Spectral Estimation of EEG Signals using AR and Welch Methods 6. Bayesian Image Denoising using MAP Estimation 7. Object Tracking in Video using Kalman Filter 8. Noise Modeling and Restoration in Scanned Documents 9. Random Process Simulator and Statistical Analyzer 10. Real-Time ARMA Model Predictor for Sensor Data 11. Machine Learning for Blind Source Separation using ICA 12. Anomaly Detection in Signals using Statistical Learning <p>Any Other Topic can be considered as per the suggestion and approval</p>
Text Books:	
1. M. H. Hayes, <i>Statistical Digital Signal Processing and Modeling</i> , Reprint ed., Hoboken, NJ, USA: John Wiley & Sons, Mar. 2008	
Reference Books:	
1. Steven. M. Kay, <i>Fundamentals of Statistical Signal Processing: Estimation Theory</i> , volume 1, Pearson Education India ,2010	
2. Robert. M. Gray and Davisson. L. D., <i>An Introduction to Statistical Signal Processing</i> , Cambridge University Press, 2007.	
3. Dimitris Manolakis, Vinay Ingle, Stephen Kogon, <i>Statistical and Adaptive Signal Processing</i> , Tata McGraw Hill. 2012.	

Program :	B. Tech. (E&TC)				Semester:	V		
Course :	Embedded System Design and RTOS				Code:	BET25PE07		
Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Others	FA		SA	Total
					FA1	FA2		
02	02	-	-	-	10	10	30	50

Prior knowledge of

a. Microcontrollers and Embedded C Programming is essential.

Course Objectives:

1. To explain the basics of Embedded systems design.
2. To discuss design and implementation of a real time system using RTOS.
3. To elaborate application specific system design.

Course Outcomes:

After completion of this course, students will be able to,

1. Understand the embedded system architecture and development toolchain.
2. Acquire a basic knowledge about fundamentals of RTOS.
3. Design multiple tasks using ucOS-II RTOS for specific embedded applications.
4. Design Device drivers with embedded Linux development systems.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	Embedded System Overview Embedded System Introduction, Hardware and software architectures of ES, Design metrics (technical and techno- economical), Prototyping models, Development tool chain insights (GNU), embedded system design challenges.	06
2	Real time systems and RTOS Introduction to Real time system, types, design approaches and considerations, Usage of Shared resources and related issues, Concept of RTOS, Types of RTOS, differences from GPOS, commercial RTOS, survey of RTOS	08
3	µcos-II –RTOS Introduction to µCOS-II RTOS, µcos-II features, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management in µCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II.	08
4	Embedded Linux Linux for embedded systems, embedded Linux development system, kernel architecture and configuration, file systems, porting Linux on ARM architecture, boot loaders, tool utilities such as Minicom, Busybox, Redboot, Libc.	08
Total		30

Text Books:

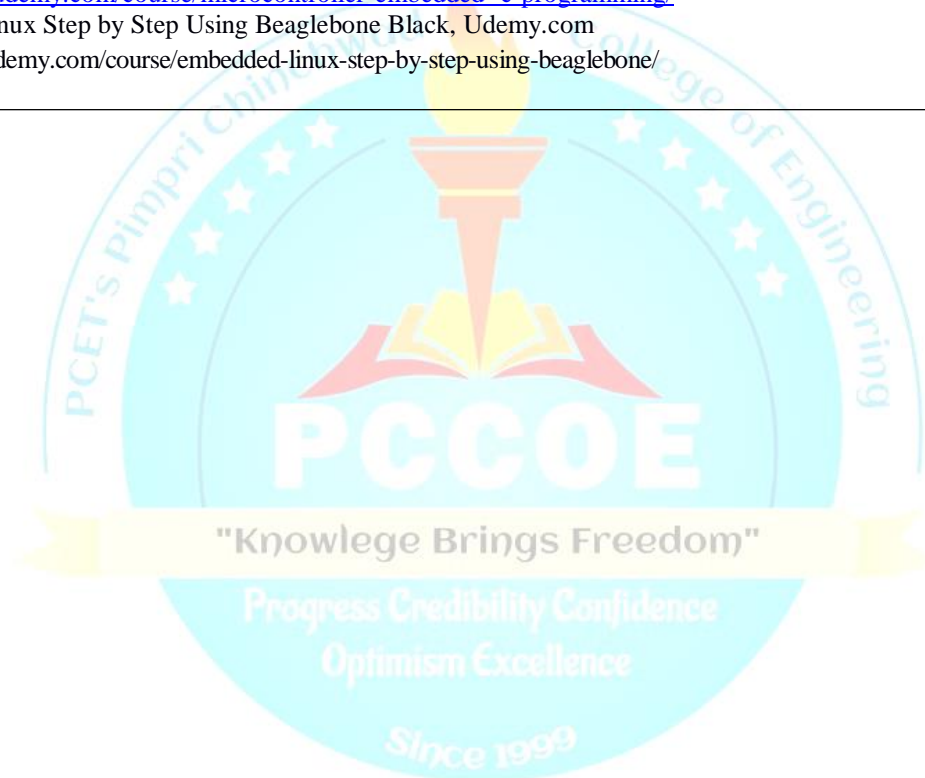
1. Rajkamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw- Hill Education, 2nd edition, 2011.
2. Qing Li, Caroline Yao, Real-Time Concepts for Embedded Systems, **CRC Press** 1st Edition , 2003
3. Jean Labrosse, MicroC OS II: The Real Time Kernel, CRC Press, 2nd edition, 2002
4. Christopher Hallinan, Embedded Linux Primer: A Practical Real-World Approach, 2nd edition, 2010

Reference Books:

1. Di Jasio, Programming 32-bit microcontrollers in C, Elsevier, 1st Edition, 2008.
2. Tammy Noergaard, Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers, Newnes, 2nd Edition, 2010.
3. K. Curtis, Embedded multitasking, 1st edition, Newnes, 2011.
4. Chris Simmonds, Master the techniques needed to build great, efficient embedded devices on Linux, Packt, 2nd Edition, 2017
5. Brian Amos, Hands-On RTOS with Microcontrollers, Packt Publishing, 1st Edition, 2020

Online Courses:

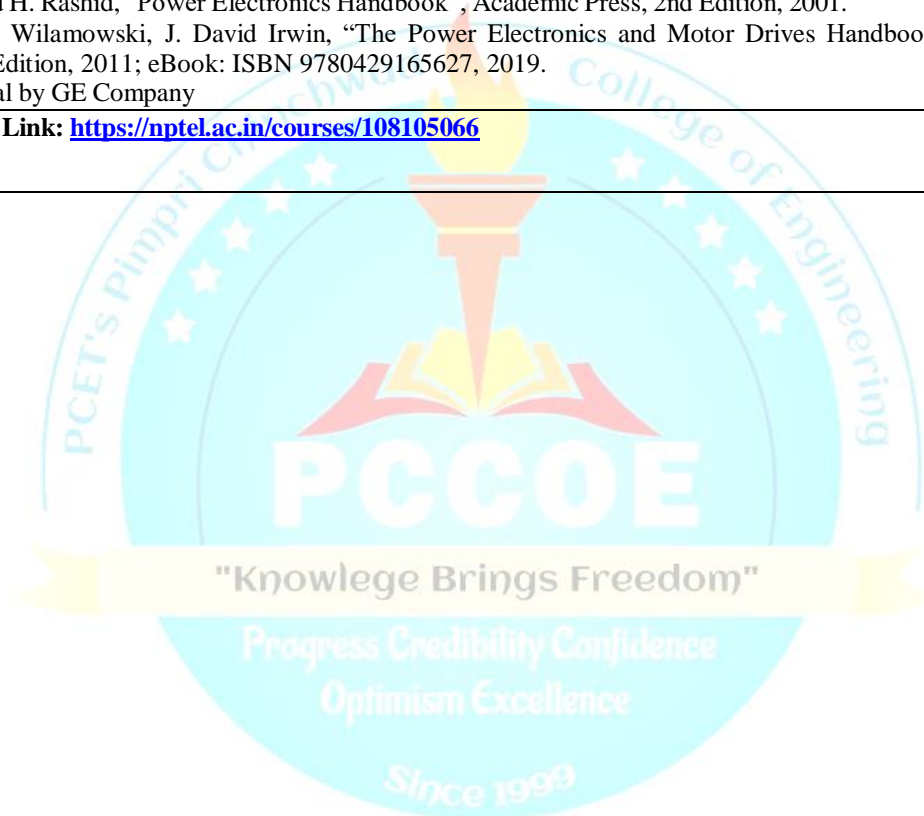
1. Embedded Systems, IIT Delhi, Prof. Santanu Chaudhary
<https://nptel.ac.in/courses/108102045>
2. Embedded System Design with ARM, IIT Kharagpur, Prof. Indranil Sengupta, Prof. Kamalika Datta
<https://nptel.ac.in/courses/106105193>
3. Introduction to Embedded System Design, IIT Jammu, Prof.Dhananjay V. Gadre, Prof. Badri N Subudhi
<https://nptel.ac.in/courses/108102169>
4. Microcontroller Embedded C Programming: Absolute Beginners, Udemy.com
<https://www.udemy.com/course/microcontroller-embedded-c-programming/>
5. Embedded Linux Step by Step Using Beaglebone Black, Udemy.com
<https://www.udemy.com/course/embedded-linux-step-by-step-using-beaglebone/>



Program:	B. Tech. (E&TC)				Semester:	V		
Course :	Embedded System Design and RTOS Lab.				Code :	BET25PE08		
	Teaching Scheme (Hrs/Week)				Evaluation Scheme			
Credit	Lecture	Practical	Tutorial	Others	TW	OR	PR	Total
01	-	02	-	-	50	-	-	50
Prior knowledge of: a Microcontrollers and Embedded C programming is essential.								
Objectives: To enable the students to understand embedded-system development process To impart knowledge of various embedded hardware and software tools To educate on implementation of RTOS based embedded systems.								
Outcomes: After completing the course, the students should be able to: 1. Develop programming skills in embedded systems for various applications 2. Write an ARM microcontroller based programs to perform various tasks using RTOS. 3. Implement microcontroller based embedded systems using open source RTOS.								
Guidelines: Any 8 Experiments are to be performed to meet the above outcomes.								
Detailed Syllabus:								
Expt. No.	List of Experiments							
1	Porting of ucos-II on ARM7 controller							
2	Implementation/Verification of multitasking (minimum 03 tasks) with ucos-II on ARM7 controller							
3	Implementation of semaphore with ucos-II service ARM7 controller for resource management and synchronization							
4	Implementation of interprocess communication with ucos-II mailbox service on ARM7 controller							
5	Implementation of interprocess communication with ucos-II message queue service on ARM7 Controller							
6	Implementation/Verification of multitasking defining two task for LCD and Keypad with ucos-II on ARM7 controller..							
7	Implementation of inter-process communication with ucos-II using MUTEX on ARM7 controller							
8	Exercise on Porting of Linux on ARM9 board							
9	Writing simple application using embedded Linux on ARM9							
10	Writing a device Driver Loading into & removing from Kernel on ARM9 board.							
11	Writing and Implementing RTC using embedded Linux on ARM9							
References: 1. Christopher Hallinan, Embedded Linux Primer: A Practical Real-World Approach, 2nd edition, 2010 2. UM10139 LPC214x User manual, NXP Semiconductor, https://www.nxp.com 3. Jean J. Labrosse (Author), Freddy Torres uC/OS-III: The Real-Time Kernel and the NXP LPC1700, Micrium, 1st Edition, 2010.								

Program :	B. Tech. (E&TC)			Semester: V			
Course :	Power Electronics			Code :	BET25PE09		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of							
a. Basics of electrical & electronics engineering. b. Electronics devices and circuits, Analog Integrated Circuits, Microcontrollers & Fundamentals of mathematics.							
Course Objectives:							
This course aims at enabling students, <ol style="list-style-type: none"> To introduce students to different power devices and their triggering/driver circuits. To make students understand working, performance analysis of various power converter circuits and their applications. 							
Course Outcomes:							
After learning the course, the students should be able to: <ol style="list-style-type: none"> Compare the construction, characteristics, ratings and typical driver circuits of different Power Devices. Analyze the performance of controlled rectifiers and Ac voltage controllers. Evaluate the performance of Inverters. Design & Analyze the performance of DC Choppers. 							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Power Semiconductor Switches: Introduction to Power Electronics & Its applications. Construction, characteristics and ratings of SCR, Power MOSFET and IGBT. Triggering/Driver circuit for SCR, Power MOSFETs and IGBTs. Thermal Protections for Power Devices. Overview of Silicon, Silicon Carbide & GaN based MOSFET/ IGBT.						08
2	AC- DC and AC-AC Converters: Concept of line & forced commutation, Single phase semi converter and full converters for R, RL, RLE and level loads. Performance parameters & its analysis for semi and full converter. Introduction to three phase controlled rectifiers with R load. Introduction to Single phase AC voltage controller and its applications.						08
3	DC-AC Converters: Inverter topologies, Single phase Full bridge square wave, quasi-square wave Inverters, performance parameters & its analysis of Inverter. Cross conduction in inverter, Need of voltage control and harmonic reduction techniques in inverters. PWM inverters, SPWM, Driver circuits for above inverters. Filters at the output of inverters. Introduction to Three phase Inverters.						07

4	DC -DC Converters: Classification and types of choppers, Chopper Control techniques. Step down chopper for R, R-L, R-L-E load and its performance analysis, Step-up chopper, Design and analysis of Buck, Boost and Buck-Boost converter. Introduction to Isolated converters –Flyback, Push pull, Half bridge, Full bridge. Introduction to AI in Power Electronics.	07
Total		30
Text Books:		
1. M. H. Rashid, “Power Electronics Circuits Devices and Applications”, PHI,4th Edition 2017 New Delhi 2. M. D. Singh and K. B. Khanchandani, “Power Electronics”, TMH, 2 nd Edition 2006		
Reference Books:		
1. Ned Mohan, T. Undeland & W. Robbins, “Power Electronics Converters Applications and Design, John Willey & sons, Singapore, 2 nd Edition Oxford University Press, New Delhi, 2005. 2. Muhammad H. Rashid, “Power Electronics Handbook”, Academic Press, 2nd Edition, 2001. 3. Bogdan M. Wilamowski, J. David Irwin, “The Power Electronics and Motor Drives Handbook”, CRC Press, 1 st Edition, 2011; eBook: ISBN 9780429165627, 2019. 4. SCR Manual by GE Company		
NPTEL Courses Link: https://nptel.ac.in/courses/108105066		



