DEPARTMENT ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY KURUKSHETRA

B.TECH. ECE PROGRAMME A.Y. 2023-24

SEMESTER —I (BATCH 2023 onwards)

<table>
<tr><th rowspan="2">Sr.No</th><th rowspan="2">Course Category</th><th rowspan="2">Course Title</th><th rowspan="2">Course Code</th><th colspan="3">Lecture(L)/ Tutorial(T)/ Practical(P) per week</th><th rowspan="2">Credits</th></tr>
<tr><th>L</th><th>T@</th><th>P</th></tr>
<tr><td rowspan="2">1</td><td rowspan="7">IC</td><td>Economics for Engineers</td><td>HSIC 102</td><td>3</td><td>0</td><td>0</td><td rowspan="2">3#</td></tr>
<tr><td>Business Studies</td><td>HSIC 104</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>Differential Calculus and Differential Equations</td><td>MAIC 101</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>3</td><td>Engineering Physics</td><td>PHIC 101</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>4</td><td>Engineering Practice</td><td>MEIC 102</td><td>1</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>5</td><td>Problems Solving and Programming using C</td><td>CSIC 103</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>6</td><td>Energy and Environment Science</td><td>CHIC 101</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td rowspan="6">7</td><td rowspan="8">NC</td><td>Indian Knowledge Systems</td><td>HSNC 106</td><td rowspan="6">2</td><td rowspan="6">0</td><td rowspan="6">0</td><td rowspan="6">2#</td></tr>
<tr><td>Teachings of Gita</td><td>HSNC 107</td></tr>
<tr><td>French Language Skills</td><td>HSNC 108</td></tr>
<tr><td>German Language Skills</td><td>HSNC 109</td></tr>
<tr><td>Japanese Language Skills</td><td>HSNC 110</td></tr>
<tr><td>Thought Lab and Practices</td><td>HSNC 111</td></tr>
<tr><td>8</td><td>NCC/ Sports /Yoga</td><td>SWNC 101</td><td>0</td><td>0</td><td>4</td><td rowspan="2">2*</td></tr>
<tr><td>9</td><td>NSS /Club/Technical Societies</td><td>SWNC 102</td><td>0</td><td>0</td><td>4</td></tr>
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Minimum number of students required to register for the subject to be offered is 50 and maximum number is 80 in one lecture group, limited to only 2 lecture groups for any subject.

@ In lieu of tutorial, wherever necessary, assignments and interactions with the students may be conducted at their own convenience by the faculty concerned.

DEPARTMENT ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY KURUKSHETRA

B.TECH. ECE PROGRAMME A.Y. 2023-24

SEMESTER —II (BATCH 2023 onwards)

<table>
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<tr><th>L</th><th>T</th><th>P</th></tr>
<tr><td rowspan="2">1.</td><td rowspan="6">IC</td><td>Communication Skills in English</td><td>HSIC 101</td><td>2</td><td>0</td><td>2</td><td rowspan="2">3#</td></tr>
<tr><td>Financial Education</td><td>HSIC 103</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td>2.</td><td>Integral Calculus and Difference Equations</td><td>MAIC-102</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>3.</td><td>Advanced Engineering Physics</td><td>PHIC 103</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>4.</td><td>Engineering Graphics (Web Design)</td><td>CSIC 102</td><td>1</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>5.</td><td>Chemistry</td><td>CHIC 103</td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td rowspan="6">6.</td><td rowspan="8">NC</td><td>Human Values and Social Responsibility</td><td>HSNC 10]</td><td rowspan="6">2</td><td rowspan="6">0</td><td rowspan="6">0</td><td rowspan="6">2#</td></tr>
<tr><td>Sanskrit Language Skills</td><td>HSNC 102</td></tr>
<tr><td>Hindi Language Skills</td><td>HSNC 103</td></tr>
<tr><td>Telugu Language Skills</td><td>HSNC 104</td></tr>
<tr><td>Constitution of India</td><td>HSNC 105</td></tr>
<tr><td>Vedic Mathematics</td><td>MANC 101</td></tr>
<tr><td>7.</td><td>NCC/ Sports /Yoga</td><td>SWNC 101</td><td>0</td><td>0</td><td>4</td><td rowspan="2">2*</td></tr>
<tr><td>8.</td><td>NSS /Club/Technical Societies</td><td>SWNC 102</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>9.</td><td>PC</td><td>Circuit Theory (Theory & Lab)</td><td>ECPC 101</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
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DEPARTMENT ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY KURUKSHETRA

B.TECH. ECE PROGRAMME A.Y. 2023-24

SEMESTER —III (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	IC	Machine Learning & Data Analytics	CSIC 221	3	0	2	3
2	PC	Electronic Devices and Circuits	ECPC 201	3	0	0	3
3		Digital Design	ECPC 202	3	0	0	3
4		Signals, Systems & Random Variables	ECPC 203	3	0	0	3
5		Fields and waves	ECPC 204	3	0	0	3
6		Communication Engineering	ECPC 205	3	0	0	3
7		Electronics-I Lab	ECPC 206	0	0	2	1
8		Digital Design lab	ECPC 207	0	0	2	1
9		MATLAB Programming Lab	ECPC 208	0	0	2	1
10	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
11	NC	NSS /Club/Technical Societies	SWNC102	0	0	4	2*
Total							**21**

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DEPARTMENT ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY KURUKSHETRA

B.TECH. ECE PROGRAMME A.Y. 2023-24

SEMESTER —IV (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	IC	Applied Linear Algebra	MAIC 204	3	0	0	3
2	PC	Analog Electronics	ECPC 209	3	0	0	3
3		Digital Communication	ECPC 210	3	0	0	3
4		Computer Architecture	ECPC 211	3	0	0	3
5		Information Theory and Coding	ECPC 212	3	0	0	3
6		Electronics-II Lab	ECPC 213	0	0	2	1
7		Communication Engineering Lab (Comm. Lab -I)	ECPC 214	0	0	2	1
8		Digital Communication Lab (Comm. Lab -II)	ECPC 215	0	0	2	1
9		Object Oriented Programming Lab	ECPC 216	1	0	2	2
10	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
11	NC	NSS /Club/Technical Societies	SWNC102	0	0	4	2*
Total							**20**

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SEMESTER —V (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	PC	Digital Signal Processing	ECPC 301	3	1	0	3
2		Antenna & Wave Propagation	ECPC 302	3	1	0	3
3	PE	Program Elective-I	ECPE xxx	3	1	0	3
4		Program Elective -II	ECPE xxx	3	1	0	3
5	OE	Open Elective-I	ECOE xxx	3	0	0	3
6	PC	DSP Lab	ECPC 303	0	0	2	1
7		HDL Lab	ECPC 304	0	0	2	1
8		Transmission Lines & Antenna Lab (Comm. Lab -III)	ECPC 305	0	0	2	1
9		Seminar	ECPC 306	0	0	1	1
10		Summer Training	ECPC 307	Six Weeks			1
11	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
12	NC	NSS /Club/Technical Societies	SWNC 102	0	0	4	2*
Total							**20**

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Sr.No	Course Category	Course Title	Course Code
COMMUNICATION AND SIGNAL PROCESSING			
1	PE	Satellite Communications	ECPE-301
2		Neuro- Fuzzy Systems	ECPE-302
3		Multicarrier Communication	ECPE-303
4		Optical Wireless Communications	ECPE-304
5		Statistical Signal Processing	ECPE-305
DEVICES AND VLSI DESIGN			
1	PE	Control System Engineering	ECPE-306
2		Verilog HDL	ECPE-307
3		Digital IC Design	ECPE-308
4		Advanced MOS Devices	ECPE-309
5		Semiconductor Photonic Devices	ECPE-310
INTERNET OF THINGS			
1	PE	Optical Wireless Techniques for IoT & 5G/6G systems	ECPE-311
2		IoT & Applications	ECPE-312
3		Wireless Sensor Networks	ECPE-313
4		Cyber Physical Systems	ECPE-314
Open Electives			
1	OE	Communication Systems	ECOE-301
2		Microprocessors	ECOE-302

SEMESTER —VI (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	PC	Computer Networks	ECPC 308	3	1	0	3
2		Processor Design	ECPC 309	3	1	0	3
3		Wireless & Mobile Communication	ECPC 310	3	1	0	3
4	PE	Program Elective –III	ECPE xxx	3	1	0	3
5		Program Elective –IV	ECPE xxx	3	1	0	3
6	OE	Open Elective-II	ECOE xxx	3	0	0	3
7	PC	Processors Lab	ECPC 311	0	0	2	1
8		Embedded System Lab	ECPC 312	0	0	2	1
9		Machine Learning lab	ECPC 313	0	0	2	1
10	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
11	NC	NSS /Club/Technical Societies	SWNC102	0	0	4	2*
Total							**21**

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COMMUNICATION AND SIGNAL PROCESSING			
Sr.No	**Course Category**	**Course Title**	**Course Code**
1	PE	Data Structure	ECPE-315
2		OFDM Systems	ECPE-316
3		Microstrip Antennas	ECPE-317
4		Adaptive Signal Processing	ECPE-318
5		Estimation & Detection	ECPE-319
6		Satellite Image Processing	ECPE-320
7		Computational Electromagnetics and its Applications	ECPE-321
DEVICES AND VLSI DESIGN			
1	PE	Embedded System Fundamentals	ECPE-322
2		Analog IC Design	ECPE-323
3		Advanced Microcontroller Architecture	ECPE-324
4		Nano Electronics	ECPE-325
5		ASICs & FPGAs	ECPE-326
INTERNET OF THINGS			
1	PE	Cryptography	ECPE-327
2		Data Science	ECPE-328
3		Image Processing	ECPE-329
4		Wireless Technology	ECPE-330
5		Advance Mobile Commn.	ECPE-331
Open Electives			
1	OE	Wireless Communications	ECOE-303
2		Logic Design and Analysis using Verilog	ECOE-304

SEMESTER —VII (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	IC	Entrepreneurship & Start Ups	XXIC-XXX	3	0	0	3
2	PC	Microelectronics & VLSI Design	ECPC-401	3	1	0	3
3	PE	Program Elective –V	ECPE xxx	3	1	0	3
4		Program Elective –VI	ECPE xxx	3	1	0	3
5	OE	Open Elective-III	ECOE xxx	3	0	0	3
6	PC	Project-I	ECPC-402	0	0	4	2
7		Summer Training	ECPC-403	Six Weeks			1
8	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
9	NC	NSS /Club/Technical Societies	SWNC102	0	0	4	2*
Total							**18**

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COMMUNICATION AND SIGNAL PROCESSING			
Sr.No	**Course Category**	**Course Title**	**Course Code**
1	PE	Deep Learning	ECPE-401
2		Image Forensic	ECPE-402
3		Biomedical Signal Processing	ECPE-403
4		Cognitive Radio	ECPE-404
5		Audio Signal Processing/ Speech processing	ECPE-405
6		Cyber Security	ECPE-406
7		Optical Communication Networks	ECPE-407
DEVICES AND VLSI DESIGN			
1	PE	Biomedical electronics	ECPE-408
2		Bio-Sensors	ECPE-409
3		VLSI Testing and Verification	ECPE-410
4		RF Microelectronics	ECPE-411
5		Analog & Mixed Signal Design	ECPE-412
		DSP Architecture	ECPE-413
INTERNET OF THINGS			
1	PE	Advance Computer Networks	ECPE-414
2		Quantum Communication	ECPE-415
3		Wireless Security	ECPE-416
4		Multiple Access Technologies	ECPE-417
5		Pattern Recognition	ECPE-418
6		Sensors	ECPE-419
Open Electives			
1	OE	Sensors	ECOE-401
2		FSM Controllers	ECOE-401

SEMESTER —VIII (BATCH 2022, 2023 and onwards)