Program: B. Tech. (E&TC)				Semester : V			
Course : Power Electronics Lab.				Code : BET25PE10			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of:							
<ol style="list-style-type: none"> Basics of electrical & electronics engineering Electronics devices and circuits & Fundamentals of mathematics, Is essential 							
Course Objectives:							
The objective of this laboratory is to provide the student with:							
<ol style="list-style-type: none"> To understand the V-I Characteristics of different power devices. To introduce the working and performance of various power converter circuits and their applications. 							
Course Outcomes:							
After completing the course, the students should be able to:							
<ol style="list-style-type: none"> Perform the V-I Characteristics of different power devices. Analyze the performance of various power converter circuits. Demonstrate the applications of power electronics converters. 							
List of Laboratory Experiment							
PART:A							
Group A (Power Device Characteristics), Expt. No 1 is compulsory, from 2 or 3 any one							
Expt. No.	List of Experiments						
1	VI Characteristics of SCR <ol style="list-style-type: none"> Plot output V-I characteristics to measure I_H, I_L and voltage before and after breakdown, "Knowledge Brings Freedom" Observe the effect of gate current on forward breakdown iii) gate characteristics iv) compare with datasheet specifications 						
2	V-I Characteristics of Power MOSFET <ol style="list-style-type: none"> Plot output characteristics and calculate output resistance Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications 						
3	V-I Characteristics of IGBT <ol style="list-style-type: none"> Plot output characteristics and calculate output resistance Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications 						
Group B (Power Converters)							
Simulation of the power converters mentioned in group B is compulsory and the performance on trainer kits							
1	Single phase Semi and Full Converter using SCR with R & R-L load <ol style="list-style-type: none"> Observe load voltage waveform, Measurement of average o/p voltage across loads, Verification of theoretical values with practically measured values 						
2	Single-Phase PWM Power MOSFET / IGBT based bridge inverter for R and motor load <ol style="list-style-type: none"> Observe output voltage waveforms and measure set of rms output voltage for varying pulse width and variable input dc voltage for R and motor load, 						

	ii. Compare measured output voltages with the theoretical findings
3	Step down (Buck) / Step up (Boost)/ Buck-Boost chopper/converter using power MOSFET / IGBT i) Measure duty cycle and observe effect on average load voltage for DC chopper
4	Single phase AC voltage controller using SCR for R and RL load i. Observe output rms voltage waveforms, ii. Measurement output voltage across load, iii) Verification of theoretical values with practically measured values.
Group C (Applications of Power Electronics Converters), Any Two	
1	To study speed control of DC / single phase AC motor/ Stepper Motor/ BLDC Motor.
2	To design and implement a solar cell operated emergency lighting system or Application of power converters in solar field.
3	SMPS /UPS Performance Evaluation i) Find load & line regulation characteristics.
4	FAN Regulator/Light Dimmer as an application of single phase AC voltage controller.
Group D Industry Visit and Industrial Exposure*	
References:	
<ol style="list-style-type: none"> 1. Ned Mohan, T. Undeland & W. Robbins, "Power Electronics Converters Applications and Design, John Willey & sons, Singapore, 2 nd Edition Oxford University Press, New Delhi, 2005 2. Muhammad H. Rashid , "Power Electronics Handbook", Academic Press, 2nd Edition, 2001. 3. Bogdan M. Wilamowski, J. David Irwin, "The Power Electronics and Motor Drives Handbook", CRC Press, 1 st Edition, 2011. ; eBook: ISBN 9780429165627, 2019. 4. SCR Manual by GE Company 	

* Industrial exposure can cover training/hands-on sessions from Industry on MATLAB, Expert talk, etc.

Program: B. Tech. (E&TC)				Semester : V			
Course : PEC Project-1				Code : BET25PE11			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	25	25		50
Prior knowledge of: a. Basic logic building and circuit design is essential							
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> To introduce the methodology of converting abstract ideas into defined project specifications. To enable students to read and analyze datasheets, research papers, and standards. To train students to identify appropriate tools, platforms, and methodologies for selected electives. 							
Course Outcomes: After completing the course, the students should be able to <ol style="list-style-type: none"> Develop the project specifications from data sheets and research paper etc. Use the appropriate tools to meet the project objectives 							
Guidelines: Elective Project Laboratory Structure <ol style="list-style-type: none"> Problem Identification & Idea Framing <ul style="list-style-type: none"> Brainstorming based on real-world needs. Define scope within chosen elective domain. Literature Review <ul style="list-style-type: none"> Study research papers, patents, datasheets, IEEE standards, case studies. Summarize relevant findings and prior art. Specification & Requirement Drafting <ul style="list-style-type: none"> Convert the idea into technical specifications. Create functional block diagrams. Tool Identification <ul style="list-style-type: none"> Choose hardware (e.g., FPGA, ARM board, PLC) and software (e.g., MATLAB, Vivado, NS3). Assess feasibility. Methodology Development <ul style="list-style-type: none"> Define step-by-step execution plan. Use flowcharts, UML diagrams, pseudocode. Project Proposal <ul style="list-style-type: none"> Submit proposal with problem statement, objectives, methodology, and tentative tools. 							
Deliverables: <ul style="list-style-type: none"> Literature Review Summary Functional Specification Document Methodology and Tool Plan Project Proposal Document Mid-Sem Seminar + End-Seminar Evaluation Criteria: <ul style="list-style-type: none"> Literature review depth and insight – 20% Specification clarity and innovation – 30% Tool and methodology relevance – 30% Documentation and presentation – 20% 							

Common Tools and Platforms

- Design and Simulation:
 - MATLAB, Simulink, Python (for algorithms and signal processing).
 - Xilinx Vivado, Cadence, Verilog/VHDL (for VLSI and embedded systems).
 - NS3, OMNeT++, GNU Radio (for communication systems).
 - PLC programming software, Arduino IDE (for automation).
- Hardware Platforms:
 - FPGAs, DSP processors, microcontrollers (ARM, PIC, Arduino, Raspberry Pi).
 - SDR platforms, sensors, actuators, and PLCs.

References:

1. "Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers" by Jonathan Valvano (2020).
2. "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris K. Manolakis (2014).
3. "MATLAB for Engineers" by Holly Moore (2020).
4. "Communication Systems Engineering" by John G. Proakis and Masoud Salehi (2013).
5. "Automation, Production Systems, and Computer-Integrated Manufacturing" by Mikell P. Groover (2015).

Online Resources

1. **Xilinx Vivado Design Suite Documentation** (2023).
 - Official documentation for FPGA design and implementation.
 - Available at: [Xilinx Documentation](#)
2. **MATLAB and Simulink Documentation** (2023).
 - Official resources for signal processing and algorithm development.
 - Available at: [MATLAB Documentation](#)
3. **GNU Radio Documentation** (2023).
 - Official guide for SDR and communication system design.
 - Available at: [GNU Radio Documentation](#)



Course Syllabus

T.Y. B.Tech.

Semester-VI

"Knowledge Brings Freedom"

Progress Credibility Confidence
Optimism Excellence

Since 1999

Program :	B. Tech. (E&TC)				Semester: VI			
Course :	Computer Networks and Security				Code :	BET26PC01		
Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Other	FA		SA	Total
					FA1	FA2		
2	2	-	-	01	10	10	30	50
Prior knowledge of Communication systems is essential.								
Course Objectives: This course aims at enabling students, <ol style="list-style-type: none"> To build an understanding among students about the fundamental concepts of computer networking, protocols, architectures, and applications. To make students aware of protocols at various layers and their functionalities. To Educate students about security issues at each layer. 								
Course Outcomes: After learning the course, the students should be able to: <ol style="list-style-type: none"> Compare and contrast different network models like OSI and TCP/IP.. Analyze routing algorithms and protocols to solve network routing problems. Analyze transport layer protocols like UDP, TCP, and SCTP and compare their functionalities. Investigate common cybersecurity threats and attacks. 								
Detailed Syllabus:								
Unit	Description							Duration [Hrs]
1	Unit 1: Introduction and Overview of Host to Network Layer Data Communications, Data Flow, Definition: Computer Network, Evolution of Computer Networks, Network Types, Network Topologies, Transmission Media, Switching Techniques, Network Models: OSI Model and TCP/IP Protocol Suite, Types of Addressing, Introduction to Networking Devices, Data Link Control, Framing, Flow and Error Control, Error Detection and correction Techniques and Protocols for Noiseless and noisy Channels,							08
2	Unit 2: Network Layer Network Layer Services, IPv4 addressing and Subnetting, IPv6 Addressing and transition Mechanisms, Network Layer Protocols, Network Address Translation (NAT), Routing Algorithms, and Routing Protocols.							07
3	Unit 3: Transport and Application Layer Introduction to Transport Layer, Transport Layer Services, User Datagram Protocol (UDP), Transmission Control Protocol (TCP, TCP Congestion Control Mechanisms, Stream Control Transmission Protocol (SCTP), Congestion Control and Quality of Service (QoS), Introduction to Application Layer, Application layer protocols.							08
4	Unit 4: Network Security Cryptography and Network Security, RSA algorithm, Security Goals, Introduction to Confidentiality, Authentication and Integrity, Internet Security at Different Layers, Cybersecurity Threats and attacks, Firewalls, AI-based cybersecurity attack detection and prevention system.							07
	Total							30
Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.								
Text Books: <ol style="list-style-type: none"> B. A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, 6th Edition, Tata McGraw-Hill, 2022 								

Reference Books:

1. A. S. Tanenbaum and D. J. Wetherall, *Computer Networks*, 5th ed. Boston, MA, USA: Pearson, 2010.
2. A. S. Godbole, *Data Communication and Networking*, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2012.
3. D. E. Comer, *Computer Networks and Internets*, 6th ed. Upper Saddle River, NJ, USA: Pearson, 2014.
4. J. F. Kurose and K. W. Ross, *Computer Networking: A Top-Down Approach*, 8th ed. Boston, MA, USA: Pearson, 2021.
5. L. L. Peterson and B. S. Davie, *Computer Networks: A Systems Approach*, 6th ed. Cambridge, MA, USA: Morgan Kaufmann, 2020.
6. N. Russo and R. White, *The Art of Network Architecture: Business-Driven Design*. Indianapolis, IN, USA: Cisco Press, 2014.
7. W. Odom, *CCNA 200-301 Official Cert Guide*. Indianapolis, IN, USA: Cisco Press, 2020.
8. C. Kaufman, R. Perlman, and M. Speciner, *Network Security: Private Communication in a Public World*, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2011.
9. K. Mitnick, *The Art of Invisibility*. New York, NY, USA: Little, Brown and Company, 2017.
10. I. Priyadarshini and R. Sharma, *Artificial intelligence and cybersecurity: Advances and Innovations*. CRC Press, 2022.

NPTEL Links :

https://onlinecourses.nptel.ac.in/noc22_cs19/preview

<https://nptel.ac.in/courses/106106091>



Program: B. Tech. (E&TC)					Semester : VI			
Course : Computer Network and Security Lab					Code : BET26PC02			
Teaching Scheme Hrs/Week					Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	Other	T W	OR	PR	Total
01	-	02	-	01	25	-	25	50
Prior knowledge of: a .Basics of communication system.								
Course Objectives: The objective of this laboratory is to provide the student with: 1. Configuring and testing network topologies, VLANs, and routing protocols for efficient data communication. 2. The ability to implement network security measures, including Access Control Lists (ACLs) and Intrusion Detection Systems (IDS), for threat mitigation. 3. Practical knowledge in setting up network services such as DHCP, wireless networking, and web hosting to support real-world applications.								
Course Outcomes: After completing the course, the students should be able to: 1. Configure different network topologies, VLANs, and static routing to enhance network performance and segmentation. 2. Implement security mechanisms, including Access Control Lists (ACLs) and Intrusion Detection Systems (IDS), to mitigate cyber threats such as DoS attacks. 3. Develop a functional network infrastructure incorporating DHCP, wireless connectivity, and web hosting services to support real-world applications.								
Guidelines: Any seven Experiments is to be performed from PART A and any one from PART B to meet the above outcomes. Practical: 1. Practical for 25 Marks. 2. Practical Assessment will be based on PART A. Term work: 1. Term Work for 25 Marks 2. For Term Work assessment will be based on both PART A & PART B.								
Detailed Syllabus:								
PART:A								
Expt. No.	List of Experiments							
1	Configure a basic network with two PCs and test connectivity using the ping command.							
2	Design and configure different network topologies (Star, Ring, Hybrid) in Cisco Packet Tracer and test network connectivity.							
3	Set up a router and implement static routing to enable communication between two networks.							
4	Create and configure VLANs (Virtual LANs) on a switch to segment network traffic.							
5	Set up a DHCP (Dynamic Host Configuration Protocol) server to assign IP addresses dynamically.							
6	Configure a wireless network using a router and connect wireless devices.							
7	Implement Access Control Lists (ACLs) on a router to restrict network access.							
8	Set up a Web and DNS server to demonstrate domain name resolution and website hosting.							
PART: B								
1	Implementation and Demonstration of DoS Attack detection.							