Sr.No	Course Category	Course Title	Course Code	Lecture(L)/ Tutorial(T)/ Practical(P) per week			Credits
				L	T	P	
1	IC	Professional Ethics & IPR	HSIR-xxx	3	0	0	3
2	PC	Microwave Theory & Devices	ECPC-404	3	1	0	3
3	PE	Program Elective –VII	ECPE xxx	3	1	0	3
4		Program Elective –VIII	ECPE xxx	3	1	0	3
5	OE	Open Elective-IV	ECOE xxx	3	0	0	3
6	PC	Microwave Lab	ECPC-405	0	0	2	2
7		Project –II	ECPC-406	0	0	4	3
8	NC	NCC/ Sports /Yoga	SWNC 101	0	0	4	2*
9	NC	NSS /Club/Technical Societies	SWNC102	0	0	4	2*
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COMMUNICATION AND SIGNAL PROCESSING			
Sr.No	**Course Category**	**Course Title**	**Course Code**
1	PE	Optical Networking and Switching	ECPE-420
2		Sonar System/Under water Communication	ECPE-421
3		Array Signal Processing	ECPE-422
4		Optical Signal Processing	ECPE-423
5		MIMO Systems	ECPE-424
6		Mathematics for Machine Learning	ECPE-425
7		Deep Learning for Advanced Communication Systems	ECPE-426
		Space Time Coding	ECPE-427
DEVICES AND VLSI DESIGN			
1	PE	Memory Testing	ECPE-428
2		MEMS	ECPE-429
3		Embedded System Security	ECPE-430
4		Mathematical Aspects of Biomedical System Design	ECPE-431
5		Advance Microprocessor & Microcontroller	ECPE-432
INTERNET OF THINGS			
1	PE	Quantum Computing	ECPE-433
2		6G N/W	ECPE-434
3		Cloud Computing	ECPE-435
4		Soft Computing & Expert Systems	ECPE-436
5		Wavelets	ECPE-437
Open Electives			
1	OE	Computer N/W & Cryptography	ECOE-403
2		Internet of Things	ECOE-404
3		Applications of Image Processing	ECOE-405

DIGITAL SIGNAL PROCESSING

Course Code	ECPC
Course Title	Digital Signal Processing
Number of Credits	3
Prerequisites (Course code)	Signals and Systems
Course Type	PC

Course Learning Objectives

To understand Discrete transforms, implementation of discrete time systems, design of FIR filters, design of IIR filters.

Course Content

UNIT I

THE Z-TRANSFORMS: Z- transform and its properties, poles and zeros, Inversion of Z-transform, One sided Z-transform and solution of differential equations. Analysis of LTI systems in Z-domain, causality, stability, Relationship between Z-transform and Fourier transform. Frequency selective filters; all pass filters, minimum-phase, maximum-phase and mixed-phase systems.

UNIT II

DFT AND FFT: Frequency domain sampling and DFT, Linear transformation, relationship to other transforms, properties of DFT, Linear filtering using DFT, Frequency analysis of signals using DFT, radix 2 & radix-4 FFT algorithms, Goertzel algorithm, Applications of FFT algorithm, computation of DFT of real sequences.

UNIT III

IMPLEMENTATION OF DISCRETE TIME SYSTEMS: Direct form, cascade form, frequency sampling and lattice structures for FIR systems. Direct forms, transposed form, cascade form parallel form. Lattice and lattice ladder structures for IIR systems. state space structures.

UNIT IV

DESIGN OF FILTERS: Characteristics of practical frequency selective filters. Filters design specifications peak pass band ripple, minimum stop band attenuation. Four types of FIR filters Design of FIR filters using windows. Kaiser window method comparison of design methods for FIR filters Gibbs phenomenon, design of FIR filters by frequency sampling method, design of optimum equiripple FIR filters, alternation theorem. Design of IIR filters from analog filters, Design by approximation of derivatives, Impulse invariance method bilinear transformation method characteristics of Butterworth, Chebyshev, and Elliptical analog filters and design of IIR filters, Frequency transformation.

Reference Books:

1. John G. Proakis, Digital Signal Processing, PHI
2. S. K. Mitra, Digital Signal Processing , TMH
3. Rabiner and Gold, Digital Signal Processing, PHI
4. Salivahan, Digital Signal Processing , TMH

Course outcomes

1. Understand discrete- time sequences and Z-transform.
2. Compute DFT and FFT of discrete time signals.
3. Design FIR and IIR filters using different techniques.
4. Design frequency selective filters.
5. Learn the DSP programming tools and use them for applications
6. Design and implement signal processing modules in DSPs

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX ANTENNA AND WAVE PROPAGATION

Prerequisites (Course code)	:	ECPC31

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description

Antenna and Wave propagation is the gateway for understanding all kinds of wireless communication for different applications. The evolution and basics of Antenna and Wave propagation technology followed by ability to identify antenna parameters of Linear wire antennas, Aperture type antennas, Antenna Arrays, Narrowband, Broadband and Frequency independent antennas forms the syllabus.

Course Content

UNIT I

Retarded vector and scalar potentials. Radiation and induction fields, Radiation from elementary and half wave dipole with different current distributions, Antenna parameters and definitions, Radiation pattern and gain, Antenna arrays and beamforming, Antenna impedance and matching

UNIT II

Monopole and Dipole antennas, Biconical Antennas, Loop antennas, Helical Antennas, Principle of pattern multiplication, Broadside arrays, Endfire arrays, Array pattern synthesis, Uniform Array, Binomial Array, Chebyshev Array, Yagi-Uda and Turnstile Antennas, Radiation from rectangular aperture, Horn antennas, Parabolic reflector antennas, Microstrip antennas, Printed antennas, Slot antennas

UNIT III

Broadband Antennas. The frequency independent concept: Rumsey's principle, Frequency independent planar log spiral antenna, Frequency independent conical spiral antenna and Log periodic antenna.
Different modes of propagation, Ground waves, Space waves, Surface waves and Tropospheric waves, Ionosphere, Wave propagation in the ionosphere, Critical frequency,

Maximum Usable Frequency (MUF), Skip distance, Virtual height, Radio noise of terrestrial and extra terrestrial origin. Multipath fading of radio waves.

UNIT IV

MIMO (Multiple-Input Multiple-Output) systems, Smart antennas, Metamaterial antennas, 5G and beyond: Antennas for next-generation wireless systems

Applications of Antenna and Wave Propagation in various sustainable technologies, case studies from the Indian knowledge system.

Reference Books:

1. John D. Kraus, Antennas, McGraw Hill. 4th Ed. 2010 , Mc Graw Hill
2. C. A Balanis Antenna theory Analysis & Design 3rd Ed. 2005 ,Wiley & Sons
3. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, PHI

Course Outcomes

At the end of the course student will be able to…

1. Develop an understanding of various Antenna Types and their families
2. Quantify the fields radiated by various types of antenna.
3. Understand the fundamentals and modes of wave propagation
4. Practising various antennas for real-life applications.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119
B.TECH 5TH SEMESTER
DSP Lab (ECLR-31)

1. (a) Generate square wave of frequency (input from keyboard); from its harmonics of sinusoidal components.
   (b) Use the pause function from MATLAB to demonstrate the effect of addition of harmonics to its fundamental frequency.
2. Find the inverse Z-transform of the following:

$$X(z)=\frac{\left(1-1.22346z^{-1}+z^{-2}\right)\left(1-0.437833z^{-1}+z^{-2}\right)\left(1+z^{-1}\right)}{\left(1-1.433509z^{-1}\right)\left(1-1.293601z^{-1}+0.556929z^{-2}\right)\left(1-0.612159z^{-1}\right)}$$

3. (a) Compute Circular convolution of x(n)= {1,2,1,0,2,1}; n >=0 and y(n)= {2,4,0,1,1,0}; n>=0
   (b) A signal sequence x (n) = {1, 1, 1} is applied to a system with an unknown impulse response h (n). The observed output is y(n)= {1,4,8,10,8,4,1}. Write a program to find h (n).
4. A linear phase, bandpass FIR filter is required to meet the following specification:

Passband	12-16 kHz
Transition width	2 kHz
Passband ripple	1 db
Stopband attenuation	45 db
Sampling Frequency	50 kHz

   Estimate the filter length and use the optimal method to determine the filter coefficient and hence plot the magnitude-frequency response. Compare the pass bands stopband ripples of the filter with the specified values.
5. Design an IIR filter with following specifications:

Lower passband	0-50 Hz
Upper passband	450-500 Hz
Stop band	200-300 Hz
Passband ripple	3 db
Stopband attenuation	20 db
Sampling frequency	1 kHz

6. Implement the above filters using SIMULINK and verify the performance.
7. Implement an FIR filter on the DSP kit by using the FDA tool and code composer studio.
8. Implement an IIR filter on the DSP kit by using the FDA tool and code composer studio.

HDL LAB

SUBJECT CODE: …………

List of Experiments:

1. Write a program to implement a 3:8 decoder.
2. Write a program to implement an 8:1 multiplexer and 1:8 demultiplexer.
3. Write a program to implement 4-bit addition/subtraction.
4. Write a program to implement a 4-bit comparator.
5. Write Verilog code for SR, D, JK, and T Flip flops.
6. Write a program to generate Mod- 10 up counter.
7. Write a program to generate the 1010 sequence detector. The overlapping patterns are allowed.
8. Write a program to perform serial to parallel and parallel to serial transfer of 4 bit binary number.
9. Write a program to design a 2-bit ALU containing 4 arithmetic & 4 logic operations.
10. Write a Verilog code to design a clock divider circuit that generates 1/2, 1/3rd and 1/4thclock from a given input clock. Port the design to FPGA and validate the functionality.

Course Outcomes: At the end of this course, students should be able to:

CO1: Write the Verilog programs to simulate Combinational circuits in Dataflow, Behavioral and Structural modelling.

CO2: Describe sequential circuits like flip flops and counters in Behavioral description and validate simulation waveforms.

CO3: debug and identify the errors in codes.

CO4: Synthesize Combinational and Sequential circuits on FPGA and test the hardware.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119

B.TECH 5TH SEMESTER
Transmission Lines & Antenna Lab (ECLR-32)

1. **To Study Attenuation in a Simulated Transmission Line.**
2. **To Study Delay using a pulse input Simulated Transmission Line.**
3. **To Study and measure the Actual Transmission Line characteristics.**
4. **To Study & measure the attenuation of Actual Transmission Line.**
5. **To Study and measure the input impedance of Actual Transmission Line.**
6. **To Study & measure the frequency characteristics of Actual Transmission Line.**
7. **To Study the fault localization in Actual Transmission Line.**
8. **To Study and measure the radiation patterns of dipole antennas.**
    a. **Study of simple dipole (λ/2) antenna.**
    b. **Study of simple dipole (λ/4) antenna.**
    c. **Study of Folded dipole (λ/2) antenna.**
9. **To Study and measure the radiation patterns of Yagi -Uda antennas.**
    a. **Study of Yagi-Uda 3 element antenna.**
    b. **Study of Yagi-Uda 5 element antenna.**
    c. **Study of Yagi-Uda 7 element antenna.**
10. **To Study and measure the radiation patterns of helical antenna.**

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Computer Networks

Pre-requisite: Basics of communication systems

L	T	P	Credits	Total contact hours
3	0	0	3	36

The objective of this course is to provide an understanding of theoretical aspects of computer networks, including the protocols involved in the exchange of information between communicating devices

UNIT I

Computer Network Topologies, Network Hardware, Network Software, OSI Model and TCP/IP protocol stack, ATM, Data communication fundamentals, wired physical layer, Wireless physical layer, and Physical layer based on telephone line. 9 hrs

UNIT II

Data Link layer design issues, Error detection & correction, Elementary Data Link protocols, Sliding Window Protocols, Example Data Link Protocols, Aloha Protocols, Wired MAC layer, IEEE 802.2: Logical Link control, Wireless MAC layer. 9hrs

UNIT III

Network layer services, Datagram and Virtual circuit services, Routing algorithms, Congestion control algorithms, Internetworking, Transport layer services, Elements of transport protocols, The Internet transport protocols: UDP & TCP. 9hrs

UNIT IV

Domain Name System, World Wide Web and HTTP, Electronic mail system, File Transfer protocol, Network security, Attacks on different network layers and their countermeasures. Use cases 9 hrs

Reference Books:

1. Tanenbaum A.S, "Computer Networks", Pearson, 4th ed., 2003.
2. Forouzan B.A, "Data Communications and Networking", Tata McGraw Hill, 4th ed. 2006.
3. Stallings W, "Data and Computer Communications", PHI, 9th ed., 2011.
4. Kurose & Ross K. W., "Computer Networking: A Top-Down Approach featuring the Internet", Pearson, 5th edition, 2010.

Course outcomes:

At the end of the course, the student will be able to:

CO1 Understand the computer network hardware and software.

CO2 Compare the OSI and TCP/IP protocol stacks.

CO3 Examine the protocols operating at different layers of network architecture.

CO4 Categorize the services offered by all layers of network's protocol stack.

CO5 Assess the cryptographic technique and Identify the sources of network security threats.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPC38 PROCESSOR DESIGN

Pre-requisite:

Course Code	ECPC38
Course Title	POCESSOR DESIGN
Number of Credits	03
Prerequisites (Course code)	ECPC22, Computer Arch.
Course Type	PC

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives

- To understand the architectures of popular processors and their area specific usage and advantages
- To learn the fundamentals of processor design
- To understand instruction level parallelism and multi-level pipelining
- To analyze Impact of workload, the degree of instruction-level parallelism, hardware parallelism , power consumption and technology on the efficiency of processors

UNIT I 8 hrs

CISC PROCESSOR DESIGN: Defining microprocessor, hardware flowchart, implementing from flowchart, exception, control store, microcode design.

UNIT II 10 hrs

RISC PROCESSOR DESIGN: Building datapath and controller, single cycle implementation, multi cycle implementation, pipelined implementation, exception and hazards handling. (Example: *DLX Processor*)

UNIT III 12 hrs

SUPERSCALAR PROCESSORS DESIGN: Superscalar organization, superscalar pipeline overview, VLSI implementation of dynamic pipelines, register renaming, reservation station, re-ordering buffers, branch predictor, and dynamic instruction scheduler etc.; simultaneous multi-threading (SMT) design. (Example: *Open SPARC T1*)

UNIT IV 12 hrs

MEMORY SYSTEM DESIGN. Application specific instruction set processor (ASIP) design. Dynamic reconfigurable processors (DRP). Impact of physical technology, trends in power consumption, low power techniques, low voltage techniques, clock distribution.

Reference Books:

1. Nick Tredennick, *Microprocessor Logic Design*, Digital Press, 1987
2. D.A. Patterson and J.L. Hennessy, *Computer Organization and Design*, Morgan Kaufman Pub., N. Delhi, 2005
3. JP Shen and MH Lipasti, *Modern Processor Design*, MC Graw Hill, Crowfords ville, 2005
4. Mike Johnson, *Superscalar Microprocessor Design*, Prentice Hall, Englewood Cliffs, NJ, 1991
5. J.L. Hennessy, and D.A. Patterson, *Computer Architecture: A quantitative approach*, Fifth Edition, Morgan Kaufman Publication, 2012
6. A. Chandrakasan and W J Bowhill, and F. Fox, *Design of High-Performance Microprocessor Circuits*, IEEE Press, 2001

Course Outcomes

At the end of the course, the student will be able to:

CO1: Design basic processor and analyse the fundamentals of processor architecture

CO2: Choose application specific processor

CO3: Optimize parallelism and multi-level pipelining for performance and efficiency

CO4: Understand the design of instruction set , memory and reconfigurable processor

Course Code	ECPC
Course Title	Wireless and Mobile Comm.
Number of Credits	3
Prerequisites (Course code)	
Course Type	PC

Subject : Wireless and Mobile Communication

Course Learning Objectives

Course will provide an in depth understanding of the principles, performance and evolution of wireless communication standards (2G to 6G)

Syllabus :

UNIT I

Cellular Communications : Introduction to Cellular Communications, Frequency reuse, Multiple Access, Technologies, Cellular Processes, GSM (SS7), Call Setup, Handover etc., Teletraffic Theory

Wireless Communications and Diversity: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.

UNIT II

Broadband Wireless Channel Modeling : WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading

CDMA : Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization.

UNIT III

OFDM: Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues

MIMO : Introduction to MIMO, MIMO Channel Capacity, SVD and Eigen modes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MRT, MIMO-OFDM.

UNIT IV

UWB (Ultrawide Band) : UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit Error Rate Performance of UWB

Evolution of Wireless Standards (2G-6G): GPRS, WCDMA, LTE/ WiMAX, Cognitive Radios, IEEE wireless standards. Spectrum Sharing Framework for 6G-enabled IoT.

Reference Books:

1. Andrea Goldsmith, Wireless Communications: Cambridge University Press.

2. Theodore Rappaport, Wireless Communications: Principles and Practice, Prentice Hall.

3. Ezio Biglieri, MIMO Wireless Communications — Cambridge University Press.

4. Aditya K. Jagannatham, Principles of Modern Wireless Communication Systems: Mc GrawHill Education Course outcomes

At the end of the course student will be able to

1. Synthesis and analyze wireless and mobile cellular communication systems over different stochastic fading channels

2. Understand advanced multiple access techniques

3. Learn diversity reception techniques

4. Explore the need of MIMO/ OFDM as the pivoting technology for capacity maximization

5. Analyse the evolution of different wireless standards (2G TO 5G stds.) And the need

6. Contribute and meet the dynamic requirements of telecom companies

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

Processors Lab

PRACTICALS

SEMESTER-V, B.TECH

ECLR-32

L	T	P	Credits	Total contact hours
0	0	2	1	14

List of Experiments

1. Arranging an Array of Bytes in Ascending /Descending Order.

2. Logic operations - Shift and rotate - Converting packed BCD to unpacked BCD, BCD to ASCII conversion.

3. String operations - Move block, Reverse string, String comparison, Length of string.

4. Find square root of a number & verify.

5. Generation of Sine, Triangular and Square wave using Interface with 8255 (PPI) and measurement of time period/frequency of sine, triangular and square wave.

6. Realize MOD-10 Up-Down Counter on 7-Segment display using Interface with 8255(PPI).

7. Interface Stepper Motor and controlling its RPM and direction of rotation.

8. ON/OFF control of SSR (Solid State Relay) using interface with 8255.

9. Interfacing of LM35/RTD temperature sensor with 8086 and display the temp value on LCD.

10. To interface traffic light system using 8086 & 8255.

EMBEDDED SYSTEM LAB

SUBJECT CODE: ………….

List of Experiments:

8051:

Interfacing of high-power devices to Micro-controller port lines, LED, relays.

Program to control a stepper motor in direction, speed and number of steps using 8051.

Implementation of Digital FIR Filter on 8051 Microcontroller

DAC interfacing and generation of the ramp wave

ADC triggering through timer (On Chip Timer)

LCD interfacing and displaying a string

Keyboard interfacing takes input from the keypad and display it on LCD

Interface a LED matrix and display a number on the matrix.

Interfacing 4x4 switch matrix with the microcontroller

Serial Communication between microcontroller and PC

ARM: LPC 2148 ARM 7 PROCESSOR

ARM programming in C language using KEIL IDE

Implement the lighting and winking LEDs of the ARM I/O port via programming.

Changing ARM state mode by using MRS/MMSR instruction and specify a start address of the text segment by using command line.

To read analog voltage and display its digital equivalent on LCD using ARM.

PIC: (PIC 16F877)

Reading matrix keypad (DK) using PIC.

AVR

Stepper Motor Control Using ATMEGA-16 Microcontroller

Temperature control using ATmega16

Course Outcomes: At the end of this course, students should be able to:

CO1. Identify the functionality of development boards to implement embedded applications.

CO2. Compile bug free assembly or C language programs for microcontrollers to a required task.

CO3. Design an electronic circuit for diverse I/O devices used in real time embedded applications.

CO4. Develop a product with all sub systems of functional requirements in optimal hardware and software components.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECLR-33
Machine learning Lab

L	T	P	Credits	Total contact hours
0	0	2	1	2

Brief Description:
This lab is regarding the design and development of Machine learning algorithms for classification/ recognition of the data. It is also for developing and modelling the real time software for classification/ recognition of the data.

Syllabus

1. Development of k- nearest neighbors algorithm for classification of image data.

2. Implementation of k-means clustering algorithm for binary and multi-class classification of image data.

3. Development of expectation maximization (EM) algorithm for binary classification of the data and find the probabilities, means and variances of the respective classes.

4. Implement principle component analysis (PCA) technique on 2-D data and determine the Eigen vectors. Plot PCA space of the first two PCs.

5. Implement linear discriminant analysis (LDA) technique for data classification.

6. Apply PCA and LDA techniques for dimensionality reduction of feature vector.

7. Study of the SVM technique using MATLAB/C and apply this technique for data classification.

8. Study of the different deep learning techniques using MATLAB/C.

9. Design a feature map of a given data using convolution and pooling operation of convolutional neural network (CNN).

10. Minor project.

Text Books / Reference

1. C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer

Course Outcomes: A student will develop different machine intelligence algorithms e.g. EM algorithm, SVM, Deep learning using MATLAB/C platform for real time application.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—SATELLITE COMMUNICATION

L	T	P	Credits	Total contact hours
3	-	-		42

Pre-requisite: A prior knowledge of analog and digital communications, and wave propagation is required.

Brief Description about the course

To understand the concepts and issues related to earth and space segments of satellite communication, analyse the performance of satellite links, and learn about the future space technologies.

Unit - I 8 hrs.

Overview of Space and Satellite

Some basic definitions, brief history, present status, and future trends of satellite communication. Types of orbits, active and passive satellites, synchronous satellite. Satellite frequency allocations and band spectrum. Technical characteristics of a satellite communication system, advantages of satellite communication.

Unit – II 14 hrs.

Communication Satellite Link Design

Satellite link attributes, satellite link analysis: path loss, losses in troposphere and atmosphere, modelling rain absorption, ionospheric losses, antenna misalignment loss. Concept of noise temperature, rain fading in terms of noise temperature, noise models, reducing noise effects in a receiving system. Carrier to noise ratio and G/T of a receiving system. Analog link and digital link design.

Unit - III 12 hrs.

Satellite Access

Types of multiple access, time division multiple access (TDMA), frequency division multiple access (FDMA), code division multiple access (CDMA), space division multiple access (SDMA). Demand assignment multiple access technique.

Unit – IV 8 hrs.

Satellites Applications

Applications of satellite in different areas: Remote-sensing satellite, Meteorological satellites, Global positioning satellite, scientific research satellites, communication satellites. Currently used satellites in defense services.

Text Books / Reference

1. Dennis Roddy "Satellite Communications," McGraw-Hill.
2. Tri T. Ha, "Digital Satellite Communications," Tata McGraw-Hill.
3. D. C. Agarwal and A. K. Maini, "Satellite Communications," Khanna Publications.
4. K. N. Raja Rao, "Fundamentals of Satellite Communications," PHI learning.
5. R. R. Gulati, "Composite Satellite and Cable Television," New Age International.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the configuration of the satellite communication system and satellite orbits.
CO2: Analyze the satellite link performance under different conditions.

CO3: Learn about various subsystems of earth station and satellite.

CO4: Comprehend the techniques for TMMA, FDMA, SDMA and challenges of space environment.

CO5: Analyze the requirements of satellites for different fields of applications.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Multicarrier Communication

Prerequisites (Course code)	**:**	**ECPC 28**		
L	T	P	Credits	Total contact hours
3	0	0	3	36-42

Course Title: Multicarrier Communication

Course Description: This course covers the principles and applications of multicarrier communication systems. Topics include discrete Fourier transform (DFT), fast Fourier transform (FFT), orthogonal frequency-division multiplexing (OFDM), multicarrier modulation (MCM), and their applications in wireless and wired communication systems.