2	Implementation of Intrusion Detection System (IDS) using Machine Learning
Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.	
<p>References:</p> <ol style="list-style-type: none"> 1. Behrouz A. Foruzan, "<i>Data Communication and Networking with TCP/IP Protocol Suite</i>", 6th Edition, 2022 2. Jesin A, "<i>Packet Tracer Network Simulator</i>", Packt Publishing, 2014 3. L. Peterson and B. Davie, <i>Computer Networks: A Systems Approach</i>, 6th ed. Cambridge, MA, USA: Morgan Kaufmann, 2021. 4. W. Stallings, <i>Data and Computer Communications</i>, 10th ed. Upper Saddle River, NJ, USA: Pearson, 2013. 5. J. F. Kurose and K. W. Ross, <i>Computer Networking: A Top-Down Approach</i>, 8th ed. Boston, MA, USA: Pearson, 2020. <p>NPTEL Links : https://archive.nptel.ac.in/courses/106/101/106101209/</p>	



Program:	B. Tech. (E&TC)				Semester: VI				
Course :	Electromagnetics				Course Code		BET26PC03		
Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks				
	Lecture	Practical	Tutorial	O	FA		SA	TW	Total
					FA1	FA2			
03	02	-	01	01	10	10	30	50	100
Prior knowledge of a. Engineering Physics b. Calculus is essential.									
Course Objectives: This course aims at enabling students, 1.To introduce the concepts of electrostatics, electric potential, capacitance and their /applications. 2.To expose to concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications. 3.To make students familiar with electrodynamic fields and its applications.									
Course Outcomes: After learning the course, the students should be able to: 1.Understand the principles of electrostatics for the solutions of problems relating to electric field and electric potential, boundary conditions. 2.Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions. 3.Interpret the concepts of time varying fields using Maxwell 's equations and Poynting Theorem 4.Analyze problems relating to uniform plane wave propagation and transmission lines using Maxwell 's equations.									
Detailed Syllabus:									
Unit	Description								Duration [Hrs]
1	Electrostatics Review of vector algebra, Review of cartesian, Cylindrical and spherical coordinate systems, Introduction to ∇ (operator, Use of del operator as gradient, divergence, curl). Coulomb 's Law, Electric field intensity, Field due to discrete and continuous charges (Point charge, line charge, surface charge), Gauss's law and applications(point and line charge). Electric potential, Relation Between E and V(problems on point ,line charge). Electric field in free space, conductors, dielectrics, Dielectric polarization, Dielectric strength, Electric field in multiple dielectrics, Boundary conditions (conductor-dielectric), significance of Poisson's and Laplace's equations, Capacitance(Parallel plate, Co-axial and Spherical capacitors) Illustrative Problems, Case Study: Electrostatic Discharge.								10
2	Magnetostatics Lorentz force, magnetic field intensity (H) , Biot–Savart's Law, Ampere's Circuit Law, H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B), B in free space, conductor, Application Case Study: Lightning, Magnetic Resonance Imaging (MRI)								07
3	Time-Varying Fields Faradays law and Lenz's law, Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: for static fields, for time varying fields, for free space, for good conductors, for harmonically varying fields. Wave equations for free space, Wave equations for conductors. Poynting theorem: Energy stored and radiated power, Complex Poynting vector.								07
4	Plane-Wave Propagation Uniform plane wave propagation: Transverse nature of uniform plane waves. Polarization, Reflection and Refraction for plane wave. Plane wave in lossy dielectric, wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance, Transmission Lines: Types, Primary and secondary Parameters, Standing waves.								06

Total	30
Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.	
Text Books:	
Text Books:	
1. Matthew N. O. Sadiku , <i>Elements of Electromagnetics</i> , 3rd edition, Oxford University Press, New Delhi, 2008.	
2. William H. Hayt Jr. , John A. Buck , <i>Engineering Electromagnetics</i> , 7th edition, Tata McGraw Hill, India, 2011	
3. R.K. Shevgaonkar, "Electromagnetics Waves", 1 st edition, Tata McGraw Hill, India 2006	
Reference Books:	
1. Kraus, J.D., <i>Electromagnetics</i> , McGraw–Hill 5 th edition (2017)	
2. Paramanik, A, <i>Electromagnetism: Theory and Applications</i> , Prentice–Hall of India (2006)	
3. N. Narayana Rao, <i>Elements of Engineering Electromagnetics</i> , (6/e), Pearson, 2006.	
Jordan, E.C. and Balmain K.G., <i>Electromagnetic Waves and Radiating Systems</i> , Prentice Hall of India 2 nd edition (2011).	

List of Tutorials

1. Vector analysis, Electric field Intensity (E): Due to Q, ρ_L, ρ_S
2. Gauss's Law, Electric flux Density (D) & Electrical Potential (V) : Due to Q, ρ_L
3. Electrostatic Boundary Conditions:
4. Poisson's and Laplace's Equation: Capacitance, Energy density.
5. Magnetic field Intensity (H)- Biot-Savart: Due to $I dL, K dS$, and Ampere's circuital law
6. Verification of Magnetic field Intensity (H) using Scilab.
7. Magnetic Boundary Conditions:
8. Faradays Law, Maxwell's Equations
9. Poynting Theorem
10. Uniform Plane Waves: Wave parameters/transmission line parameter measurement.
11. Case Study of EMF- Applications in AI/ML.

*Expt 9 can be conducted using Matlab simulation tools.

Program: B. Tech. (E&TC)					Semester : VI			
Course : VLSI Design Lab					Code : BET26PC04			
Teaching Scheme Hrs/Week					Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	Other	TW	OR	PR	Total
02	-	04	-	01	50	-	50	100
Prior knowledge of:								
a. Digital Circuits and Electronics Devices is essential								
Course Objectives:								
This course aims at enabling students,								
<ol style="list-style-type: none"> 1. To model digital circuits using Verilog HDL and implement them on FPGA platforms. 2. To provide students with the skills to analyze the behavior of CMOS circuits through simulation tools. 3. To equip students with the knowledge to design and evaluate analog circuits, focusing on key performance metrics like gain and power consumption. 4. To help students understand VLSI design techniques such as ASIC flow, testability, fault tolerance, and low-power strategies, and their effects on performance and reliability. 								
Course Outcomes:								
After completing the course, the students should be able to:								
<ol style="list-style-type: none"> 1. Model digital circuits using Verilog HDL and implement them on FPGA platforms. 2. Analyze the behavior of CMOS circuits using simulation tools. 3. Design and analyze a variety of analog circuits, evaluating key performance parameters such as gain, power consumption, accuracy, and impedance characteristics. 4. Understand VLSI design techniques like ASIC design flow, testability, fault tolerance, low-power strategies, and FinFET technology. 								
Guidelines: Any Five Experiments from Part A,B and C each are to be performed to meet the above outcomes.								
Practical:								
<ol style="list-style-type: none"> 1. Practical for 50 Marks. 2. Practical Assessment will be based on PART A and PART B 								
Term work:								
<ol style="list-style-type: none"> 1. Term Work for 50 Marks 2. For Term Work assessment, assignments that will be given on topics of PART C are to be submitted. 								
Detailed Syllabus:								
PART A: Digital Design using HDL (Verilog)								
Expt. No.	List of Experiments							
1	Model and verify 4:1 Multiplexer using HDL and implement on FPGA.							
2	Model and verify 4-bit Full adder in HDL using structural modeling and implement on FPGA							
3	Model and verify 8-bit ALU using HDL and implement on FPGA.							
4	Model and verify D-Flip Flop and 4 bit shift register using HDL and implement on FPGA							
5	Model and verify n bit counter using HDL and implement on FPGA							
6	Model and Verify a Finite State Machine (FSM) for a Sequence Detector using HDL and implement on FPGA							
7	Model and Verify RAM using HDL and implement on FPGA							
PART B : Digital CMOS Design								

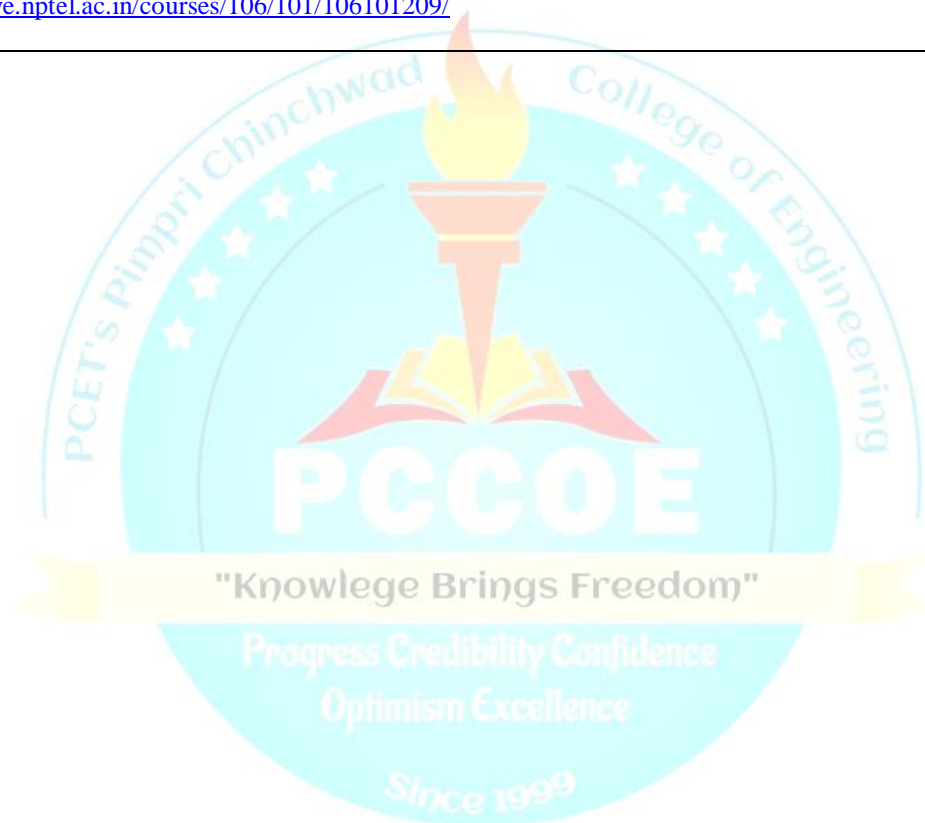
1	Study of MOSFET Characteristics (IV Curves & Biasing) - Simulate and plot the IV characteristics of NMOS and PMOS transistors, and determine key parameters such as threshold voltage and mobility.
2	Draw the CMOS schematic and Layout of the inverter circuit, simulate both schematic and layout to determine propagation delay, rise time fall time and Q-point and comment on the results.
3	Draw the CMOS schematic of the 2 input NAND and NOR gate, also draw the layout of the same, and simulate.
4	Draw the CMOS schematic of the Half Adder circuit and verify it with truth table, and draw the layout of the same, and simulate.
5	Draw the CMOS circuit of the 2:1 Multiplexer circuit and verify it with truth table, and also draw the layout of the same, and simulate.
6	Draw the CMOS schematic of One bit SRAM Cell and verify it with truth table, and also draw the layout of the same, and simulate.
PART C : Assignments	
1	Current Mirror Circuits for Biasing Applications <ul style="list-style-type: none"> ● Problem Statement: Compare different current mirror topologies (simple, Wilson, cascode) in terms of accuracy and output impedance.
2	CMOS Differential Amplifier <ul style="list-style-type: none"> ● Problem Statement: Design of CMOS Differential Amplifier and analyze/study gain, CMRR, and power consumption.
3	Design and Characterization of a Common-Source Amplifier <ul style="list-style-type: none"> ● Problem Statement: Design a common-source amplifier with proper biasing and study/analyze gain, bandwidth, and power consumption.
4	Study of ASIC Design Flow (RTL to GDSII) <ul style="list-style-type: none"> ● Problem Statement: Explore and document each step of the ASIC design flow from RTL coding to physical layout. (Prepare a report)
5	Study of Design for Testability (DFT) in VLSI Circuits <ul style="list-style-type: none"> ● Problem Statement: Explore the various Designs for Testability (DFT) techniques used in VLSI circuits, such as scan chains, built-in self-test (BIST), and boundary scan. Prepare a report comparing different DFT strategies and their impact on chip testing and reliability.
6	Testability and Fault Tolerance in VLSI <ul style="list-style-type: none"> ● Problem Statement: Study different types of faults (stuck-at, bridging, delay faults) and their impact on circuit operation. (Tool: Research and Report Writing)
7	Study of Low-Power Techniques in VLSI Design <ul style="list-style-type: none"> ● Problem Statement: Explore various power reduction techniques such as clock gating, power gating, and multi-Vt design.
8	Introduction to FinFET <ul style="list-style-type: none"> ● Problem Statement: Explore FinFET technology, detailing its structure, benefits over MOSFETs, fabrication challenges, and impact on performance and power efficiency. Examine the design and tool requirements for FinFET devices and assess the future potential of FinFETs in next-generation semiconductor applications.
Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.	