UNIT 1: Introduction to Multicarrier Communication, Historical background and motivation for multicarrier communication, Overview of multicarrier communication systems, Discrete Fourier Transform (DFT) and its properties, Fourier Transform and Fast Fourier Transform (FFT), Fast Fourier Transform (FFT) algorithms and their implementation

UNIT 2: Orthogonal Frequency-Division Multiplexing (OFDM), Principles of OFDM, OFDM system model and block diagram, Implementation of OFDM transceiver, Guard interval and cyclic prefix, Frequency and time synchronization in OFDM

UNIT 3: Principles of MCM and its properties, Multi-Carrier FDMA, Multi-Carrier TDMA, Single carrier versus multi carrier, system Applications of Multicarrier Communication, Multicarrier techniques in wireless communication systems (e.g., LTE, WiMAX), Multicarrier techniques in wired communication systems (e.g., DSL), Advanced Topics in Multicarrier Communication, Multiuser MCM techniques (e.g., OFDMA), Carrier aggregation and its applications,

UNIT 4: MIMO techniques in multicarrier communication systems, Performance Analysis of Multicarrier Communication Systems, Error analysis and performance metrics, Interference analysis and mitigation techniques, Future Directions in Multicarrier Communication, 5G and beyond, Emerging trends in multicarrier communication research

Recommended Textbooks:

John Proakis , Massoud Salehi, Digital Communications, McGraw Hill, (2008).

"Orthogonal Frequency Division Multiplexing for Wireless Communications" by Jianhua Zhang and Hsiao-Hwa Chen

"Multicarrier Techniques for 4G Mobile Communications" by E. Biglieri, R. Calderbank, A. Constantinides, A. Goldsmith, and H. V. Poor

"Digital Communications: Fundamentals and Applications" by Bernard Sklar

.Simon Haykin, Digital Communication Systems, Wiley, (2013).

B.P Lathi , Zhi Ding, Modern Digital & Analog Communication Systems, Oxford

Publication, (2011).

Course outcomes:

At the end of the course, the students will be able to:

CO1: Understand the basic concepts of Multicarrier Communication

CO2: Understand the concepts of OFDM

CO3: Understand Multicarrier techniques in wired communication systems.

CO4: Analyze performance of Multicarrier Communication.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE-- OPTICAL WIRELESS COMMUNICATIONS

L	T	P	Credits	Total contact hours
3+1	-	-		40

Pre-requisite: Students need to have prior knowledge of basics of optics, analog and digital modulation schemes.

Brief Description about the course

It is envisaged that the course will provide the fundamentals and basic concepts of wireless channels and their effect on the wireless optical system (WOC) performance. The fundamental limitation of wireless optical communication systems arises from the environment through which light signal propagates. The modulation and demodulation techniques used in WOC systems are quite different from those used in optical fiber systems. In this course, the students would be exposed to atmospheric/free-space channel characterization, transmitter and receiver design and link feasibility.

Unit - I 8 hrs.

Introduction to optical wireless communication systems
Wireless access schemes, brief history of OWC, OWC/Radio Comparison, OWC Application Areas, OWC Challenges. Optical sources and detectors.

Unit – II 12 hrs.

Channel modelling
Indoor Optical Wireless Communication Channel: LOS Propagation Model, Non-LOS Propagation Model, Ceiling Bounce Model, Hayasaka–Ito Model, Model. Artificial Light Interference, Incandescent Lamp, Fluorescent Lamp Driven by Conventional Ballast, Fluorescent Lamp Model. Outdoor Channel: Atmospheric Channel Loss, Fog and Visibility, Beam Divergence, Optical and Window Loss, Pointing Loss. The Atmospheric Turbulence Models: Log-Normal Turbulence Model, Spatial Coherence in Weak Turbulence, Limit of Log-Normal Turbulence Model, the Gamma–Gamma Turbulence Model, the Negative Exponential Turbulence Model.

Unit - III 8 hrs.

Modulation techniques
Analogue Intensity Modulation, Digital Baseband Modulation Techniques, Pulse Position Modulation, Pulse Interval Modulation (PIM), Dual-Header PIM, Multilevel DPIM, Subcarrier Intensity Modulation, Orthogonal Frequency Division Multiplexing.

Unit – IV 8 hrs.

Detection techniques

Detection techniques: Photon counter, PIN/APD, PMT, coherent techniques viz., homodyne and heterodyne, bit error rate evaluation in presence of atmospheric turbulence, concept of adaptive threshold.
Role of OWC in 5G technology based systems.

Text Books / Reference

1. Z. Ghassemlooy, W. Popoola, S. Rajbhandari, Optical Wireless Communications, CRC Press, 2013.
2. L. C. Andrews, R. L. Phillips, Laser Beam Propagation through Random Media, SPIE Press, USA, 2005.
3. J. H. Franz, V. K. Jain, Optical Communications: Components and Systems, Narosa Publishing House, 2000.
4. D. Chadha, Terrestrial Wireless Optical Communication, Tata McGraw-Hill, 2012.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of wireless optical communications, optical sources and optical detectors.

CO2: Understand different modulation techniques and channel modelling techniques for OWC systems.

CO3: Apply different channel modelling techniques to observe their effect on OWC system performance.

CO4: Apply different channel modelling techniques to observe their effect on OWC system performance.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—SATELLITE COMMUNICATION

L	T	P	Credits	Total contact hours
3+1	-	-		30

Pre-requisite: A prior knowledge of analog and digital communications, and wave propagation is required.

Brief Description about the course

To understand the concepts and issues related to earth and space segments of satellite communication, analyse the performance of satellite links, and learn about the future space technologies.

Unit - I 6 hrs.

Overview of Space and Satellite

Some basic definitions, brief history, present status, and future trends of satellite communication. Types of orbits, active and passive satellites, synchronous satellite. Satellite frequency allocations and band spectrum. Technical characteristics of a satellite communication system, advantages of satellite communication.

Unit – II 9 hrs.

Communication Satellite Link Design

Satellite link attributes, satellite link analysis: path loss, losses in troposphere and atmosphere, modelling rain absorption, ionospheric losses, antenna misalignment loss. Concept of noise temperature, rain fading in terms of noise temperature, noise models, reducing noise effects in a receiving system. Carrier to noise ratio and G/T of a receiving system. Analog link and digital link design.

Unit - III 10 hrs.

Satellite Access

Types of multiple access, time division multiple access (TDMA), frequency division multiple access (FDMA), code division multiple access (CDMA), space division multiple access (SDMA). Demand assignment multiple access technique.

Unit – IV 5 hrs.

Satellites Applications

Applications of satellite in different areas: Remote-sensing satellite, Meteorological satellites, Global positioning satellite, scientific research satellites, communication satellites. Currently used satellites in defense services.

Text Books / Reference

1. Dennis Roddy "Satellite Communications," McGraw-Hill.
2. Tri T. Ha, "Digital Satellite Communications," Tata McGraw-Hill.
3. D. C. Agarwal and A. K. Maini, "Satellite Communications," Khanna Publications.
4. K. N. Raja Rao, "Fundamentals of Satellite Communications," PHI learning.
5. R. R. Gulati, "Composite Satellite and Cable Television," New Age International.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the configuration of the satellite communication system and satellite orbits.
CO2: Analyze the satellite link performance under different conditions.

CO3: Learn about various subsystems of earth station and satellite.

CO4: Comprehend the techniques for TMMA, FDMA, SDMA and challenges of space environment.

CO5: Analyze the requirements of satellites for different fields of applications.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—MIMO SYSTEMS

Pre-requisite: Students need prior knowledge of signals and systems, analog and digital communications, and information and coding schemes.

L	T	P	Credits	Total contact hours
3	-	-		30

Brief Description about the course

It is envisaged that the course will provide the fundamentals and basic concepts of SISO, MISO and MIMO wireless channels and their effect on the system performance.

Unit - I 5 hrs.

Introduction to multi antenna systems

A comparative analysis of single antenna and multi antenna systems. Space time wireless channels systems, Shannon's capacity formula, and Extended Capacity formula for MIMO channels. Capacity of SIMO- MISO channels. Capacity with Rice and Rayleigh channels for multi antenna systems.

Unit – II 10 hrs.

Introduction to Space time coding

Introduction, MIMO System and space time coding: Methodologies and diversity, Overview of diversity techniques of SIMO, MISO and MIMO systems. Space time block codes: Alamouti transmit technique, orthogonal space time block codes. Space time trellis codes: Encoding and decoding, Performance analysis and code design. Spatial multiplexing: V-Blast Algorithm, Space time coding with CSI knowledge, no CSI knowledge and partial CSI knowledge at the transmitter.

Unit - III 8 hrs.

Feedback Techniques and Antenna Selection in MIMO Systems

Feedback Techniques introduction, Limited feedback MIMO: System Description, channel quantization, quantized signal adaptation, Quantized signal Adaptation algorithms: Beam forming example, precoded orthogonal space time block codes, precoded spatial multiplexing. Antenna Selection: Implementing Antenna Selection: Criteria and Algorithms, Performance with non-idealities. Antenna selection with spatial correlation.

Unit – IV 7 hrs.

Real Time MIMO Signal Processing and General Issues

Implementation Concept, Channel Estimation, Adaptation to time variant channel, Data Reconstruction. Implementation, Complexity and system integration. Issues: Network planning: Introduction to network planning. Coverage and capacity enhancement methods. Base stations with downlink transmit diversity and beam forming, Deployment, Smart Antenna Planning Example.

Text Books / Reference

1. George Tsoulos; MIMO System Technology for wireless communications, Taylor & Francis Group.
2. Claude Oestges, Bruno Clerckx; MIMO wireless communications: from real world propagation to space time coding design, Elsevier
3. Volker Kuhn,Wreless Communication over MIMO Chaneels, John Wiley.

<u>Course Outcomes</u>: At the end of the course, students will be able to:

CO1: Understand the basics of wireless channels, SIMO, MISO, MIMO systems, and different diversity schemes.

CO2: Apply different diversity techniques to compute system performance.

CO3: Classify and analyse different antenna selection algorithms for MIMO systems.

CO4: Apply network planning to enhance coverage and capacity.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—OFDM SYSTEMS

Pre-requisite: Prior knowledge of signals and systems, analog and digital communications, and information and coding schemes is required.

L	T	P	Credits	Total contact hours
3	-	-		30

Brief Description about the course

The course will provide the fundamentals and basic concepts of fading channels, SISO and OFDM systems. The performance of these systems under AWGN and fading channels.

Unit - I 8 hrs.

Introduction
Mobile communication systems: past, present, and future. Multicarrier techniques for 4G systems, Mobile channel modelling: path loss, excess delay, power delay profile, root-mean-squared (RMS) delay spread, coherence bandwidth, Doppler spread, and coherence time. Categorization of fading channels: frequency non-selective and slowly fading channels, frequency selective fading channels, time – selective fading channels, frequency and time - selective fading channels. Methods for channel fading mitigation.

Unit – II 6 hrs.

Fundamentals of MCM/OFDM
Introduction to OFDM, origin of OFDM, use of discrete-time Fourier transform, insertion of cyclic prefix for current form of OFDM. OFDM system architecture, Discrete-time model of an OFDM system.

Unit - III 8 hrs.

OFDM Characteristics
Bit-error rate in AWGN channel, Bit-error rate of CPSK-based OFDM system in Rayleigh fading channels, Bit-error rate of DPSK-based OFDM system in Rayleigh fading channels, Bit-error rate in frequency selective and time selective Rayleigh fading channels.
Strengths and drawbacks of OFDM. Time and frequency synchronization, Time and frequency offset compensation.

Unit – IV 8 hrs.

Peak to Average Power Ratio (PAPR) Reduction
PAPR definition, statistical properties of PAPR, different techniques to reduce PAPR in OFDM. Applications of OFDM. Future research directions: MIMO-OFDM, Optical-OFDM.

Text Books / Reference

1. Man-On Pun, Michele Morelli, and C-C Jay Kuo; Multi-Carrier Techniques for Broadband Wireless Communications: A Signal Processing Perspective, Imperial College Press London.
2. Shinsuke Hara, Ramjee Prasad; Multi-Carrier Techniques for 4G Mobile Communications, Artech House Boston London.
3. Ahmad R. S. Bahai, Burton R. Saltzberg and Mustafa Ergen; Multi-Carrier Digital Communications: Theory and Applications of OFDM, Springer.
4. Richard van Nee, Ramjee Prasad; OFDM for Wireless Multimedia Communications, Artech House Boston London.
5. Marc Engels; Wireless OFDM Systems: How to make them work?, Kluwer Academic Publishers London.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of multicarrier techniques and effect of fading channels.

CO2: Apply discrete Fourier transform to design OFDM system and see the effect of cyclic prefix on it.

CO3: Analyze different characteristics of OFDM systems under different fading environments.