References:

1. Neil Weste and David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson Education India, 2015
2. Behzad Razavi, "Design of analog CMOS integrated circuits", 2nd Edition, McGraw Hill, 2017
3. Charles H. Roth Jr, Lizy Kurian John "Digital systems design using VHDL", 2nd Edition, Thomson Learning, Inc, 2008
4. FPGA Programming for Beginners: Bring Your Ideas to Life by Creating Hardware Designs and Electronic Circuits with SystemVerilog 2010
5. FinFETs and Other Multi-Gate Transistors (Integrated Circuits and Systems) 2008th Edition by J.-P. Colinge

NPTEL Links :

<https://archive.nptel.ac.in/courses/106/101/106101209/>



Program :	B. Tech. (E&TC)			Semester: VI			
Course :	System Design Using FPGA			Code :	BET26PE01		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of Digital logic design and fundamental electronic circuits Basic knowledge of VHDL/Verilog and C is essential							
Course Objectives: This course aims to enable students, 1. Explore and understand the relationship between FPGA-based system design, High-Level Synthesis (HLS), and their practical application in modern embedded systems. 2. Design efficient FPGA accelerators using C-based HLS and hardware-software integration.							
Course Outcomes: After learning the course, the students should be able to: 1. Develop, simulate, and implement FPGA-based modules using High-Level Synthesis (HLS) techniques. 2. Apply combinational and sequential logic design principles to develop digital systems using FPGAs 3. Design and integrate reusable IP cores in FPGA-based system designs. 4. Analyze advanced FPGA applications and recent research trends							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Foundations of FPGA-Based System Design Evolution of Programmable Logic Devices, CPLDs to advanced FPGAs. FPGA Architecture: Configurable Logic Blocks (CLBs), Look-Up Tables (LUTs), interconnects, DSP blocks, and memory blocks. Specialized blocks in FPGA Comparison with ASIC and Microcontrollers, FPGA Design Flow, High-Level Synthesis (HLS): Converting C/C++ to Verilog/VHDL, Behavioral vs. Structural vs. RTL Design Methodologies, Simulation & Verification Techniques (HLS Simulation, RTL Simulation)						07
2	FPGA Design: Introduction to system design using FPGA, Combinational and Sequential Logic Design: ED blink, 7-segment display control, PWM generation, Registers, counters, Simple DSP Blocks, Finite State Machines (FSMs), Memory blocks (RAM, FIFO), Timing Analysis. Setup time, hold time, clock skew, Critical path analysis, and timing constraints, Synchronous vs. Asynchronous Design.						08
3	System Design using FPGA: Introduction to IP Cores: Types of IP cores (soft, firm, hard). Custom IP Design: Designing reusable IP blocks (e.g., UART, PWM, memory controllers), Packaging, and integrating custom IP into larger designs. High-Level Synthesis (HLS): Introduction to HLS tools, Converting C/C++ code to HDL.						07
4	Emerging Trends & Research in FPGA-Based System Design FPGA Acceleration for AI & Machine Learning, Partial Reconfiguration & Dynamic Hardware Adaptation, Security Challenges in FPGA Design (IP Protection, Side-Channel Attacks), Case Study: Sobel Edge Detection on FPGA (Image Processing Acceleration), Real-World Applications: Automotive, IoT, Edge Computing, Cloud FPGA						08
	Total						30
Text Books: 1. Sanjay Churiwala, Designing with Xilinx® FPGAs: Using Vivado, Springer International Publishing AG; Softcover reprint of the original 1st ed. 2017 edition (7 July 2018)							

Reference Books:

1. Introduction to Hardware/Software Codesign: Introduction to Chip and System Design, Springer, 1992.
2. G. De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 2003.
3. Mike Fingeroff, High-Level Synthesis Blue Book, Mentor Graphics, 2010.
4. Ünsalan, Cem, and Bora Tar. 2017. Digital System Design with FPGA: Implementation Using Verilog and VHDL. 1st ed. New York: McGraw-Hill Education
<https://www.accessengineeringlibrary.com/content/book/9781259837906>
5. Philippe Coussy & Adam Morawiec, High-Level Synthesis from Algorithm to Digital Circuit, Springer, 2008.

e-sources:

FPGA Design with VIVADO HLS -High Level Synthesis <https://www.udemy.com/course/fpga-design-with-high-level-synthesis-vivado-hls/>

NPTEL Course lectures links:

C-Based VLSI Design https://onlinecourses.nptel.ac.in/noc22_cs109/preview



Program: B. Tech. (E&TC)				Semester : VI			
Course : System Design Using FPGA Lab.				Code : BET26PE02			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of:							
Course Objectives: The objective of this laboratory is to provide the student with: 1. Understand and apply FPGA-based system design methodologies using High-Level Synthesis (HLS) and Hardware-Software Codesign techniques. 2. Develop optimized hardware implementations for digital signal processing, machine learning, and real-time embedded applications on FPGA platforms.							
Course Outcomes: After completing the course, the students should be able to: 1. Design and implement complex digital modules and controllers 2. Develop and integrate custom and vendor-provided IP cores, including HLS-generated blocks, into FPGA-based systems for domain-specific applications like image processing.							
Guidelines: Any 8 Experiments is to be performed to meet the above outcomes.							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Modeling and FPGA implementation of a n-bit Counter						
2	Modeling and FPGA implementation of FSM Controller						
3	Generating a PWM signal to control the brightness of an LED on FPGA						
4	Modeling of FIFO Memory						
5	Modeling and FPGA implementation of Memory Arbiter						
6	Modeling and FPGA implementation of DMA controller						
7	Create a Custom IP Core for any of the above designs.						
7	Use Vendor-Provided IP Cores Part -1						
8	Use Vendor-Provided IP Cores Part -2						
9	Integrating an HLS-Generated IP Core with Zynq Processing System						
10	Case Study: FPGA-Based Acceleration of Image Processing Using Sobel Edge Detection						
Text Books: 1. Sanjay Churiwala, Designing with Xilinx® FPGAs: Using Vivado, Springer International Publishing AG; Softcover reprint of the original 1st ed. 2017 edition (7 July 2018) 2. Ünşalan, Cem, and Bora Tar. 2017. Digital System Design with FPGA: Implementation Using Verilog and VHDL. 1st ed. New York: McGraw-Hill Education. https://www.accessengineeringlibrary.com/content/book/9781259837906							
Reference Books: 1. Introduction to Hardware/Software Codesign: Introduction to Chip and System Design, Springer, 1992. 2. G. De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 2003. 3. Mike Fingeroff, High-Level Synthesis Blue Book, Mentor Graphics, 2010.							

e-sources:

FPGA Design with VIVADO HLS -High Level Synthesis <https://www.udemy.com/course/fpga-design-with-high-level-synthesis-vivado-hls/>

NPTEL Course lectures links:

C-Based VLSI Design https://onlinecourses.nptel.ac.in/noc22_cs109/preview



Program :	B. Tech. (E&TC)			Semester: VI			
Course :	Information Theory and Coding			Code :	BET26PE03		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of							
1. Basic concepts of Probability and Communication System is essential.							
Course Objectives:							
This course aims at enabling students,							
1. To introduce the terminology and basic concepts of information theory.							
2. To encourage the students to study the different data compression methods.							
3. To motivate the students to study the different error coding techniques							
4. To make the students familiar with different types of error correcting codes							
Course Outcomes:							
After learning the course, the students should be able to:							
1. To apply the basics concept of information theory.							
2. To analyze the different data compression methods.							
3. To construct the different error coding techniques							
4. To identify the different types of error correcting codes							
Detailed Syllabus							
Unit	Description						Duration [Hrs]
1	Introduction to Information theory:- Probability, Uncertainty, self-information, Entropy and information rate, mutual information and their properties, Discrete memory less channel, Channel capacity						08
2	Source Coding:- Source coding theorem, Data compression, Huffman coding, Lempel-Ziv coding, Run-length encoding, Introduction to cryptography AI in Source Coding						07
3	Channel Coding:- Channel coding theorem, Introduction to Error control codes, Block codes, linear block codes, cyclic codes, BCH and RS codes AI in Channel Coding						08
4	Convolution Code :- Introduction to Convolution Codes, Properties, convolution encoder and Decoder, Turbo codes, Repetition code, Golay code, LDPC code, ARQ						07
	Total						30
Text Books:							
1. Simon Haykin, "Communication Systems", 5th Edition, John Wiley and Sons, 2009.							
2. Ranjan Bose, —Information Theory coding and Cryptography , McGraw-Hill, 2nd E, 4th Edition 2008							
Reference Books:							
1. Lin, Shu, and Daniel J. Costello. Error control coding. Vol. 2. No. 4. New York: Prentice hall, 2001.							
2. Moon, Todd K. Error correction coding: mathematical methods and algorithms. John Wiley & Sons, 2020.							
3. Khalid Sayood, —Introduction to Data compression, Morgan Kaufmann Publishers, 2nd Edition 2011.							
NPTEL/ MOOC courses							
1. An Introduction to Information Theory https://onlinecourses.nptel.ac.in/noc22_ee49/preview							
2. Information Theory https://onlinecourses.nptel.ac.in/noc20_ee96/preview							

Program: B. Tech. (E&TC)				Semester : VI			
Course : Information Theory and Coding Lab				Code : BET26PE04			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of:							
<ol style="list-style-type: none"> 1. Basic concepts of Probability and communication system 2. MATLAB /Simulink/ Open source platform programming is essential 							
Course Objectives:							
The objective of this laboratory is to provide the student with:							
<ol style="list-style-type: none"> 1. To introduce the basics of Information theory 2. To inculcate the implementation of source coding techniques for data compression 3. To instill the knowledge of various channel coding techniques and their implementation. 							
Course Outcomes:							
After completing the course, the students should be able to:							
<ol style="list-style-type: none"> 1. Analyze the different terminologies related to information theory 2. Design and verify the source coding algorithm for data compression 3. Design and verify the Channel coding algorithm for error detection and correction. 							
Guidelines: Any Six Experiments is to be performed to meet the above outcomes.							
Detailed Syllabus							
Expt. No.	List of Experiments						
1	Simulate a program to find the entropy for the given source.1.Read any 1 D signai 2.Read any 2D signal to understand the concepts of self information						
2	Simulate a program to find different entropies , Mutual information and channel capacity for given channel.appy mutual information in ML based concept						
3	Implement a program to find the coding efficiency using Huffman source coding also use any AI tool to generate Huffman tree						
4	Simulate a program to encode and decode using LBC						
5	Simulate a program to encode using Cyclic code						
6	Simulate a program to decode using Cyclic code						
7	Implement a program to encode and decode using BCH code						
8	Simulate a program encode and decode using RS code						
9	Simulate a program encode and decode using Convolution code						
10	Case study on Data compression						
11	To study the applications of different types of code						
12	To study the Cryptography techniques						

References:

1. Ranjan Bose, —Information Theory coding and Cryptography, McGraw-Hill, 2nd Ed, 2008
2. Murlidhar Kulkarni, K.S.Shivaprakasha, —Information Theory & Coding, Wiley Public.2010
3. Simon Haykin, —Communication Systems, John Wiley & Sons, Fourth Edition. 2008
4. Shu lin and Daniel j, Cistello jr., —Error control Coding, Pearson, 2nd Edition. 2001



Program :	B. Tech. (E&TC)			Semester: VI			
Course :	Time-Frequency Analysis and Wavelets			Code :	BET26PE05		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of

- Basic knowledge of Signal Processing
- Fundamentals of Linear Algebra
- Fourier Analysis concepts

is essential.

Course Objectives:

This course aims at enabling students,

- Introduce fundamental concepts of time-frequency analysis and their significance.
- Explain the limitations of traditional Fourier Transform and the need for Wavelet Transforms.
- Provide mathematical foundations and computational techniques for Short-Time Fourier Transform (STFT), Continuous Wavelet Transform (CWT), and Discrete Wavelet Transform (DWT).
- Explore multi resolution analysis and wavelet-based signal/image processing applications.
- Apply time-frequency methods to real-world problems such as speech processing, image compression, and biomedical signal analysis.

Course Outcomes:

After learning the course, the students should be able to:

- Understand and analyze signals in the time-frequency domain.
- Implement Short-Time Fourier Transform (STFT) and interpret spectrograms.
- Apply Wavelet Transform (CWT & DWT) for signal analysis and processing.
- Perform multi resolution analysis (MRA) using discrete wavelets.
- Utilize wavelets for practical applications such as denoising, compression, and feature extraction.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	Short-Time Fourier Transform (STFT) <ul style="list-style-type: none"> Introduction to Time-Frequency Analysis Limitations of Fourier Transform Basics of Time-Frequency Representations (TFRs) Concept of Windowed Fourier Transform Spectrogram Analysis Trade-off Between Time and Frequency Resolution Applications in Speech and Audio Processing 	8
2	Continuous Wavelet Transform (CWT) <ul style="list-style-type: none"> Concept of Scale and Translation Properties of Mother Wavelets Selection of Wavelet Functions (Haar, Daubechies, Morlet, etc.) Comparison Between STFT and CWT 	7
3	Discrete Wavelet Transform (DWT) and Multiresolution Analysis <ul style="list-style-type: none"> Multiresolution Analysis (MRA) and Filter Banks Discrete Wavelet Transform (DWT) and Fast Wavelet Transform (FWT) Wavelet Families: Haar, Daubechies, Coiflet, and Symlet Applications in Signal Denoising and Compression 	8
4	Advanced Topics and Applications <ul style="list-style-type: none"> Wavelet Packet Transform (WPT) Empirical Mode Decomposition (EMD) Applications in Image Processing, Biomedical Signals, and Machine Learning 	7
Total		30

Text Books:

1 Mallat, S. A Wavelet Tour of Signal Processing, 3rd Edition, Academic Press, 2008.

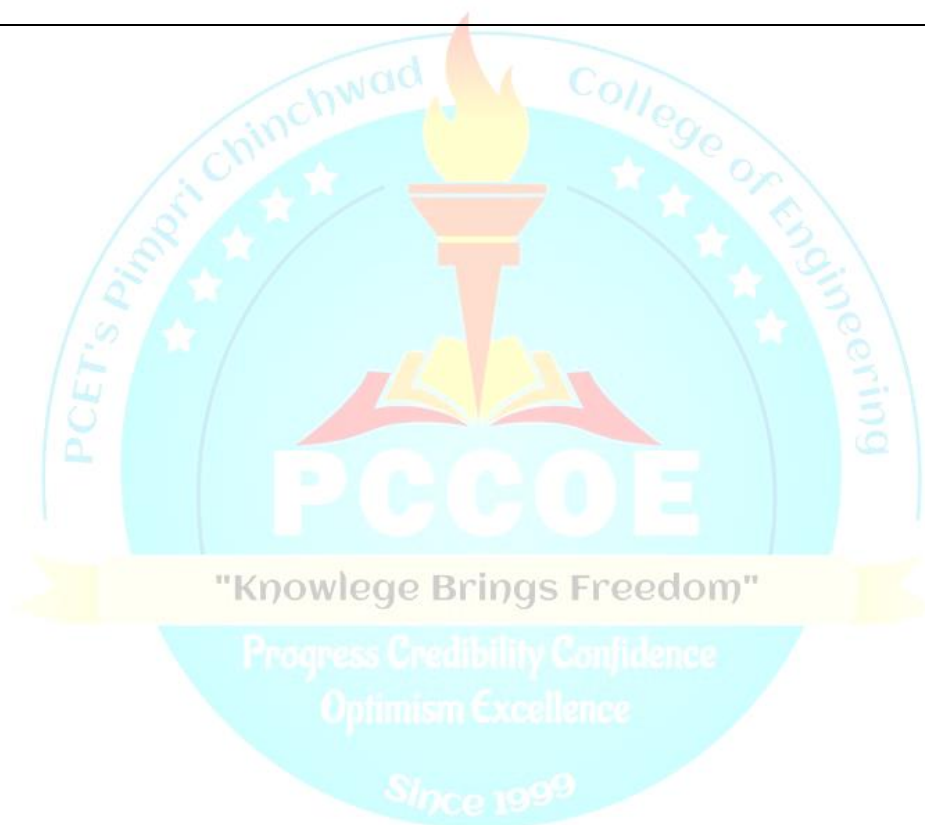
Reference Books:

1. Daubechies, I. Ten Lectures on Wavelets, SIAM, 1992.
2. Vetterli, M. & Kovacevic, J. Wavelets and Subband Coding, Prentice Hall, 1995.
3. Goyal, V. K. Foundations of Time-Frequency Analysis, Birkhäuser, 2001.
4. Misiti, M., Misiti, Y., Oppenheim, G., Poggi, J.M. Wavelet Toolbox User's Guide, MathWorks, 2017.
5. Strang, G. & Nguyen, T. Wavelets and Filter Banks, Wellesley-Cambridge Press, 1996.