CO4: Apply different algorithms to compute PAPR analysis of OFDM system.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPC—COMMUNICATION ENGINEERING

L	T	P	Credits	Total contact hours
3	-	-		30

Pre-requisite: Prior knowledge of signals and systems, is required.

Brief Description about the course

The course will provide the fundamentals and basic concepts of different modulation schemes. The effect of AWG noise on these systems.

Unit - I 4 hrs.

Introduction
Analog and digital signals/sources and systems, deterministic and random signals, frequency allocations, block diagram of a communication system. Modulation, need for modulation.

Unit – II 8 hrs.
Amplitude Modulation Systems
Frequency translation, a method of frequency translation, recovery of base-band signal. Amplitude modulation (AM), Generation of AM waves, Demodulation of AM waves. Types of AM: DSBSC, SSB. Generation of DSBSC waves, coherent detection of DSBSC waves, generation of SSB waves and coherent detection of SSB waves. Comparison among AM, DSBSC, and SSBSC.

Unit - III 10 hrs.
Frequency Modulation Systems
Basic definitions: Phase modulation (PM) and Frequency Modulation (FM), Relationship between FM and PM, Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Transmission bandwidth of FM Wave - Generation of FM Waves, Detection of FM, Balanced Frequency discriminator, Zero crossing detector, Phase locked loop, Comparison of FM and AM.
Pulse analog modulations.

Unit – IV 9 hrs.

Noise
AM receivers, Signal-to-noise ratios (SNR), SNR for coherent reception with DSBSC modulation, SNR for coherent reception with SSB modulation. Noise in AM receivers using envelope detection.
FM receivers, noise in FM reception. Threshold effect in Angle Modulation System, Pre-emphasis and de-emphasis.
Applications of AM and FM in current radio communication systems.

Text Books / Reference

1. Simon Haykins , Communication Systems , Wiley & Sons , 4th Edition.

2. Herbert Taub, and Donald L. Schilling, Principles of Communication Systems, TMcGraw-Hill.

3. B.P. Lathi , Modern Digital and Analog Communications, Oxford.

4. George Kennedy and Bernard Davis, Electronics & Communication Systems.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand different modulation schemes.
CO2: Analyze power requirement of different waveforms of modulated signals.
CO3: Analyze different characteristics of receiver.
CO4: Compute the effect of noise by computing SNR in AM and FM receivers.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECOE—COMMUNICATION SYSTEMS

Pre-requisite: None.

L	T	P	Credits	Total contact hours
3	-	-		30

Brief Description about the course

The course will provide the fundamentals concepts of signals, Fourier Transform and Modulation and Demodulation schemes. The effect of noise on AM and FM receivers will also be discussed.

Unit - I 8 hrs.

Introduction
Signals: Continuous Signals, Discrete Signals, Digital Signals, Random Signals. Fourier Transform, Properties of Fourier Transform, Fourier Transforms of signals used in communications.

Unit – II 6 hrs.

Amplitude Modulation
Concept of Modulation, Amplitude modulation: Double-Sideband Suppressed Carrier, Double-Sideband Full Carrier, Single Sideband and vestigial sideband modulation; Demodulation: Carrier Recovery in AM, Coherent Demodulation, Envelope Detector, Square-Law Demodulator; Integrated Super heterodyne Receiver.

Unit - III 8 hrs.

Angle Modulation
Frequency Modulation, Phase Modulation, Narrow Band Angle Modulation, Wideband FM, Modulators, Demodulators. Sampling, Pulse amplitude modulation, Pulse width modulation, Pulse position modulation.
Brief introduction about Digital modulation.

Unit – IV 8 hrs.

Performance Analysis of Receivers under AWGN
Effects of Noise in Analog Modulation Systems. Case study of AM and FM Receivers. Analog and Digital Receiver performance in AWGN.

Text Books / Reference Books

1. S. Haykin, “Communication Systems,” John Wiley & Sons, 5th Ed., 2009.
2. B.P. Lathi and Z. Ding, “Modern Digital and Analog Communication Systems,” 4th Ed., Oxford University Press, 2009.
3. Louis E. Frenzel, “Principles of Electonic Communication Systems,” 3rd Ed., Tata McGraw-Hill, 2008.
4. Dennis Roddy and John Coolen, “Electronic Communications,” 4th Ed., Pearson, 2008.
5. J. G. Proakis and M. Salehi, “Fundamentals of Communication Systems,” Prentice Hall, 2004.
6. Leon W. Couch, Digital and Analog Communication Systems, 4th Ed., Macmillan Coll Div., 1993.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of signals and Fourier transforms.

CO2: Understand the basics of Amplitude and Frequency Modulation and demodulations.

CO3: Apply Fourier transform to get the spectrum of different modulated signals and decide the requirement of bandwidth.

CO4: Analyze the effect of noise in AM and FM receivers.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX: **Statistical Signal Processing**

Faculty: Dr. Hemant Sharma

Pre-requisite:

L	T	P	Credits	Total contact hours
3	0	0	3	36

i) Brief Description about the course

ii) **Unit - I**

Problem Formulation and Objective of Signal Detection and Signal Parameter Estimation in Discrete-Time Domain, classification of estimation and detection problems, Applications: Radar, image processing, speech, communications.

6 hrs.

Unit – II

Recap of calculus, linear algebra, Probability and stochastic processes, Review of Gaussian Variables and Processes spectral characteristics of signals and noise, Bias, Minimum Variance Unbiased Estimation (MVUE), Fisher Information Matrix, Cramer-Rao Lower Bound

8 hrs.

Unit - III

Linear Models, Finding MVU estimators via linear models Generalized Minimum Variance Unbiased Estimation, Rao Blackwell Lehman Sheffe theorem, Best Linear Unbiased Estimators (BLUE), Maximum Likelihood Estimation (MLE), Bayesian: Minimum mean square error (MMSE), Linear MMSE, Minimum absolute error, Minimum probability of error (MAP), Least Squares, Applications: image, radar, processing, speech, communications.

12 hrs.

Unit - IV

Hypothesis Test, Likelihood Ratio Test, Neyman-Pearson Theorem, Receiver Operating Characteristics, Minimum Probability of Error, Bayes Risk, Multiple Hypothesis Testing, Detection of Deterministic Signals: Matched Filter, Generalized Matched Filter, Detection of Random Signals: Estimator-Correlator, Linear Model, General Gaussian Detection Statistical.

10 hrs.

Text Books / Reference

1. S. M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, *Vol-I*, Prentice Hall PTR, 2009.
2. H. V. Poor, An Introduction to Signal Detection and Estimation, Springer, 2/e, 1998.
3. Harry L. Van Trees, Detection, Estimation and Modulation Theory" (Detection, Estimation and Modulation Theory, Part-I, John Wiley & Sons, 2002.

Course Outcomes

CO 1: Understanding of signal detection and estimation problems.

CO 2: Learning of the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators

CO 3: Understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.

CO 4: Possess fundamental grounding and sophistication needed to apply statistical signal processing to real world problems.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX CONTROL SYSTEM ENGINEERING

Pre-requisite: ECPC23 (Signals, Systems & Random Variables)

L	T	P	Credits	Total contact hours
3	-	-	3	40

Brief Description about the course:

The purpose of this course is to make the students understand control systems and its components, mathematical modelling, time response analysis, the root locus technique, frequency response analysis, stability and state variable analysis.

Unit - I 10hrs.

Introduction to Control Systems, Basic Control System Components, Concept of Feedback and its Impact on the Performance, Differential Equations of Physical Systems, Laplace Transforms, Transfer Function, Mathematical Modelling of Electrical, Mechanical, and Electro-mechanical Systems, Block Diagrams, Block Diagram Reduction Techniques, Signal Flow Graph, Mason's Gain Formula.

Unit – II 10hrs.

Standard test signals, Time Response Analysis of First and Second Order Systems, Steady State Analysis, Steady State Error, Static Error Constants, Stability, Routh-Hurwitz Theorem, Relative Stability Criteria. Root Locus Technique for Stability, Root Contours

Unit - III 8hrs.

Frequency Response Analysis of First and Second Order Systems, Polar plot, Gain Margin, Phase Margin, Nyquist Stability Criteria, Bode Plot, Determining Transfer Function from Bode Plot, Design of Compensators: Lead, Lag, Lead-lag

Unit – IV 10hrs.

Controllers: Proportional, Derivative, Integral, PI, PD and PID

State Space Analysis, State Variables, State Transition Matrix, Free Response, Forced Response, Concept of Controllability and Observability, Pole placement by state feedback.

Applications: Home Automation, Transportation Systems, Automobiles and Consumer Electronics

Text Books / Reference

1. ‘‘Modern Control Systems’ by R. C. Dorf, R. H. Bishop, Prentice Hall.
2. ‘Modern Control Engineering’ by Katsuhiko Ogata, Prentice Hall
3. ‘Control Systems, Principles and Design ‘by M. Gopal, McGraw Hill Education

Course Outcomes

CO1: Understand the control system and its components

CO2: Develop mathematical model of basic electrical mechanical systems

CO3: Determine the stability in time and frequency domain using various methods

CO4: Understand the impact of feedback on the performance of the control system

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECXXXX VERILOG HDL

Course Code	ECXXXX
Course Title	VERILOG HDL
Number of Credits	03
Prerequisites (Course code)	Digital Logic Design, Computer Architecture, Programming: Familiarity with programming concepts and syntax, Hardware Description Languages. Familiarity with HDL Simulation and Synthesis EDA Tools
Course Type	XX

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives
Learning Verilog HDL and using to design basic digital circuits
Designing complex arithmetic circuits and sequential circuits
Implementation of Verilog Design on FPGAs and their analyses.

UNIT I 10 hrs

INTRODUCTION TO VERILOG HDL Overview of Verilog HDL and its importance in digital circuit design, Basic syntax, data types, and operators in Verilog HDL, Verilog HDL design flow and simulation basics, Designing combinational circuits using Verilog HDL, Sequential Circuit Design using Verilog HDL
INTRODUCTION TO SEQUENTIAL CIRCUITS AND THEIR APPLICATIONS, Creating Flip-Flops and Latches using Verilog HDL, Designing Finite State Machines (FSMs) using Verilog HDL, Synthesis and optimization of sequential circuits using Verilog HDL

UNIT II 8 hrs

MODELING IN VERILOG HDL, Overview of Behavioral Modeling in Verilog HDL, Data flow and Structual Modelling, and Using Always block and conditional statements in Verilog HDL, Blocking and Non-Blocking Statements, Delay modeling and Timing Control, tasks and Functions , Creating testbenches for Verilog HDL design verification.

UNIT III 1 0 hrs

ADVANCED TOPICS IN VERILOG HDL, Hierarchical design and reusable modules, Parameterized Modules and Macros, Designing Memories and Arithmetic circuits in Verilog HDL, Designing Finite State Machines with Mealy and Moore Models, Verification process and types of simulation, Debugging and error tracing in Verilog HDL design

UNIT IV 14 hrs

DESIGN PROJECTS USING VERILOG HDL: Applying the knowledge gained in the course to design digital circuits in Verilog HDL , designing Verilog project from scratch, FPGA architecture, verification, and implementation of projects on FPGA and demonstrations.

Reference Books:

1. Samir Palnitkar , Verilog HDL: A Guide to Digital Design and Synthesis.
2. Frank Vahid and Roman Lysecky, Digital Design with RTL Design, Verilog and VHDL
3. Blaine Readler, Verilog by Example: A Concise Introduction for FPGA Design.
4. Pong P. Chu, FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version.
5. Zainalabedin Navabi, Verilog Digital System Design: Register Transfer Level Synthesis, Testbench, and Verification.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Learn Verilog HDL and apply it for simple and complex designs

CO2: Design datapath and controller for CPUs,

CO3: Understand various types of FPGAs, their architectures.

CO4: Use Vivado tool for Verilog designs and implement them on FPGA boards

CO5: Understand FPGA based design flow.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Digital IC Design

Pre-requisite: PHIC11 and PHIC13 (Semiconductor Physics), Electronic Devices and Circuits

L	T	P	Credits	Total contact hours
3	0	0	3	42

Brief Description of the Course:

Course Learning Objectives

To learn the digital integrated circuits design process.
To understand CMOS logic, and circuits and overcome power, delay and timing issues in digital ICs.