Program: B. Tech. (E&TC)				Semester : VI			
Course : Time-Frequency Analysis and Wavelets Lab				Code : BET26PE06			
Teaching Scheme: Hrs./Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of:							
<ol style="list-style-type: none"> 1. Basic understanding of Signal Processing 2. Familiarity with Fourier Analysis 3. Basic programming skills in MATLAB/Python 							
is essential.							
Course Objectives:							
The objective of this laboratory is to provide the student with:							
<ol style="list-style-type: none"> 1. To provide hands-on experience in time-frequency analysis and wavelet techniques for analyzing real-world signals and images using computational tools. 							
Course Outcomes:							
After completion of this course, students will be able to,							
<ol style="list-style-type: none"> 1. To implement and analyze time-frequency and wavelet transforms for signal processing applications using programming tools like MATLAB/Python.. 							
Expt. No.	List of Experiments						
1.	Fourier Transform and Spectrogram Visualization <ul style="list-style-type: none"> • Compute and interpret the Fourier Transform of signals. • Generate and analyze spectrograms using the Short-Time Fourier Transform (STFT). 						
2.	STFT Analysis of Speech and Audio Signals <ul style="list-style-type: none"> • Implement windowed Fourier transform for speech signals. • Analyze the trade-off between time and frequency resolution 						
3.	Continuous Wavelet Transform (CWT) for Signal Analysis <ul style="list-style-type: none"> • Compute CWT using different wavelet functions (e.g., Morlet, Mexican Hat). • Analyze time-frequency features of non-stationary signals. 						
4.	Discrete Wavelet Transform (DWT) and Multiresolution Analysis <ul style="list-style-type: none"> • Implement DWT-based multiresolution analysis (MRA). • Perform signal decomposition using Haar and Daubechies wavelets. 						
5.	Signal Denoising Using Wavelet Thresholding <ul style="list-style-type: none"> • Implement soft and hard thresholding techniques. • Compare results with Fourier-based denoising. 						
6.	Wavelet-Based Image Compression <ul style="list-style-type: none"> • Apply DWT for JPEG 2000 compression. • Analyze compression performance using PSNR and SSIM metrics 						
7.	Feature Extraction Using Wavelets for Machine Learning <ul style="list-style-type: none"> • Extract wavelet features from signals and images. • Apply them to classification tasks (e.g., ECG signal classification, object recognition). 						
8.	Wavelet Packet Transform (WPT) for Signal Analysis <ul style="list-style-type: none"> • Implement wavelet packet decomposition and analyze frequency bands. 						
9.	Empirical Mode Decomposition (EMD) for Nonlinear Signal Analysis <ul style="list-style-type: none"> • Apply EMD to real-world signals and extract intrinsic mode functions (IMFs). 						

10.	Real-Time Signal Analysis Using Wavelets in MATLAB/Python
Textbook: <ul style="list-style-type: none"> • Mallat, S. <i>A Wavelet Tour of Signal Processing</i>, 3rd Edition, Academic Press, 2008. 	
References: <ol style="list-style-type: none"> 1. Daubechies, I. <i>Ten Lectures on Wavelets</i>, SIAM, 1992. 2. Vetterli, M. & Kovacevic, J. <i>Wavelets and Subband Coding</i>, Prentice Hall, 1995. 3. Goyal, V. K. <i>Foundations of Time-Frequency Analysis</i>, Birkhäuser, 2001. 4. Misiti, M., Misiti, Y., Oppenheim, G., Poggi, J.M. <i>Wavelet Toolbox User's Guide</i>, MathWorks, 2017. 5. Strang, G. & Nguyen, T. <i>Wavelets and Filter Banks</i>, Wellesley-Cambridge Press, 1996. 	



Program :	TY B. Tech. (E&TC)			Semester: VI			
Course :	Embedded System for Connected Devices			Code :	BET26PE07		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of a. microcontrollers is essential.							
Course Objectives: This course aims at enabling students, 1. To introduce the fundamental concepts of embedded systems, including hardware components, memory management, and debugging techniques, enabling students to understand the design and development of embedded applications. 2. Understanding of embedded networking concepts, communication protocols, and device interfaces essential for efficient data exchange in embedded systems.							
Course Outcomes: After learning the course, the students should be able to: 1. To explain the architecture, components, and debugging methods of embedded systems and make informed decisions on processor and memory selection for embedded applications. 2. To implement and configure embedded communication protocols such as RS232, RS485, CAN, SPI, and I2C for effective data transfer in embedded applications. 3. To apply different EDLC phases and modeling techniques to develop efficient embedded firmware with hardware-software co-design considerations. 4. To implement RTOS-based embedded systems with efficient task scheduling, process synchronization, memory management, and debugging strategies.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Introduction to embedded systems Introduction to Embedded Systems – The Build Process for Embedded Systems- Structural Units in Embedded Processor - Selection of Processor, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), embedded software running on single-/multi-/many-core systems and Memory Devices- DMA – Memory Management Methods- Timer and Counting Devices - Watchdog Timer - Real Time Clock - In Circuit Emulator – Target Hardware Debugging.						08
2	Embedded Networking Embedded Networking: Introduction - I/O Device Ports & Buses– Serial Bus Communication Protocols – RS232 Standard – RS422 – RS485 – CAN Bus - Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – Need for Device Drivers.						08
3	Embedded Firmware Development Environment Embedded Product Development Life Cycle - Objectives - Different Phases of EDLC - Modelling of EDLC - Issues in Hardware - Software Co-design – Data Flow Graph - State Machine Model - Sequential Program Model – Concurrent Model - Object Oriented Model.						07
4	RTOS Based Embedded System Design Introduction to Basic Concepts of RTOS - Task - Process & Threads – Interrupt Routines in RTOS - Multiprocessing and Multitasking - Preemptive and Non-Preemptive Scheduling - Task Communication Shared Memory – Message Passing - Inter Process Communication – Synchronization between Processes Semaphores - Mailbox - Pipes - Priority Inversion - Priority Inheritance. Static and dynamic memory allocation, debugging embedded systems: Intrusive and non-intusive debugging, Past bugs to analyze current bugs, Boundary conditions, Static and dynamic code analysis tool, timing issues, debugging statements, protocol and Connection errors. Postmortem analysis of logs. Bug documentation, Bug checklists						07
	Total						30

Self Learning**Embedded System Application and Development**

Case study of Scanner, copier and printer. Controlling the Printer using Raspberry Pie fixture.

The following references may be valuable:

Klipper Firmware

Klipper is an open-source firmware for 3D printers that distributes tasks between a general-purpose computer (like a Raspberry Pi) and the printer's microcontroller. This separation allows for advanced control features, including support for various kinematics and precise stepper motor management.

OctoPrint

OctoPrint is an open-source 3D printer controller application providing a web interface for connected printers. It enables users to monitor and control print jobs remotely, offering features like webcam integration, G-code visualization, and a plugin system for extended functionality.

These resources offer practical insights into controlling printers using Raspberry Pi, which could be adapted for similar applications in scanners and copiers.

Text Books:

1. J. K. Peckol, Embedded Systems: A Contemporary Design Tool, 2nd ed., Hoboken, NJ, USA: Wiley, 2019.
2. J. J. Labrosse, MicroC/OS-II: The Real-Time Kernel, 2nd ed., Newton, MA, USA: CMP Books, 2002.

Reference Books:

1. R. Kamal, Embedded Systems: Architecture, Programming and Design, 3rd ed., New Delhi, India: McGraw-Hill Education, 2014.
2. J. W. Valvano, "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers," 5th ed., CreateSpace Independent Publishing Platform, 2014.
3. M. Barr and A. Massa, "Programming Embedded Systems: With C and GNU Development Tools," 2nd ed., O'Reilly Media, 2006.
4. F. Vahid and T. Givargis, "Embedded System Design: A Unified Hardware/Software Introduction," 1st ed., Wiley, 2001.
5. Q. Li and C. Yao, "Real-Time Concepts for Embedded Systems," 1st ed., CMP Books, 2003.
6. J. Ganssle, "The Art of Designing Embedded Systems," 3rd ed., Newnes, 2011.



Program: B. Tech. (E&TC)				Semester : VI			
Course : Embedded System for Connected Devices Lab				Code : BET26PE08			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of: a. microcontroller is essential							
Course Objectives: The objective of this laboratory is to provide the student with: 1. To develop proficiency in programming 8-bit microcontrollers (such as AVR, PIC, and Arduino) using Assembly and C, including the use of cross-compilers, in-circuit emulators, and debugging tools. 2. To provide hands-on experience in I/O programming, including timers, interrupts, serial communication, PWM generation, motor control, and sensor interfacing with microcontrollers.							
Course Outcomes: After completing the course, the students should be able to: 1. Write, debug, and execute Assembly and C programs for 8-bit microcontrollers, interfacing with various peripherals. 2. Integrate microcontrollers with external devices such as sensors, motors, and serial communication interfaces for embedded applications..							
Guidelines: Any eight Experiments is to be performed to meet the above outcomes.							
Detailed Syllabus:							
PART:A							
Expt. No.	List of Experiments						
1	Programming in High- Level Languages / Platforms						
2	Programming with 8-bit Microcontrollers, Assembly programming, Study on in-circuit Emulators, cross compilers, debuggers						
3	I/O Programming with 8-bit Microcontrollers I/O Interfacing: Timers/ Interrupts / Serial port programming						
4	I/O Programming with 8-bit Microcontrollers I/O Interfacing: PWM Generation/ Motor Control / Sensor Interfacing						
5	Programming with AVR / PIC Microcontrollers: Assembly, C programming, programming Interfacing peripherals, Study on in circuit, Emulators, cross-compilers, debuggers						
6	I/O Programming with AVR / PIC Microcontrollers I/O Interfacing: Timers / Interrupts / Serial port programming						
7	I/O Programming with AVR / PIC Microcontrollers I/O Interfacing: PWM Generation/Motor Control /Sensor Interfacing						
8	Programming with Arduino Microcontroller Board: Study on in circuit emulators, cross compilers, debuggers						
9	Programming with Arduino Microcontroller Board: Study on in circuit emulators, cross compilers, debuggers						

References:

1. M. A. Mazidi, R. D. McKinlay, and D. Causey, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, Pearson/Prentice Hall, 2008.
2. M. A. Mazidi, S. Naimi, and S. Naimi, The AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson, 2014.
3. M. Banzi and M. Shiloh, Getting Started with Arduino, 3rd ed., Maker Media, 2020.



Program :	B. Tech. (E&TC)			Semester: VI			
Course :	Connected, Autonomous & Electric Vehicle -I			Code	BET26PE09		
				:			
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2			10	10	30	50
Prior knowledge of Chemistry, Power Electronics, Basics of electronics and electrical is essential.							
Course Objectives: This course aims at enable students, 1. Acquire foundational knowledge and practical skills in electric vehicle (EV) dynamics, component sizing, and simulation techniques. 2. To get aware of battery technology 3. To make aware of ADAS and autonomous vehicle technologies 4. To get familiar with the principles of wireless networking and their applications in vehicle autonomy							
Course Outcomes: After learning the course, the students should be able to: 1. Apply simulation tools to model and analyze the performance and sizing of key electric vehicle components. 2. Analyze battery electric and thermal management systems with safety protocols for battery packs, BMS, and charging systems in EVs. 3. Illustrate the role of ADAS and autonomous vehicle technologies 4. Understand the principles of wireless networking technologies to enhance vehicle autonomy and connectivity.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
I	Introduction to EV Systems: Basics of Electric Vehicle Overview, Vehicle Dynamics (Governing Equations and Simulations), Defining the component sizing (Battery Pack, Electrical Machine, Traction Inverter, DC-DC Convertor, and Onboard Charger)						7
II	Battery Technology: Basics of Lithium-ion cells, Battery Management System, Hardware, Software Function, Communication Protocol, Battery Thermal Management System, Function Safety associated with Battery Pack and BMS System, Battery charging system: Onboard charger and charging station						8
III	Autonomous Vehicle Essentials: Overview of ADAS and Autonomous vehicle Technology SAE levels of ADAS/ AD Software Stack Architecture, Overview of ADAS Features LDW/ LCA /LKA , ACC, IHC, Blind Spot Detection, Forward Collision Warning, Automatic Emergency Braking, Introduction to Simulation for ADAS/ AD- Commons tools and Platform sensors, Map , Traffic, Introduction to ADAS Software Testing Process- Unit/System/ Integration Testing						8
IV	Connected Vehicle Fundamental: Overview of Wireless Networks for Connected Vehicles, Standards for Autonomous Vehicle Applications, Transmission & Receiver Systems, Radio Transmission Concepts for Automotive Application, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals & Overview to 2G to 5G Networks for Automotive Application						7
	Total						30
	Reference books: 1. Plett, G. Battery Management Systems, Volume I: Battery Modeling; Artech, 2015. 2. Quan Ouyang, Jian Chen, Advanced Model-Based Charging Control for Lithium-Ion Batteries-Springer, 2023 3. Daniel Watzenig, Martin Horn, Automated Driving: Safer and More Efficient Future Driving, Springer, 2016						

4. Seth Leitman., Bob Brant. - Build Your Own Electric Vehicle-McGraw-Hill Professional (2009)
5. Umar Zakir, Abdul Hamid ,Fadi Al-Turjman, Towards Connected and Autonomous Vehicle Highways, Technical, Security and Social Challenges, Springer, 2021D. Linden and T. S. Reddy, "Handbook of Batteries," 3rd Edition, McGraw-Hill, 2002.
6. Vincent Cocron, "Introduction to EV Systems and Battery Technology", CRC Press in 2020