Course Content

UNIT-I **Hrs 12**
Overview of Digital Circuits, The MOSFET Threshold Voltage, The MOSFET I-V model, Subthreshold Conduction, MOSFET DC Analysis, IC Fabrication, , MOSFET Capacitances, Static Behavior of Inverter, Calculating Inverter Delay, Sizing Inverter for minimum delay, Sizing Inverter Chain for minimum delay, Inverter Power and Energy

UNIT-II **Hrs 10**
Layout, Design Rules, CAD tools, CMOS Logic Schematic & Layouts. CMOS Logic VTC and Delay Calculations, CMOS Logic Energy and Power, Ratioed Logic, Pass-Transistor Logic, Domino Logic , Signal Integrity Issues in Dynamic Logic, Sizing Logic Networks for minimum delay - Logical Effort

UNIT-III **Hrs 10**
Synchronous System Design, Static Latches and Registers - D, RS FF,CC, Dynamic Latches and Registers - PT, TSPC, pulse-based, Interconnect RLC and Delay Models, Minimzing Interconnect Delay - Buffer Insertion, Adder Design

UNIT-IV **Hrs 10**
Semiconductor Memory Architectures, CMOS ROM, Non-voltatile Memory - Flash Architecture 6T SRAM, Sense Amplifiers, Sense Amplifiers, Peripherals - Voltage references, Charge Pumps Peripherals - Address Decoders, DRAM, DRAM Sensing

Text Books / Reference

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic, *Digital Integrated Circuits: A*
2. *Design Perspective, Second Edition***,** Prentice Hall,
3. D. Hodges, H. Jackson and R. Saleh, *Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology, Third Edition,* McGraw-Hill, 2004.
4. S. Kang and Y. Leblebici, *CMOS Digital Integrated Circuits, Third Edition,* McGraw-Hill, 2003.
5. K. Bernstein *et al., High Speed CMOS Design Styles,* Kluwer, 1998.
6. N. Weste and K. Eshraghian, *Principles of CMOS VLSI Design, 2nd Ed.,* Addison Wesley, 1993.

Course Outcomes:

Students who successfully complete this course will:

CO1: Have an idea about basic CMOS circuits in VLSI
CO2: Know the performance metrics of IC design.
CO3: Design integrated circuits using CMOS logic.
CO4: be able to understand power, delay and timing issues in digital ICs.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Advanced MOS Devices

Pre-requisite: Semiconductor Physics, Electronic Devices and Circuits

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description of the Course:

Course Learning Objectives
To enable the students to understand the basics of advanced MOS Devices for high-performance and low-power analog & digital Applications.

Course Content

UNIT I 6Hrs

MOSFETs: Review of MOS Characteristics, Short channel MOSFET, Subthreshold Characteristics, Equivalent Circuits, Short channel Effects. Models for Long Channel and Short Channel MOSFETs.

UNIT II 8 Hrs

History of Multigate MOSFETs, Multigate MOSFET Physics, Classical physics, Natural length and short-channel effects, Current drive, Corner effect, Quantum effects. Nanoscale Devices.

UNIT III 8 Hrs

High-speed semiconductor Devices: Basic concepts, Requirements for high-speed circuits, devices and materials, Classification and properties of semiconductor devices, Ternary compound semiconductors and their applications, MESFET, Hetero junctions and HEMT.

UNIT IV 8 Hrs

BSIM CMG A Compact Model for Multi-Gate Transistors: BSIM CMG Model, Surface Potential Model, I-V Model, C-V Model, Modeling Physical Effects of Real Devices, Quantum Mechanical Effects (QME), Short-channel Effects (SCE).

Text Books / Reference

1. Y. Taur and T. K. Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press
2. MS Tyagi, Introduction to Semiconductor Materials & Devices, John-Wiley
3. B. G. Streetman, Solid state electronic Devices, Pearson India Education
4. Jean-Pierre Colinge, FinFETs and Other Multi-Gate Transistors, Springer
5. Simon M. Sze, High-Speed Semiconductor Devices, Wiley.

Course Outcomes:

At the end of the course student will be able to

CO1: Inculcate the in-depth knowledge of long and short channel MOS Devices

CO2: understand the recent advancement in multigate and nanoscale devices that are in production.

CO3: Understand the basics of high speed and hetero junction devices

CO4: Understand generation of compact models for advance semiconductor devices

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Semiconductor photonic devices

Pre-requisite: PHIC 11 & PHIC 13

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

To provide a detailed exposure to the physics, principle of operation, design, and characteristics of widely used semiconductor optoelectronic devices for applications in Optoelectronics, Optical Communication and Optical Signal Processing. Specific emphasis will be on semiconductor optical amplifiers, sources, detectors, and modulators, which also lead to the realization of Photonic Integrated Circuits.

Unit - I

Review of Semiconductor Physics for Photonics: The Band Structure; The Density of States $\rho(k)$ and $\rho(E)$; Density of States in a Quantum Well Structure; Carrier Concentration & Fermi Level; Quasi Fermi Levels. Semiconductor Optoelectronic Materials; Heterostructures, Strained-Layers, Bandgap Engineering; Heterostructure p-n junctions; Schottky Junctions & Ohmic Contact.

Interaction of Photons with Electrons and Holes in a Semiconductor; Optical Joint Density of States, Probabilities of Emission and Absorption; Rates of Emission and Absorption; Absorption Spectrum of Semiconductors. Amplification by Stimulated Emission; The Semiconductor Optical Amplifier.

Unit – II

Absorption Spectrum of Quantum Well Structures; Quantum Confined Stark Effect and Franz-Keldysh Effect. Electro-absorption Modulator: Principle of Operation and Device Configuration.

Injection Electroluminescence. Light Emitting Diode: Device Structure and Output Characteristics, Modulation Bandwidth, Materials for LED, and Applications. White light LEDs.

Unit – III

General Characteristics of Photodetectors, Impulse Response of Photodetectors. Photoconductors, Semiconductor Photo-Diodes, PIN diodes and APDs: Structure, Materials, Characteristics, and Device Performance. Photo-Transistors. Array Photodetectors: Quantum well infrared photodetectors (QWIP), CCD; Photomultiplier Tube, Thermal detectors, Solar cell.

Unit – IV

Laser Diodes: Device Structure and Output Characteristics, Single Frequency Lasers; DFB, DBR Lasers, VCSEL, Quantum Well Laser, Quantum Cascade Laser, Micro-cavity lasers. Modulation of Laser Diodes, Practical Laser Diodes & Handling.

Photonic Integrated Circuits - PICs; some examples and design issues.

Reference Books:

1. Saleh, Bahaa EA, and Malvin Carl Teich. *Fundamentals of photonics*. john Wiley & sons, 2019.

2. Ghione, Giovanni. *Semiconductor devices for high-speed optoelectronics*. Vol. 116. Cambridge: Cambridge University Press, 2009.

3. Bhattacharya, Pallab. *Semiconductor optoelectronic devices*. Prentice-Hall, Inc., 1997.

4. Singh, Jasprit. *Semiconductor optoelectronics: physics and technology*. Vol. 2. New York: McGraw-Hill, 1995.

5. Keiser, Gerd. *Optical fiber communications*. Vol. 2. New York: McGraw-Hill, 2000.

6. Yariv, Amnon, and Pochi Yeh. *Photonics: optical electronics in modern communications*. Oxford university press, 2007.

Course Outcomes:

At the end of the course student will be able to…

CO 1 understand Interaction of Photons with Electrons and Holes in a Semiconductor; Rates of Emission and Absorption; Amplification by Stimulated Emission; The Page 2 Semiconductor Optical Amplifier etc.

CO 2 learn fundamentals of Laser Diodes: Device Structure and Output Characteristics, Single Frequency Lasers; DFB, DBR Lasers, VCSEL, Quantum Well and Quantum Cascade Laser, Micro-cavity lasers.

CO 3 understand Modulation of Laser Diodes, Practical Laser Diodes & Handling.

CO 4 learn Photodetectors: General Characteristics of Photodetectors, Impulse Response, Photoconductors, PIN, APD, Array Detectors, CCD, Solar Cell. Photonic Integrated Circuits.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Optical Wireless Techniques for IoT & 5G/6G systems

Pre-requisite: ECPC28, ECPC 25

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Optical Wireless Communications (OWC) has become a promising technology for supporting high-data-rate 5G communication and the massive connectivity of IoT. This course broadly covers the four important aspects of OWC systems: (a) the fundamental principles of OWC, (b) devices and systems, (c) modulation techniques and (d) channel models and system performance analysis.

Unit - I

Introduction – Optical Wireless Communication Systems: Existing wireless systems, OWC/Radio Comparison, Potential OWC Application Areas.

Optical Sources: LEDs and Lasers (Internal and External Quantum Efficiency, Power and Luminesce Efficiency and modulation bandwidth).

Detectors: PIN and APD detectors, photo detection techniques, photo detection noise.

Unit – II

Indoor Optical Wireless Communication Channel modelling: LOS propagation model, Non-LOS propagation model, Interference from other light sources.

Outdoor Optical Wireless Communication Channel modelling: Atmospheric channel loss, Beam divergence, Pointing loss, Different atmospheric turbulence models.

Underwater Optical Wireless Communication Channel modelling: Absorption, scattering, turbulence, multipath interference, physical obstruction and background noise.

Unit – III

Modulation schemes: Digital baseband modulation techniques like PPM, PAM, PIM etc., Multi-Carrier Modulation (OFDM) for OWC, Color shift keying, NOMA etc.

System performance analysis - indoor OWC: Effect of ambient light sources on indoor OWC performance, link performance for multipath propagation

Unit – IV

System performance analysis - outdoor OWC: FSO link performance under effect of atmospheric turbulence, atmospheric turbulence induced penalty and mitigation strategies.

Use cases and simulation exercises: Indoor OWC link, O-OFDM and CSK-modulation schemes, Wifi-Lifi coexistence, V2V Communications

Reference Books:

1. Keiser, Gerd. *Optical communications essentials*. McGraw-Hill Education, 2003.

2. Ghassemlooy, Zabih, Luis Nero Alves, Stanislav Zvanovec, and Mohammad-Ali Khalighi, eds. *Visible light communications: theory and applications*. CRC press, 2017.

3. Ghassemlooy, Zabih, Wasiu Popoola, and Sujan Rajbhandari. *Optical wireless communications: system and channel modelling with Matlab®*. CRC press, 2019.

4. Majumdar, Arun K., and Jennifer C. Ricklin, eds. *Free-space laser communications: principles and advances*. Vol. 2. Springer Science & Business Media, 2010.

Course Outcomes:

At the end of the course student will be able to…

CO 1 identify types of light sources, their structures and optical characteristics

CO 2 understand process of photo-detection, including different type of encountered noise in photo-detection and statistics of optical detection process

CO 3 learn characteristics of channel impulse response for indoor, outdoor and underwater to enable efficient design of OWC systems.

CO 4 select and implement appropriate modulation technique for indoor/outdoor OWC in terms of power and bandwidth efficiency.

CO 5 learn different OWC use cases in context of 5G/6G and IoT systems including design considerations and performance parameters

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX IOT & IT'S APPLICATION (V, PE)

Pre-requisite: …….

L	T	P	Credits	Total contact hours
3	0	0	3	40

i) Brief Description about the course

This course will be focused on introducing students to new trends, applications, system architecture and challenges involved in developing/deploying internet of things systems using real industrial use cases. A number of systems are getting connected to the internet, where the sensor data is analyzed to monitor and control the systems. Correctly analyzing data coming from multiple sensors, choosing the right hardware given the power and performance tradeoff, hardware heterogeneity and security are some of the challenges involved in developing IoT applications. The course will cover the real-world use cases of IoT applications and hands-on projects related to those based on the concepts learned in the class.

ii) Unit - I 8 hrs.

Overview of IoT systems: New trends, applications and challenges. IoT system architecture: Edge devices, sensors, actuators, gateway, data storage and historical analysis in the cloud.

Unit – II 10 hrs.

Sensor networks: Wireless sensor networks (WSN), localization, node mobility, energy efficiency in WSN. Communication: MQTT, wifi, Bluetooth, RFID, LoRa, LoRaWAN, communication security.

Unit - III 12 hrs.

IoT system optimization: Low power devices, energy harvesting, performance trade-off, choosing the right hardware. Applications of deep learning in IoT: Introduction to deep learning, camera-based IoT applications in healthcare, retail and agriculture.

Unit – IV 10 hrs.

Smart and connected devices: Raspberry-pi, Google home mini, Alexa, Echo show Industrial use cases: smart home and agriculture. Case studies: Smart cities, transportation, manufacturing, automobile.

Text Books / Reference

1. Peter Waher "Learning Internet of Things"
2. S. Misra, C. Roy, and A. Mukherjee, 2020 "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press.
3. Simone Cirani, Gianluigi Ferrari, Marco Picone, and Luca Veltri, "Internet of Things: Architectures, Protocols and Standards" WILEY.
4. Andrew Minteer, "Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices".

Course Outcomes

On completion of this course, you should be able to:

CO 1 Understand the IoT system and its applications.

CO 2 Understand IoT system optimization and communication.

CO 3 Analyze the applications of deep learning in IoT.

CO 4 Apply the IoT knowledge in smart cities, transportation and manufacturing.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX WIRELESS SENSOR NETWORKS

Pre-requisite: Computer networks

L	T	P	Credits	Total contact hours
3	-	-	3	45

Course objective:

- To understand the fundamentals of wireless sensor networks and their application to critical real-time scenarios.
- To study the various protocols at different layers and their differences from traditional protocols.
- To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Unit - I

Introduction to ad-hoc/sensor networks: Key definitions of ad-hoc/sensor networks, unique constraints, and challenges, advantages of ad-hoc/ sensor networks, driving applications, issues in ad-hoc wireless networks, issues in the design of sensor network, sensor network architecture, data dissemination, and gathering.

Unit – II

MAC Protocols: issues in designing MAC protocols for ad-hoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor networks, S-MAC.
Routing Protocols: issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power-aware routing protocols.

Unit - III

Topology control, clustering, Time-synchronization: clocks and the synchronization problem, time synchronization in WSNs, Time synchronization protocols, Localization: Ranging techniques, Ranging-based localization, Event-driven localization.

Unit – IV

Power management: Local power management aspects, Dynamic power management,
Security: challenges of security in WSNs, IEEE 802.15.4 Standard, and ZigBee.

Text Books / Reference:

1. C. Siva Ram Murthy, and B.S. Manoj, “Ad-hoc Wireless networks,” Pearson publication, 2008.
2. W. Dargie, and C. Poellabauer, “Fundamentals of wireless sensor networks: Theory and practice,” John Wiley and Sons Ltd., 2010.
3. I. F. Akylidiz, and M.C. Vuran, “Wireless sensor networks,” John Wiley and Sons Ltd., 2010.
4. Feng Zhao and Leonides Guibas, “Wireless sensor networks,” Elsevier publication, 2004.

Course Outcomes

CO 1: Technical knowledge in building a WSN network.

CO 2: Analysis of various critical parameters in deploying a WSN.

CO 3: Analysis of specific protocols related to medium access control, routing, and time-synchronization problems.

CO 4: Comprehend the study of localization strategies, power management, and security aspects.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPEXX DATA STRUCTURE

Pre-requisite:

Course Code	ECPEXX
Course Title	DATA STRUCTURE
Number of Credits	3
Prerequisites (Course code)	C++
Course Type	PE

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives
To learn the efficient storage mechanisms of data for an easy access and implementation of various basic and advanced data structures. Also, understand the various techniques for representation of the data in the real world with the concepts of protection and management of data.

UNIT I 8hrs

INTRODUCTION: Understanding pointers, usage of pointers, arithmetic on pointers, memory allocation, memory management functions and operators, debugging pointers dangling pointers, memory leaks, etc. The Concept of data type, definition and brief description of various data structures, data structures versus data types, operations on data structures, algorithm complexity, Big O notation.

UNIT II 12hrs

LINKED LIST, STACKS AND QUEUES: Linear and multi-dimensional arrays and their representation, operations on arrays, sparse matrices and their storage. Linear linked list, operations on linear linked list, doubly linked list, operations on doubly linked list, application of linked lists. Sequential and linked representations, operations on stacks, application of stacks such as parenthesis checker, evaluation of postfix expressions, conversion from infix to postfix representation, implementing recursive functions. Sequential representation of queue, linear queue, circular queue, operations on linear and circular queue, linked representation of a queue and operations on it, deque, priority queue, applications of queues.

UNIT III 12hrs

TREE AND HEAP: Basic terminology, sequential and linked representations of trees, traversing a binary tree using recursive and non-recursive procedures, inserting a node, deleting a node, brief introduction to threaded binary trees, AVL trees and B-trees.

Representing a heap in memory, operations on heaps, application of heap in implementing priority queue and heap sort algorithm.

UNIT IV 10hrs

GRAPHS, SORTING AND SEARCHING: Basic terminology of Graphs, representation of graphs (adjacency matrix, adjacency list), traversal of a graph (breadth-first search and depth-first search), and applications of graphs. Comparing direct address tables with hash tables, hash functions, concept of collision and its resolution using open addressing and separate chaining, double hashing, rehashing. Searching an element using linear search and binary search techniques, Sorting arrays using bubble sort, selection sort, insertion sort, quick sort, merge sort, heap sort, shell sort and radix sort, complexities of searching & sorting algorithms.
Case study: Advance data structure, Dynamic Graphs, Dynamic Optimality, including geometric data structures, like a map, and temporal data structures, as in storage that happens over a time series.

Reference Books:

1. Sartaj Sahni, Data Structures, Algorithms and Applications in C++, Tata McGraw Hill.
2. Tenenbaum, Augenstein, & Langsam, Data Structures using C and C++, Prentice Hall of India.
3. R. S. Salaria, Data Structures & Algorithms Using C++, Khanna Book Publishing Co. (P) Ltd.
4. Seymour Lipschutz, Data Structures, Schaum's Outline Series, Tata McGraw Hill
5. Kruse, Data Structures & Program Design, Prentice Hall of India.
6. R. S. Salaria, Test Your Skills in Data Structures

Course outcomes

At the end of the course, student will be able to:

CO1: Understand the efficient storage mechanisms of data for an easy access. Design and implementation of various basic and advanced data structures.

CO2: Comprehend various techniques for representation of the data in the real world.

CO3: Develop application using data structures. Understand the concept of protection and management of data.

CO4: Implement various techniques for efficient storage and access of data.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—OFDM SYSTEMS

Pre-requisite: Prior knowledge of signals and systems, analog and digital communications, and information and coding schemes is required.

L	T	P	Credits	Total contact hours
3	-	-		30

Brief Description about the course

The course will provide the fundamentals and basic concepts of fading channels, SISO and OFDM systems. The performance of these systems under AWGN and fading channels.

Unit - I 8 hrs.

Introduction

Mobile communication systems: past, present, and future. Multicarrier techniques for 4G systems, Mobile channel modelling: path loss, excess delay, power delay profile, root-mean-squared (RMS) delay spread, coherence bandwidth, Doppler spread, and coherence time. Categorization of fading channels: frequency non-selective and slowly fading channels, frequency selective fading channels, time – selective fading channels, frequency and time - selective fading channels. Methods for channel fading mitigation.

Unit – II 6 hrs.

Fundamentals of MCM/OFDM

Introduction to OFDM, origin of OFDM, use of discrete-time Fourier transform, insertion of cyclic prefix for current form of OFDM. OFDM system architecture, Discrete-time model of an OFDM system.

Unit - III 8 hrs.

OFDM Characteristics

Bit-error rate in AWGN channel, Bit-error rate of CPSK-based OFDM system in Rayleigh fading channels, Bit-error rate of DPSK-based OFDM system in Rayleigh fading channels, Bit-error rate in frequency selective and time selective Rayleigh fading channels.

Strengths and drawbacks of OFDM. Time and frequency synchronization, Time and frequency offset compensation.

Unit – IV 8 hrs.

Peak to Average Power Ratio (PAPR) Reduction

PAPR definition, statistical properties of PAPR, different techniques to reduce PAPR in OFDM.

Applications and case study of OFDM System. Future research directions: MIMO-OFDM, Optical-OFDM.

Text Books / Reference

1. Man-On Pun, Michele Morelli, and C-C Jay Kuo; Multi-Carrier Techniques for Broadband Wireless Communications: A Signal Processing Perspective, Imperial College Press London.
2. Shinsuke Hara, Ramjee Prasad; Multi-Carrier Techniques for 4G Mobile Communications, Artech House Boston London.
3. Ahmad R. S. Bahai, Burton R. Saltzberg and Mustafa Ergen; Multi-Carrier Digital Communications: Theory and Applications of OFDM, Springer.
4. Richard van Nee, Ramjee Prasad; OFDM for Wireless Multimedia Communications, Artech House Boston London.
5. Marc Engels; Wireless OFDM Systems: How to make them work?, Kluwer Academic Publishers London.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of multicarrier techniques and effect of fading channels.

CO2: Apply discrete Fourier transform to design OFDM system and see the effect of cyclic prefix on it.

CO3: Analyze different characteristics of OFDM systems under different fading environments.

CO4: Apply different algorithms to compute PAPR analysis of OFDM system.

ADAPTIVE SIGNAL PROCESSING

Course Code	ECPE
Course Title	Adaptive Signal Processing
Number of Credits	3
Prerequisites (Course code)	
Course Type	PE

UNIT-I

Linear prediction Direct form linear prediction filtering. Normal equations for linear prediction filtering. Levinson algorithm. Linear prediction lattice filtering.

UNIT-II

Digital Wiener filtering Wiener smoothing and prediction filters. Application of Wiener smoothing to noise cancelling. Application of Wiener prediction filters. Constrained, linear MMSE filtering. Minimum variance beam forming.

Least mean squares adaptive filter LMS adaptive algorithm. Properties of LMS adaptive filter. Normalized forms. Finite precision effects. Adaptive beam forming.

UNIT-III

Orthogonalized adaptive filters Frequency domain adaptive filters. Adaptive lattice filters

Least squares adaptive filters Godard algorithm. Lattice.

UNIT-IV

Other adaptive filtering techniques Neural networks and multi-layer perceptrons. Adaptive IIR filtering. The constant modulus algorithm.

Blind adaptive filtering Cost functions. Higher-order statistics. Examples.

REFERENCES

1. Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition, 2001.
2. Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley, 2003.
3. Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
4. Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall, 1985.
5. Theory and Design of Adaptive Filters, J. Triechler, C. Johnson Prentice-Hall, 1995.
6. Adaptive Filtering: Algorithms and Practical Implementation, P. Diniz, Kluwer, 1997.
7. Adaptive Filters: Structures, Algorithms and Applications, M. Honig, D. Messerschmitt, Kluwer, 1984.
8. Adaptive Signal Processing, L. Sibul, Ed., IEEE Press, 1987.
9. Time Series Analysis: Forecasting and Control, G. Box, G. Jenkins, Holden- Day, 1976.

10. Time Series, D. Brillinger, Holt-Reinhart-Wilson, 1975.
11. Signal Processing: The Modern Approach, J. Candy, McGraw Hill, 1988.
12. Signal Processing: The Model Based Approach, J. Candy, McGraw Hill, 1986.
13. Digital Spectral Analysis, S. Marple, Prentice-Hall, 1987.
14. Blind Deconvolution, S. Haykin, ed., Prentice-Hall, 1994.

Course outcomes:

At the end of the course, student will be able to

1. Understand the concept of linear prediction and its applications.
2. Understand the Weiner filtering methods and LMS adaptive filtering techniques and their applications
3. Understand the concept of frequency domain adaptive filtering.
4. Understand and analyze the higher statistics based filtering methods.
5. Analyze various adaptive filtering techniques and apply the appropriate technique suitable for a particular application.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX ESTIMATION AND DETECTION

Prerequisites (Course code)	:	

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description

Estimation and detection are at the heart of most signal processing systems which are central in Information and Communication Technology (ICT) and also provide the foundation for data analytics in a broader context (e.g. finance, medicine, industry, earth science). This course gives an introduction to the basic techniques for estimation and detection with focus on signals. cessing aspects.