E-sources:

1. Fundamentals of Electric vehicles: Technology & Economics:

<https://nptel.ac.in/courses/108106170>

2. Electric Vehicles - Part 1: https://onlinecourses.nptel.ac.in/noc22_ee53/preview

3. EV - Vehicle Dynamics and Electric Motor Drives:

https://onlinecourses.nptel.ac.in/noc24_ee30/preview



Program:	B. Tech. (E&TC)			Semester: VI			
Course:	Connected, Autonomous & Electric Vehicle Lab-I			Code: BET26PE10			
Credits	Teaching Scheme (Hrs. /Week)			Evaluation Scheme and Marks			
	Theory	Practical	Tutorial	TW	OR	P R	Total
1	-	2	-	50	-		50
Prior knowledge of 1. Basics of Electrical and Electronics, Chemistry is essential.							
Course Objectives: 1. To develop the learner's simulation skill in the drive cycle of EV components 2. To introduce learners to the basics of batteries and their parameter 3. To understand the fundamentals of the ADAS/AD system and connected vehicles.							
Course Outcomes: After completion of this course, the students will be able to, 1. Analyze the drive cycle of EVs. 2. Summarize the need for DC-DC converter topology. 3. Analyze the ADAS system for EVs. 4. Explore the need for connected vehicles.							
Guidelines:							
Detailed Syllabus							
Expt . No.	Suggested List of Experiments						
1	Drive cycle Simulation of EV Components in MATLAB and Simulink (Battery cell, Power Electronics, Electrical Machine simulation)						
2	Practical based on the battery using MATLAB Simscape						
3	Practical based on ADAS/AD using Carla MATLAB Simulink tool						
4	Study of connected vehicles related to IOT						
5	Visit to any EV industry/ Research laboratory						
References: 1. D. Linden and T. S. Reddy, "Handbook of Batteries," 3rd Edition, McGraw-Hill, 2002. 2. MATLAB Documents							

Program :	B. Tech. (E&TC)			Semester: VI			
Course :	System Verilog for Verification			Code :	BET26PE11		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of							
a. Basics of Verilog language b. A basic understanding of digital hardware design c. Fundamentals of Object-Oriented Programming is essential.							
Course Objectives:							
This course aims at enabling students to:							
1. Analyze various verification processes and methodologies to determine their effectiveness. 2. Apply System Verilog Object-Oriented Programming concepts to complex verification scenarios. 3. Evaluate functional coverage metrics and their implications on simulation accuracy and completeness. 4. Design and develop advanced UVM (Universal Verification Methodology) environments using System Verilog verification features.							
Course Outcomes:							
After learning the course, the students should be able to:							
1. Evaluate various verification methodologies to determine the most effective approaches. 2. Design and implement advanced test benches and PLI programs in System Verilog. 3. Interpret functional coverage data to ensure comprehensive verification. 4. Develop sophisticated UVM (Universal Verification Methodology) environments using System Verilog verification features.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Verification Methodology Overview Introduction to Verification Methodology, Verification Process, Verification Environment Architecture, System Verilog Introduction & Logic Data Type, Procedures Statements and Procedural Blocks, Operators System Verilog Tasks & Functions, System Verilog Interfaces.						08
2	System Verilog Object Oriented Programming Introduction, Class Data Type & Objects, User-Defined Data Types and Structures, Inheritance & Super, Static properties & methods and Pass by ref, Polymorphism, Virtual & Parameterized classes, System Verilog Randomization, System Verilog Assertions, Immediate Assertions, Concurrent Assertions, Building a Testbench.						08
3	Functional Coverage Introduction, Interfaces in Verification, Cover group Coverage, Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, Parameterized Cover Groups, Analyzing Coverage Data, Measuring Coverage Statistics During Simulation.						08
4	Universal Verification Methodology Overview Introduction to UVM Methodology, UVM Environment & Components, Stimulus Modeling, Simulation Phases, Building a Basic UVM testbench.						06
Total						30	

Text Books:

1. System Verilog for Design: A Guide to Using System Verilog for Hardware Design and Modeling, 2nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer 2006.
2. Bergeron, Janick. Writing testbenches using System Verilog, 1st Edition, Springer Science & Business Media, 2007.
3. System Verilog for Verification: A Guide to Learning the Testbench Language Features Third Edition by ChrisSpear and Greg Tumbush, 2012.
4. Introduction to SystemVerilog, Ashok B Mehta, Springer, 2022

Reference Books:

1. Vijayaraghavan, Srikanth, and Meyyappan Ramanathan. A practical guide for System Verilog assertions, Springer Science & Business Media, 2006.
2. Open Verification Methodology Cookbook, Mark Glasser, Springer, 2009
3. Donald Thomas, "Logic Design and Verification Using System Verilog", CreateSpace Independent Publishing Platform, 2014.

MOOC course list:

1. <https://www.udemy.com/course/soc-verification-systemverilog>
2. <https://www.udemy.com/course/fundamentals-of-verification-and-system-verilog>



Program: B. Tech. (E&TC)				Semester :VI			
Course :System Verilog for VerificationLab.				Code : BET26PE12			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-		50
Prior knowledge of							
a. Basics of Verilog language							
b. A basic understanding of digital hardware design							
c. Fundamentals of Object-Oriented Programming is essential.							
Course Objectives:							
The objective of this laboratory is to provide the student with:							
1. To demonstrate practical expertise and proficiency in creating System Verilog testbenches to ensure the proper functioning of various digital circuits, such as Full Adders, ALUs, and both Synchronous and Asynchronous Up-Down Counters.							
2. To provide practical experience with 'Interface' in System Verilog and the PLI application, and demonstrate practical skills in measuring functional coverage and designing UVM Environments.							
Course Outcomes:							
After completing the course, the students should be able to:							
1. Demonstrate expertise in using System Verilog to verify the functionality of digital circuits such as Full Adders, ALUs, synchronous and asynchronous up-down counters.							
2. Create immediate and concurrent assertions in testbenches and gain practical experience in generating and analyzing random numbers.							
3. Apply the System Verilog 'Interface' construct to demonstrate the Full Adder circuit and utilize the PLI application to gain hands-on experience.							
4. Design UVM environments for adders/subtractors and Random-Access Memory using System Verilog, and demonstrate proficiency in measuring functional coverage for BCD to seven-segment decoders and Serial-In-Parallel-Out (SIPO) registers.							
General Guidelines: Any Eight Experiments is to be performed to meet the above outcomes.							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Develop a System Verilog testbench to verify the functionality of a Full Adder digital circuit.						
2	Implement a System Verilog testbench to verify the functionality of an Arithmetic Logic Unit (ALU) digital circuit.						
3	Design and implement a System Verilog testbench to verify the functionality of a Synchronous Up-Down Counter digital circuit.						
4	Develop a System Verilog testbench to verify the functionality of an Asynchronous Up-Down Counter digital circuit.						
5	Create a System Verilog testbench to generate random numbers and evaluate their distribution.						
6	Use System Verilog to create both immediate and concurrent assertions and verify their behavior in a testbench.						
7	Develop a System Verilog UVM Environment to Verify UART (Universal Asynchronous Receiver-Transmitter) Protocol.						
8	Demonstrate the PLI (Programming Language Interface) application for a 4-bit binary Adder-Subtractor.						
9	Develop a System Verilog program to measure the functional coverage of a BCD to Seven-segment decoder.						
10	Develop a System Verilog program to measure the functional coverage of a Serial-in-Parallel-Out (SIPO) register.						
11	Design a UVM (Universal Verification Methodology) Environment for an 8-bit adder/subtractor.						
12	Design and Verify a FIFO (First-In-First-Out) Memory Using System Verilog Testbench.						

References:

1. Introduction to SystemVerilog, Ashok B Mehta, Springer, 2022
2. Vijayaraghavan, Srikanth, and Meyyappan Ramanathan, A practical guide for System Verilog assertions, Springer Science & Business Media, 2006.
3. Open Verification Methodology Cookbook, Mark Glasser, Springer, 2009
4. System Verilog for Verification: A Guide to Learning the Testbench Language Features Third Edition by

ChrisSpear and Greg Tumbush, 2012

5. Donald Thomas, Logic Design and Verification Using System Verilog, CreateSpace Independent PublishingPlatform, 2014.

MOOC course list:

1. <https://www.udemy.com/course/soc-verification-systemverilog>
2. <https://www.udemy.com/course/fundamentals-of-verification-and-system-verilog>



Program :	B. Tech. (E&TC)			Semester: VI			
Course :	Transmission lines and Antenna			Code :	BET26PE13		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of 1. Electromagnetics is essential							
Course Objectives: This course aims at enabling students, 1. To comprehend concepts of electromagnetism to obtain parameters of Transmission line. 2. To make them aware of the basic concepts of antenna. 3. To Introduce operating principles of antenna array. 4. To Share knowledge about HF and VHF, UHF antennas and appropriate antenna selection for specific applications.							
Course Outcomes: After learning the course, the students should be able to 1. Understand basics of transmission line parameters and related concepts. 2. understand basic concepts of antenna and its types. 3. Design an antenna array for various applications.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Transmission line Basics: Transmission Line parameters, equations, concept of distributed elements, Reflection Coefficient and Transmission Coefficient, Standing Wave and Standing Wave Ratio, Lossless and low loss transmission lines, Impedance Smith Chart, Smith Chart, Applications of Smith chart Single Stub matching.						07
2	Antenna Basics: radiation mechanism, efficiency, directivity, beam efficiency, intensity, gain, power theorem and its application, radiation pattern, far field and near field, antenna aperture, effective height, bandwidth, radio communication link, antenna impedance. Different types of antennas: Wire Antennas - Dipole antenna, Short Dipole antenna, radiation resistance of short dipole antenna, Helix antenna, Loop antenna. Reflector Antenna: Parabolic reflectors with Applications. Aperature Antenna: Horn Antenna						08
3	Antenna Array: Concept of antenna arrays, Two element arrays and their directional characteristics, Principles of pattern multiplication & their application, Linear array analysis (uniform antenna array), Broadside and end fire arrays. Array Antenna types: Yagi-Uda antenna						07
4	Antenna for modern wireless communication: Ultra-wideband antenna: MIMO antenna. Different Antenna applications in AI/ML, Antennas for Biomedical applications, Wearable antenna, Antennas for Terrestrial communication - mobile handsets and base station, vehicle to vehicle communication.						08
	Total						30
Text Books: 1. R.K. Shevgaonkar, "Electromagnetic Waves", TMH ,2006 2. C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 3rd edition, Wiley & Sons, New York, USA. 3. K.D. Prasad, "Antennas and Wave Propagation", Khanna or Satya Publications							

Reference Books:

1. Peter S. Hall," Antennas and propagation for body centric wireless communication",
2. e book By Albert Sabban" Novel Wearable Antennas for Communication and Medical Systems", CRC press.
3. Antennas and Wave Propagation – Harish and Sachidananda: Oxford University Press, 2007

NPTEL courses

1. Advanced antenna Theory, Dr. Amalendu Patnaik, IIT Roorkee

<https://nptel.ac.in/courses/117107035>

2. Antennas, Dr. Girish Kumar, IIT Mumbai

https://onlinecourses.nptel.ac.in/noc20_ee20/preview



Program :	B. Tech. (E&TC)			Semester: VI			
Course:	Transmission lines and antenna Lab			Code :	BET26PE14		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	TW	FA		SA	Total
				FA1	FA2		
01	-	02	50	-	-	-	50
Prior knowledge of: 1. Electromagnetics and uniform plane wave is essential							
Course Objectives: This course aims at enabling students, 1. Understand VSWR of a transmission line at various conditions. 2. To comprehend radiation patterns of different antennas. 3. To make them aware of antenna design using different simulation tools.							
Course Outcomes: After learning the course, the students should be able to: 1. Evaluate VSWR of a transmission line at various conditions. 2. Analyze radiation patterns of different antennas. 3. Design antenna using antenna simulation tools.							
General Guidelines: Any Eight Experiments are to be performed.							
Detailed Syllabus							
Expt. No.	List of Experiments						
1	Plot Standing Wave pattern and Measure SWR for open, short, and matched termination.						
2	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Dipole Antenna.						
3	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Folded Dipole Antenna.						
4	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Yagi Uda Antenna.						
5	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Horn Antenna.						
6	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Parabolic Reflector Antenna.						
7	MATLAB simulation of Broad side linear array with uniform spacing and amplitude						
8	MATLAB simulation of End fire linear array with uniform spacing and amplitude.						
9	Design Of Rectangular Microstrip Patch Antenna Using Strip Line Feed.						
10	Design Of Rectangular slotted Microstrip Patch Antenna using strip line fed.						
11	Understanding /reading of research paper.						
12	Field Visit						
Text Books: 1. R.K. Shevgaonkar, "Electromagnetic Waves", TMH ,2006 2. C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 3rd edition, Wiley & Sons, New York, USA. 3. K.D. Prasad, "Antennas and Wave Propagation", Khanna or Satya Publications							
Reference Books: 1. C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 3rd edition, Wiley & Sons, New York, USA. 2. K.D. Prasad, "Antennas and Wave Propagation", Khanna or Satya Publications, 2 nd edition, 2007							

Program :	B. Tech. (E&TC)	Semester: VI
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Course :		Digital Image Processing			Code :		BET26PE15
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of 1.Basic Signals and Signal Processing is essential							
Course Objectives: This course aims at enabling students, 1. To make students familiar with fundamental concepts of Digital Image Processing with basic relationship of pixels and mathematical operations on 2-D data. 2. To introduce design and integrate image enhancement. 3. To make students aware of the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques 4. To make student apprised of object segmentation and image analysis techniques							
Course Outcomes: After learning the course, the students should be able to: 1. Develop basic mathematical operations on digital images. 2. Analyze image enhancement problems. 3. Apply 2-D data compression techniques for digital images. 4. Design image processing algorithms for object segmentation							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Fundamentals of Image Processing: Steps in Image processing, Human visual system, Sampling & quantization, Representing digital images, spatial and gray level resolution, Basic relationships between pixels, Distance Measures, Basic operations on images – image addition, subtraction, logical operations, scaling translation, rotation, Data Augmentation						08
2	Image Enhancement: Log transformation, Power law transformation, Piecewise linear transformation, Image histogram, histogram equalization, Mask processing of images, filtering operations- Image smoothing, image sharpening, frequency domains image enhancement: 2D DFT, smoothing and sharpening in frequency domain , Basics of CNN, Autoencoders for Noise Reduction and Super-Resolution						07
3	Image Compression: Types of redundancy, Fidelity criteria, Compression models - Information theoretic perspective – Fundamental coding theorem, Lossless Compression: Huffman Coding- Arithmetic coding. Introduction to DCT, Lossy compression: DCT based compression; Wavelet based compression , Autoencoder-Based Image Compression						08
4	Image Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, Adaptive thresholding, Otsu's method, Edge detection – First order derivative Prewitt and Sobel, Second order derivative – LoG, DoG, Canny. Edge linking, Hough transform, Region growing and region merging. Morphological operators: Dilation, Erosion, Opening, Closing, Hit or Miss transforms Boundary detection, CNN-Based Edge Detection and Boundary Recognition						07
Total						30	

Text Books:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education, 4th edition 2018
2. Iain E. G. Richardson, —H.264 and MPEG 2010
3. Video Compression: Video Coding for Next Generation Multimedial, John Wiley and Son's Publication, 3rd Edition.2011

Reference Books:

1. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
2. Pratt William K. "Digital Image Processing", John Wiley & sons 2009
3. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000
4. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", MIT Press, 2016



Program: B. Tech. (E&TC)				Semester : VI			
Course : Digital Image Processing Lab				Code : BET26PE16			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of:							
1. MATLAB /Simulink/ Open source platform programming is essential							
Course Objectives:							
The objective of this laboratory is to provide the student with:							
2. To demonstrate Digital Image processing with basic relationship of pixels and mathematical operations on 2-D data.							
3. To make aware the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques							
4. To give an idea of object segmentation and image analysis techniques							
Course Outcomes:							
After completing the course, the students should be able to:							
1. Analyze image enhancement algorithms.							
2. Apply 2-D data compression techniques for digital images.							
3. Design image processing Algorithms for object segmentation							
Guidelines: Any Six Experiments is to be performed to meet the above outcomes.							
Term work:							
1. Term Work for 50 Marks							
2. For Term Work Assessment Two open ended projects (1. Data augmentation+Image enhancement 2. Image compression+segmentation) should be done. Additionally, last topic of every unit can be added.							
3. High performance computing concepts should be added							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Implement basic operations on images.						
2	Perform histogram equalization.						
3	Apply log transform, Power law transform & piece wise linear transform on gray level images						
4	Simulate image filtering in spatial domain.						
5	Apply image filtering in frequency domain.						
6	Simulate image compression using DCT / Wavelet transform.						
7	Implement edge detection using various masks.						
8	Perform global and adaptive thresholding.						
9	Apply morphological operators on an image.						
10	Perform various thresholding operations on images						
11	Simulate & analyse image region growing & region merging for segmentation						
12	Perform Canny edge detection for object segmentation						

References:

1. A.K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
2. Pratt William K. "Digital Image Processing", John Wiley & sons 2009
3. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000



Program :	TY B. Tech. (E&TC)			Semester: VI			
Course :	C++ FOR EMBEDDED SYSTEMS			Code :	BET26PE17		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of a. C language is essential.							
Course Objectives: This course aims at enabling students, 1. To introduce the fundamental concepts of C++ programming, including syntax, data types, control structures, functions, and memory management, enabling students to develop structured and efficient programs. 2. understanding of control flow mechanisms, type conversion, function overloading, and pointers in C++, enabling students to write efficient and well-structured programs.							
Course Outcomes: After learning the course, the students should be able to: 1. Write, debug, and execute basic C++ programs using proper syntax, control structures, functions, and memory management techniques. 2. Implement control structures, perform type conversions, utilize function overloading, and effectively use pointers for memory manipulation and function parameter passing in C++. 3. Implement C++ programs using object-oriented principles such as encapsulation, constructors, destructors, and static members. 4. Manage dynamic memory, utilize std::string for string operations, and perform file and stream-based input/output operations in C++.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	C++ Basics Statements and the structure of a program - Comments - Introduction to objects and variables - Variable assignment and initialization - Keywords and naming identifiers - Whitespace and basic formatting - Introduction to literals and operators- Data Types - Variable Types - Variable Scope - CONSTANTS/LITERALS - Basic Input and Output with Streams - Type Qualifiers in C++ - STORAGE CLASSES – Arrays – Strings – Operators – Loop types and Decision making POINTERS – REFERENCES – Enum - Structures - Pointers to Structures – typedef - Math Operations in C++ - Dynamic Memory - Introduction to functions - Function return values (value-returning functions) - Void functions (non-value returning functions) - Introduction to function parameters and arguments - Forward declarations and definitions - Naming collisions and an introduction to namespaces - Introduction to the preprocessor - Header files - Header guards - How to design your first programs						08
2	Control Flow, Type Conversion, Function Overloading, Pointers Control flow introduction – if statements and common if statement problems – switch statement – Introduction to loops and while statements – Do while – for loop – break and continue – Implicit type conversion – explicit type conversion – type detection – Introduction to function overloading –Function overloading differentiation – Default arguments – inline functions -Command line arguments – Introduction to pointers – null pointers – Pointers and const – Pass by address – Pass by value – Pass by reference - Return by reference and return by address						08
3	Basic Object-oriented Programming Welcome to object-oriented programming - Classes and class members - Public vs private access specifiers - Access functions and encapsulation - Constructors - Constructor member initializer lists - Non-static member initialization - Overlapping and delegating constructors - Destructors - The hidden “this” pointer - Class code and header files - Const class objects and member functions - Static member variables - Static member functions - Friend functions and classes - Anonymous objects - Nested types in classes						07

4	Memory management, std::String, Input and Output Pointers - Function Pointers - Memory Allocation - Dynamic Memory Allocation for Arrays and Objects - 'new' and 'delete' Operators - std::string and std::wstring - std::string construction and destruction - std::string length and capacity - std::string character access and conversion to C-style arrays - std::string assignment and swapping - std::string appending - std::string inserting – Input and output (I/O) streams - Input with istream - Output with ostream and ios - Stream classes for strings - Stream states and input validation - Basic file I/O - Random file I/O	07
Total		30
Self Learning Error Handling and Exception handling Common semantic errors in C++ - Detecting and handling errors - std::cin and handling invalid input - Assert and static_assert - The need for exceptions - Basic exception handling - Exceptions, functions, and stack unwinding - Uncaught exceptions and catch-all handlers - Exceptions, classes, and inheritance - Rethrowing exceptions - Function try blocks - Exception dangers and downsides To enhance your understanding of error and exception handling in C++, consider the following video resources: Exception Handling in C++ Programming - https://www.youtube.com/watch?v=EyXXLpFriMc This video provides a comprehensive introduction to exception handling, covering the basics of try, catch, and throw statements, along with practical examples. Exception Handling C++ Tutorial - https://www.youtube.com/watch?v=5nCXSDv6e4I This tutorial delves into the nuances of exception handling in C++, explaining how to implement try and catch blocks effectively, and discussing best practices for robust error management.		
Text Books: 1. Michael J. Pont, <i>C++ Programming for Embedded Systems</i> , CMP Books, 2002.		
Reference Books: 1. Igor Viarheichyk, <i>Embedded Programming with Modern C++ Cookbook</i> , Packt Publishing, 2020. 2. Maya Posch, <i>C++17 for Embedded Systems: Application Development for Small Microcontrollers</i> , Packt Publishing, 2018. 3. Michael Barr, <i>Programming Embedded Systems in C and C++</i> , O'Reilly Media, 1999. 4. Christopher Kormanyos, <i>Real-Time C++: Efficient Object-Oriented and Template Microcontroller Programming</i> , Springer, 3rd Edition, 2021.		

Program: B. Tech. (E&TC)				Semester : VI			
Course : C++ for EMBEDDED SYSTEMS Lab				Code : BET26PE18			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of: a. C++ language is essential							
Course Objectives: The objective of this laboratory is to provide the student with: 1. To develop proficiency in C++ programming for embedded systems, focusing on data structures, file handling, memory management, multithreading, and system-level programming. 2. To provide hands-on experience in implementing C++ programs for embedded applications, including data manipulation, file operations, dynamic memory allocation, and inter-thread communication.							
Course Outcomes: After completing the course, the students should be able to: 1. Implement C++ programs for embedded applications, using structures, arrays, functions, and object-oriented principles. 2. Apply C++ concepts such as memory management, file handling, and multithreading to solve real-world problems in embedded systems.							
Guidelines: Any Six Experiments from Part A and six from Part B is to be performed to meet the above outcomes.							
Detailed Syllabus:							
PART:A							
Expt. No.	List of Experiments						
1	Create a structure called student to store the student's details such as name, dept, current CGPA. Define a pre-processor macro with max no of students. Create an array of student structure with max student as array size. Create a function called "Add" that will add the students details in the array. Create a function called "Remove" that will remove the students in the array. Create a function called "Print" to print all the details of all the students.						
2	Write a program to delete all duplicate elements from an array.						
3	Write a program to merge two sorted arrays.						
4	Write a program to Add two matrices.						
5	Write a program to print hollow pyramid star pattern.						
6	Write a program to create an Array of objects.						
7	Write a program to find the largest element in the array.						
8	Program to illustrate Order of Constructor Invocation						
PART:B							
9	Write a program to count a number of words and characters in a file.						
10	Write a program to delete a specific line from a file.						
11	Allocate memory in one thread and free in another by using signal handlers.						
12	Find the number of vowels, consonants, digits and white spaces in the given set of strings.						

Self Learning

1. Program to illustrate Order of Destructor Invocation with/without Virtual keyword.
2. Program to demonstrate Constructor Overloading.
3. Program to illustrates the use of Constructors in single inheritance.
4. Program to Compare Two Strings using operator Overloading "=".
5. Write programs to demonstrate the below:
 - a. Copy constructor
 - b. Constructor with member initialization list
 - c. Shallow copy and Deep copy
 - d. Parameterized constructor with Dynamic initialization
6. Program to demonstrate run-time polymorphism.
7. Program to illustrate the use of pure virtual function in Polymorphism.
8. Program to illustrates the use of Virtual base class.
9. Program to illustrate Abstract Base Class.
10. Program to illustrate an example of Pure Virtual functions.
11. Find the day, month and year from the input string DD/MM/YY.
12. Write a program to use function pointers to call callbacks in synchronous way.
13. Write a program to use function pointers to call callbacks in asynchronous way.
14. Write a program to raise an exception of below categories and catch it.

Exception Description

- `std::bad_alloc` This exception is thrown by a new keyword.
- `std::bad_cast` This is an exception thrown by `dynamic_cast`.
- `std::bad_exception` A useful device for handling unexpected exceptions in C++ programs.
- `std::bad_typeid` An exception thrown by `typeid`.
- `std::logic_error` This exception is theoretically detectable by reading code.
- `std::invalid_argument` An exception thrown for using invalid arguments.
- `std::length_error` An exception thrown after creating a big `std::string`.
- `std::out_of_range` Thrown by `at` method.
- `std::overflow_error` This exception is thrown after the occurrence of a mathematical overflow.
- `std::range_error` This exception is thrown when you attempt to store an out-of-range value. C3
- `std::underflow_error` An exception thrown after the occurrence of mathematical Underflow.

References:

1. M. Samek, Practical UML Statecharts in C/C++: Event-Driven Programming for Embedded Systems, 2nd ed., Newnes, 2008.
2. S. Meyers, Effective C++: 55 Specific Ways to Improve Your Programs and Designs, 3rd ed., Addison-Wesley, 2005.
3. S. Meyers, Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14, O'Reilly Media, 2014.

Program :	TY B. Tech. (E&TC)			Semester: VI			
Course :	Embedded Automotive			Code :	BET26PE19		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50
Prior knowledge of Microcontrollers and its interfacing is essential.							
Course Objectives:							
This course aims at enabling students,							
1. Provide foundational knowledge of embedded systems used in automotive applications.							
2. Introduce students to automotive sensors, actuators, and microcontrollers.							
3. Explore automotive communication protocols such as CAN, LIN, FlexRay, and Automotive Ethernet.							
4. Discuss functional safety in automotive systems.							
Course Outcomes:							
After learning the course, the students should be able to:							
1. Elaborate the role and evolution of embedded systems in modern automobiles.							
2. Identify and describe various automotive sensors, actuators, and microcontrollers.							
3. Analyze different automotive communication protocols.							
4. Implement basic automotive control functions using embedded software.							
Detailed Syllabus:							
Unit	Description						Duration [Hrs]
1	Introduction to Embedded Automotive Systems Overview of embedded systems in automobiles, Evolution of automotive electronics, Automotive ECU architecture and domain control units, Impact of AI-ML in automotive Introduction to vehicle functional domains: - Powertrain Systems (Engine control, Transmission control), Body Electronics (Lighting, HVAC, Power windows), Infotainment & Telematics (Audio, Navigation, Connectivity), ADAS & Safety (Airbags, ABS, Electronic Stability Control, ADAS features) Automotive safety standards and regulations (ISO 26262, AUTOSAR, MISRA-C)						07
2	Automotive Sensors and Actuators Types of sensors used in vehicles: [Temperature, Pressure, Proximity, Speed, Acceleration, Lidar, Radar, Ultrasonic] Actuators: [Motors, Solenoids, Relays, Fuel Injectors, Electronic Throttle Control] Interfacing sensors and actuators with automotive microcontrollers						07
3	Automotive Communication Protocols Need for vehicle networking and communication Controller Area Network (CAN): Architecture, Message Frame, Error Handling Local Interconnect Network (LIN): Features and Applications FlexRay and Media Oriented Systems Transport (MOST) Overview Automotive Ethernet: Advantages and Use Cases Hands-on: Implementing CAN protocol using microcontrollers/simulators						08
4	Automotive Safety and Security Functional Safety in Automotive (ISO 26262): - Risk classification (ASIL - Automotive Safety Integrity Level), Safety goals, hazards, and failure modes, Software and hardware redundancy for safety-critical applications Case Studies on Safety Systems: - Anti-lock Braking System (ABS), Electronic Stability Control (ESC), Adaptive Cruise Control (ACC), Airbags & Crash Detection Systems, Advanced Driver Assistance Systems (ADAS) features, SDV (software defined vehicle)						08
Total						30	
Text Books:							
1. Nicolas Navet, Francoise Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press, 2017.							

Reference Books:

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw-Hill Education, 2017.
2. ISO 26262 Functional Safety Standard (Latest Edition).
3. William B. Ribbens, Understanding Automotive Electronics, Butterworth-Heinemann, 2017.
4. Robert Bosch GmbH, Automotive Handbook, Wiley, 2018.
5. P. Sivakumar, B. Vinoth Kumar, R. S. Sandhya Devi, Software Engineering for Automotive Systems: Principles and Applications, CRC Press 2022
6. Glaf Păun, George Stamatescu, Embedded Systems for Automotive Applications, Springer, 2022.
7. Wolfgang W. Fink, Advanced Driver Assistance Systems (ADAS) and Automated Driving, Springer, 2021.



Program: B. Tech. (E&TC)				Semester : VI			
Course :Embedded Automotive Lab				Code : BET26PE20			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50
Prior knowledge of: Microcontrollers and its interfacing is essential.							
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> To develop an in-depth understanding of sensor interfacing, communication protocols, and control mechanisms using STM32 microcontrollers for automotive applications. To equip students with the skills to model, simulate, and analyze automotive sensor systems and communication protocols using simulation tools like MATLAB and Simulink. 							
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> Design and implement real-time embedded systems integrating various automotive sensors and communication interfaces such as CAN, LIN, FlexRay, and Automotive Ethernet using STM32 microcontrollers Develop and validate simulation models for various automotive sensors, control systems, and communication networks, ensuring efficient system performance analysis before hardware implementation. 							
Guidelines: Any Four Experiments from Part A and any Four from Part B is to be performed to meet the above outcomes.							
Detailed Syllabus:							
PART:A							
Expt. No.	List of Experiments						
	<ol style="list-style-type: none"> Interfacing a Temperature Sensor (LM35) with STM32 Pressure Sensor-Based Tire Pressure Monitoring System (TPMS) using STM32 Ultrasonic Sensor-Based Parking Assist System LiDAR-Based Object Detection Electronic Throttle Control using PWM CAN Bus Communication Between Two STM32 Boards 						
PART:B							
Expt. No.	List of Experiments						
	<ol style="list-style-type: none"> Temperature Sensor Modeling and Simulation Pressure Sensor Simulation for Tire Pressure Monitoring System (TPMS) CAN Bus Communication Simulation in MATLAB LIN Bus Communication Simulation in MATLAB FlexRay Protocol Simulation for Real-Time Data Transfer Automotive Ethernet-Based Data Transfer Simulation Simulation of Battery Management System (BMS) Vehicle-to-Vehicle (V2V) Communication Simulation 						
References:							
<ol style="list-style-type: none"> MPU6050 Datasheet STMicroelectronics HAL I2C Library MATLAB Simulink Sensor Modeling Guide MATLAB Serial Communication Toolbox MATLAB Simulink Automotive Toolbox NXP FlexRay Protocol Guide IEEE 802.3 Standard for Automotive Ethernet MATLAB Network Traffic Analysis Toolbox 							

Program: B. Tech. (E&TC)				Semester : VI			
Course : PEC Project-2				Code : BET26PE21			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100
Prior knowledge of: a. Basic logic building and circuit design is essential							
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> To introduce the methodology of converting abstract ideas into defined project specifications. To enable students to read and analyze datasheets, research papers, and standards. To train students to identify appropriate tools, platforms, and methodologies for selected electives. 							
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> To implement the project defined in Phase I using domain-specific tools. To test and validate the system against performance parameters. To document and present the work with publishable outcomes 							
Guidelines: Elective Project Laboratory Structure <ul style="list-style-type: none"> <input type="checkbox"/> Hardware/Software Implementation <ul style="list-style-type: none"> • Develop code (VHDL, C/C++, Python), implement control logic. • Integrate components on FPGA, ARM, PLC, SDR, etc. <input type="checkbox"/> Testing and Validation <ul style="list-style-type: none"> • Functional verification and debugging. • Use test benches, simulation, and real hardware evaluation. <input type="checkbox"/> Data Analysis and Optimization <ul style="list-style-type: none"> • Analyze outputs, optimize performance. • Compare with literature results. <input type="checkbox"/> Result Compilation and Documentation <ul style="list-style-type: none"> • Draft comprehensive report. • Prepare graphs, tables, result snapshots. <input type="checkbox"/> Knowledge Dissemination <ul style="list-style-type: none"> • Prepare a research paper / poster / project video. • Optionally submit to competitions or journals. 							
Deliverables: <ul style="list-style-type: none"> • Implementation & test results • Functional Demonstration • Final Report • Research paper draft • Poster or video presentation Evaluation Criteria: <ul style="list-style-type: none"> • Implementation quality and complexity – 30% • Testing, validation, and performance – 25% • Innovation and practical relevance – 20% • Report quality and presentation – 25% 							

References:

1. "Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers" by Jonathan Valvano (2020).
2. "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris K. Manolakis (2014).
3. "MATLAB for Engineers" by Holly Moore (2020).
4. "Communication Systems Engineering" by John G. Proakis and Masoud Salehi (2013).
5. "Automation, Production Systems, and Computer-Integrated Manufacturing" by Mikell P. Groover (2015).

Online Resources

1. **Xilinx Vivado Design Suite Documentation** (2023).
 - o Official documentation for FPGA design and implementation.
 - o Available at: [Xilinx Documentation](#)
2. **MATLAB and Simulink Documentation** (2023).
 - o Official resources for signal processing and algorithm development.
 - o Available at: [MATLAB Documentation](#)
3. **GNU Radio Documentation** (2023).
 - o Official guide for SDR and communication system design.
 - o Available at: [GNU Radio Documentation](#)



Program: B. Tech. (E&TC)				Semester: VI			
Course: Computational Tools for AIML				Code: BET26VS01			
Teaching Scheme: Hrs /Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	FA1+FA2	Total
02	01	02	-	50	-	25+25	100
Teaching Scheme: <ul style="list-style-type: none"> Lecture: 1 hour/week, Practical: 2 hours/week, Total: 3 hours/week (2 Credits) Total Evaluation Scheme: 100 Marks <ul style="list-style-type: none"> Term Work (TW): 50 Marks & Formative Assessment (FA1 & FA2): 50 Marks Duration: 60 Hours <ul style="list-style-type: none"> Theory: 20 Hours, Practical: 30 Hours & Mini Project: 10 Hours 							
Prior knowledge of: <ul style="list-style-type: none"> Familiarity with fundamental programming concepts in MATLAB and Python Basic knowledge of Artificial Intelligence and Machine Learning (AIML) is essential							
Course Objectives: The objective of this laboratory is to provide the student with: <ol style="list-style-type: none"> Hands-on experience in performing and visualizing using MATLAB and Python in AIML The ability to apply concepts in Artificial Intelligence and Machine Learning. Practical exposure to basics of Artificial Neural Network and Convolution Neural Network The opportunity to develop a mini-project showcasing the application of AIML basic concepts using computational Tools 							
Course Outcomes: After completing the course, the students should be able to: <ol style="list-style-type: none"> Perform mathematical operations and visualizations using MATLAB and Python. Apply and analyze the concepts for Artificial Intelligence and Machine Learning. Implement the applicability of Artificial Neural Networks and Convolution Neural Network Develop mini-projects incorporating AIML concepts using both MATLAB and Python. 							
Guidelines: All Ten Experiments is to be performed to meet the above outcomes along with the Mini-Project Term work: 50 Marks <ol style="list-style-type: none"> Continuous assessment of Practical work for 50 Marks will be based on PART A Each Practical is assessed on 100 marks scaled down to 10 marks Formative Assessment (FA1 & FA2): 50 Marks <ol style="list-style-type: none"> Mini-Project assessment will be based on PART B Formative Assessment (FA1): Mini- Project implementation for 25 Marks Formative Assessment (FA2): Viva & Report:25 Marks 							
PART: A							
Unit No.	List of Topic/Experiments						
Unit 1	Introduction to MATLAB & Python for AI & ML (Theory: 5 Hours Practical: 8 Hours) <ul style="list-style-type: none"> Introduction to AI & ML using Computational tools MATLAB & Python Understanding & Accessing Datasets MATLAB for Data Analytics: Libraries, Importing & Exporting Data Python for Data Analytics: Libraries, Importing & Exporting Data Lab Exercises: <ol style="list-style-type: none"> Introduction to MATLAB Programming 						

	<ol style="list-style-type: none"> 2. Introduction to Python Programming 3. Air Quality Data Analysis using MATLAB 4. Stock Market Trend Analysis using Python
Unit 2	<p>Introduction to Supervised and Unsupervised Algorithms (Theory: 5 Hours Practical: 8 Hours)</p> <ul style="list-style-type: none"> • Overview of Supervised and Unsupervised Learning • Supervised Algorithms: <ul style="list-style-type: none"> • Regression Analysis • Classification based on support Vector Machine • Unsupervised Algorithm: K-means clustering <p>Lab Exercises:</p> <ol style="list-style-type: none"> 1. Implement Linear regression analysis for housing prices dataset using Python 2. Implement Linear and Non-Linear Regression Analysis using MATLAB 3. Human activity classification using machine learning algorithm using Python 4. Implement K-means clustering using MATLAB
Unit 3	<p>Introduction to ANN (Theory: 5 Hours Practical: 8 Hours)</p> <ul style="list-style-type: none"> • Concept of Artificial Neural Networks (ANN) • Logic gates using McCulloch-Pitts (MP) neuron model • Concept of Deep Learning • Introduction to Convolutional Neural Network and its evaluation <p>Lab Exercises: "Knowledge Brings Freedom"</p> <ol style="list-style-type: none"> 1. Implement simple logic gates using McCulloch-Pitts (MP) neuron model using MATLAB or Python 2. To implement a defect identification system using audio data with MATLAB or Python 3. Implement character recognition using CNN with MATLAB or Python 4. Object detection using Convolutional Neural Network using MATLAB or Python
PART B: Mini Project	
Unit 4	<p>Mini-Project & Practical Applications (Theory: 5 Hours Practical: 6 Hours Mini-Project: 10 Hours)</p> <p>Students will work on a mini-project based on the mathematical concepts covered.</p> <p>The project should include:</p> <ol style="list-style-type: none"> 1. Identify Case study: Define and formulate a problem/case studies using AI/ML mathematical concepts. 2. Implementation in MATLAB and Python: Develop a solution using both programming environments. 3. Visualization & Analysis: Interpret results using graphical representations.

4. **Report & Presentation:** Submit a brief report and demonstrate the project.

Suggested Mini-Project Topics can be implemented using MATLAB or Python:

1. Financial Data Analysis
2. SDGs related topics
3. Statistical Analysis of COVID-19 Cases
4. Heart Disease Prediction
5. Diabetes Prediction
6. Customer Segmentation
7. AI-Driven Weather Forecasting
8. Movie Recommendation System
9. Automated Resume Screening
10. Any Other Topic as per the suggestion and approval

Assessment Criteria:

- **Lab Experiments (50%):** Execution, understanding, and submission of practical work.
- **Mini-Project (30%):** Innovation, execution, and presentation.
- **Viva & Report (20%):** Conceptual clarity and explanation.

Reference Books:

1. Jake Vander Plas and O'Reilly, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly Media, Inc. 2019
2. Phil Kim, "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", APress, 2017.
3. Stuart Russell, Peter Norvig, Artificial Intelligence, A Modern Approach, Pearson Education/Prentice Hall of India, 2015.
4. Ethem Alpaydm, "Introduction to Machine Learning", Second Edition, MIT Press 2010.
5. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks using MATLAB", McGraw Hill, 2006

Online Resources:

1. SWAYAM: NPTEL - Machine Learning Course
⇒ https://swayam.gov.in/nd1_noc20_cs46/
2. NPTEL Online Course: Data Science and Machine Learning
⇒ https://onlinecourses.nptel.ac.in/noc21_cs33/
3. NPTEL Online Course: Deep Learning
⇒ https://onlinecourses.nptel.ac.in/noc20_cs62/
4. MathWorks: Teaching Data Science with MATLAB
⇒ <https://www.mathworks.com/academia/courseware/teaching-data-science-with-matlab.html>

Vision and Mission of E&TC program

VISION : To be recognized as a distinguished department in the field of electronics and telecommunication transforming students into competent technocrats by providing an Ethical, Sustainable and Value-Added Quality Education.

MISSION :

1. To create competent Electronics and Tele-communication engineers with Knowledge, Skill and Attitude by establishing a conducive learning environment.
2. To nurture technical competency, entrepreneurship skills and promote higher studies through the state-of-art facilities for building successful careers.
3. To facilitate research by engaging in projects of industrial requirement and national importance.
4. To impart Life skills, Ethical and Social values for self-sustainability.

Programme Educational Objectives (PEO's)

1. Establish a strong base in mathematics, basic sciences, and the fundamental principles of Electronics and Telecommunication Engineering for the students.
2. Equip students with a comprehensive understanding of Electronics and Telecommunication Engineering, enabling them to effectively comprehend, analyse, design, and to innovate practical solutions for real-world challenges.
3. Foster the development of effective communication skills, teamwork, and professional ethics among students, in order to meet the demands of employers and prepare them for higher studies and successful careers.
4. Promote social consciousness and a sense of responsibility among students, creating awareness about their commitment and obligations to society.

Program Outcomes (PO's)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

1. **PSO1:** Ability to exhibit the competency to solve the problems related to Electronics & Telecommunications Engineering by applying advanced knowledge in the fields of VLSI, Embedded Systems, Signal Processing, Communication, Computing and Automation.
2. **PSO2:** Ability to design and analyse Electronics & Telecommunications systems using state of the art hardware and software tools to address the needs of the industry and society.
3. **PSO3:** Ability to build research and problem-solving attitude through Project based learning to address the societal, environmental, health and safety issues.