Course Content

UNIT I

Overview of estimation and detection problems, Mathematical background and notation, Basic concepts and terminology

Review of probability theory, Random variables and their properties, Probability density functions and cumulative distribution functions, Joint, conditional, and marginal distributions

UNIT II

Point estimation: maximum likelihood estimation, method of moments, Interval estimation: confidence intervals, hypothesis testing, Properties of estimators: bias, consistency, efficiency

Least squares estimation, Bayesian estimation, Minimum mean square error (MMSE) estimation, Maximum a posteriori (MAP) estimation

UNIT III

Detection Theory: Binary hypothesis testing, Signal detection in noise, Receiver Operating Characteristic (ROC) curves, Neyman-Pearson criterion, Optimal detectors: matched filter, likelihood ratio test

Estimation and Detection in Gaussian Noise, Gaussian random variables and processes, Linear estimation: Wiener filter, linear regression, Optimal detection in Gaussian noise

UNIT IV

Introduction to Signal Processing Applications: Radar and sonar systems, Communications systems, Image and video processing, Sensor networks

Applications of Estimation and detection in various sustainable technologies, case studies from the Indian knowledge system.

Reference Books:

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory," Pearson.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory," Pearson.
3. H. V. Poor, "An Introduction to Signal Detection and Estimation," Springer.
4. H. L. Van Trees, Detection, Estimation and Modulation Theory, Parts 1 and 2, John Wiley Inter-Science.
5. E. L. Lehman, Testing Statistical Hypothesis, John Wiley.
6. Mourad Barkat, Signal Detection and Estimation, Second Edition, Artech House

Course Outcomes:

At the end of the course, students will be able to:

CO1: Analyze the estimator properties such as Bias, Efficiency, Linearity and CR bound.

CO2: Use classical estimation techniques such as MLE and LS for estimation of parameters.

CO3: Apply Bayesian estimation approaches in various applications.

CO4: Comprehend methods of detection of signals with known and unknown parameters and apply them to real engineering problems.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Introduction to Computational Electromagnetics and its applications

Pre-requisite: ECPC 25

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

The course covers the mathematical formulation of the following methods: Integral Equations Methods (and their solution by the Method of Moments), the Finite Element Method, and the Finite Difference Time Domain method. These methods are illustrated by their use in solving scattering problems and antenna radiation/impedance calculation problems.

Unit - I

Review of vector calculus, electromagnetic fields, and an overview of computational electromagnetics.

Unit - II

Surface integral equations in 2D, Green's functions, solving surface integral equations by method of moments (MoM), Solving volume integral equations by method of moments.

Finite difference methods (FDM): Central/forward/backward differences, solving Poisson equations on a rectangular domain.

Unit – III

Finite Element Method (FEM): Introduction to finite element methods (FEM), Finite element method (FEM) in 1D, Finite element method (FEM) in 2D.

Finite Difference Time Domain Method (FDTD): Finite difference time domain (FDTD) method: introduction, materials and boundary conditions, perfectly matched layers.

Unit – IV

Applications of CEM: inverse problems and antenna radiation problems, antenna radiation problems and hybrid methods.

Reference Books:

1. Peterson, Andrew F., Scott L. Ray, Raj Mittra, *Computational methods for electromagnetics*. Vol. 351. New York: IEEE press, 1998.

2. Balanis, Constantine A. *Advanced engineering electromagnetics*. John Wiley & Sons, 2012.

3. Chew, Weng Cho. *Waves and fields in inhomogenous media*. Vol. 16. John Wiley & Sons, 1999.

4. Volakis, John Leonidas, John L. Volakis, Arindam Chatterjee, and Leo C. Kempel. *Finite element method for electromagnetics*. Universities Press, 1998.

Course Outcomes:

At the end of the course student will be able to…

CO 1 understand various methods used to solve complex electromagnetic engineering problems.

CO 2 learn fundamentals of Method of moments (MoM).

CO 3 understand basics of Finite element method (FEM) & Finite Difference method (FDM).

CO 4 understand basics of Finite difference time domain (FDTD) method.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPEXX EMBEDDED SYSTEMS FUNDAMENTALS

L	T	P	Credits	Total contact hours
3	0	0	3	42

Pre-requisite: Computer Organization and Processors.

Brief Description about the course

This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems, in tune with the requirements of Industry. The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

UNIT-1: Introduction to Embedded Systems: Embedded systems Overview. Processor in the System, Other Hardware Units. Software Embedded into a System. Embedded System – On-Chip (SOC).
Processor and Memory Organization: Structural Units in a Processor, Processor Selection for an Embedded System, Memory Devices, Memory Selection for an Embedded Systems, Interfacing Processors, Memories and Input Output Devices **10 hrs**

UNIT-II: Introduction to ARM Processors: Introduction to ARM processors, Evolution of ARM processors, ARM Processor cores and CPU cores.
Device Drivers and Interrupts Servicing Mechanics: Device Drivers, Parallel Port and Serial Port Device Drives in a System, Device Drovers for Internal Programmable Timing Devices, Interrupt Servicing Mechanism. **10 hrs**

UNIT-III: Embedded Systems Interfacing: I/O Devices. Timer and Counting Devices. Serial Peripheral Interface (SPI), Inter-Integrated Circuit, RS-232, Universal Serial Bus, CAN, IrDA, Bluetooth, PCI and AMBA bus protocols. Computer Parallel Communication between the Networked I/O. Advanced I/O Buses **12 hrs**

UNIT-IV: Hardware-Software Co-Design in an Embedded System: Embedded System Project Management. Embedded System Design and Co-Design issues in System Development Process.
Design Cycle in the Development Phase for an Embedded System: Use of Target Systems, Use of Software Tools for Development of an Embedded System, Hardware Tests, Issues in Embedded System Design.
Applications: Flashing of LEDS using Shift Register, Interfacing stepper motor, Interfacing temperature sensor, Interfacing ADC. **12 hrs**

Text Books/ References:

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications, Elsevier, Third Edition, 2014.
2. Santanu Chattopadhya, Embedded System Design, Second Edition, PHI, 2013.
3. T. Noergaard, "Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers", Elsevier Pvt. Ltd. Publications, 2005.
4. F. Vahid and T. D. Givargis, "Embedded system Design: A Unified Hardware/Software Introduction", John Wily & Sons Inc, 2002.
5. P. Marwedel, "Embedded System Design", Science Publishers, 2007.
6. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", TMH.

Course Outcomes:

At the end of this course, students will be able to:

CO1 Understand the processor and memory organization.

CO2 Learn different types of I/O Devices, timer and counting devices.

CO3 Understand the exception, interrupts and interrupt handling schemes

CO4 Understand the importance of Hardware-Software Co-design in an Embedded System.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Analog IC Design

Pre-requisite: Semiconductor Physics, EDC, Analog Electronics

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description of the Course:

Course objectives: (1) To learn the basics of CMOS amplifier design (2) To develop the skills to design an analog VLSI circuit for a given specification.

Course Content

Unit - I Hrs 10

Basic MOS Device Physics: General Considerations, MOS I/V Characteristics, Second Order effects, MOS small signal Model, NMOS versus PMOS devices, single stage amplifiers-common source amplifiers with different types of loads, source follower, common gate amplifiers.

Unit – II Hrs 10

Cascode stage, choice of device models, Differential amplifiers-analysis of single-ended and differential output amplifiers, common mode response, differential pair with MOS load, gilbert cells, Frequency response of amplifiers

Unit - III Hrs 10

Current Mirrors: Current sources and sinks, basic current mirrors, cascode current mirror, analysis of current mirrors, CMOS bandgap references: Supply independent biasing, temperature independent references, PTAT and CTAT current generation, constant Gm biasing, speed and noise issues.

Unit – IV Hrs 10

CMOS Operational Amplifiers: Performance parameters, one-stage and two-stage Op Amps, gain boosting, input range limitations, slew rate, Stability and Frequency Compensation.

Text Books / Reference

1. B. Razavi, *Design of Analog CMOS Integrated Circuits*, MH.
2. P R Gray and R G Meyer, *Analysis and Design of Analog Integrated Circuits*, 5th Edition, Wiley, 2009.
3. P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, Second Edition, OUP.

Course Outcomes: At the end of the course student will be able to

1. draw the small signal equivalent diagram of an analog circuit and analyse its performance.
2. design basic amplifiers, current mirrors, differential amplifiers, bandgap reference and op-amp circuits for a given specification.
3. analyse the frequency response of the different configurations of an amplifier.
4. understand the feedback topologies involved in the amplifier design.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Analog IC Design

Pre-requisite: Semiconductor Physics, EDC, Analog Electronics

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description of the Course:

Course objectives: (1) To learn the basics of CMOS amplifier design (2) To develop the skills to design an analog VLSI circuit for a given specification.

Course Content

Unit - I Hrs 10

Basic MOS Device Physics: General Considerations, MOS I/V Characteristics, Second Order effects, MOS small signal Model, NMOS versus PMOS devices, single stage amplifiers-common source amplifiers with different types of loads, source follower, common gate amplifiers.

Unit – II Hrs 10

Cascode stage, choice of device models, Differential amplifiers-analysis of single-ended and differential output amplifiers, common mode response, differential pair with MOS load, gilbert cells, Frequency response of amplifiers

Unit - III Hrs 10

Current Mirrors: Current sources and sinks, basic current mirrors, cascode current mirror, analysis of current mirrors, CMOS bandgap references: Supply independent biasing, temperature independent references, PTAT and CTAT current generation, constant Gm biasing, speed and noise issues.

Unit – IV Hrs 10

CMOS Operational Amplifiers: Performance parameters, one-stage and two-stage Op Amps, gain boosting, input range limitations, slew rate, Stability and Frequency Compensation.

Text Books / Reference

1. B. Razavi, *Design of Analog CMOS Integrated Circuits*, MH.
2. P R Gray and R G Meyer, *Analysis and Design of Analog Integrated Circuits*, 5th Edition, Wiley, 2009.
3. P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, Second Edition, OUP.

Course Outcomes: At the end of the course student will be able to

1. draw the small signal equivalent diagram of an analog circuit and analyse its performance.
2. design basic amplifiers, current mirrors, differential amplifiers, bandgap reference and op-amp circuits for a given specification.
3. analyse the frequency response of the different configurations of an amplifier.
4. understand the feedback topologies involved in the amplifier design.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPEXX ADVANCED MICROCONTROLLER ARCHITECTURE

Pre-requisite:

Course Code	ECPEXX
Course Title	ADVANCED MICROCONTROLLER ARCHITECTURE
Number of Credits	03
Prerequisites (Course code)	
Course Type	PE

L	T	P	Credits	Total contact hours
3	0		0	42

Course Objectives

Provide an opportunity to the students to learn ARM architecture, instruction set and programming. ARM is very popular for portable applications because of its high performance with low power consumption. Students will learn architecture, assembly language and C programming for ARM microcontroller in this course.

UNIT I 10hrs

ARM INTRODUCTION: Types of computer Architectures, ISA's and ARM, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Embedded System Software and Hardware.

ARM ARCHITECTURE AND PIPELINE STRUCTURE: The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, ARM 3 stage Pipeline, ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution, Stack implementation in ARM, Endianness, condition codes. Processor core Vs CPU core, ARM7TDMI Interface signals.

NIT II 10hrs

ARM7TDMI ASSEMBLY LANGUAGE INSTRUCTIONS AND PROGRAMMING: Different Types of Instructions, ARM Instruction set, data processing instructions. Shift Operations, shift Operations using RS lower byte, Immediate value encoding. Data processing Instructions. Addressing modes with examples. Instruction Timing, Swap Instructions, Swap Register related Instructions, Loading Constants. Program Control Flow, Control Flow Instructions, B & BL instructions, BX instruction. Interrupts and Exceptions, Exception Handlers, Reset Handling. Aborts, software Interrupt Instruction, undefined instruction exception. Interrupt Latency, Multiply Instructions,. Thumb state, Thumb Programmers model, Thumb Implementation, Thumb

Applications. Thumb Instructions, Interrupt processing. Interrupt Handling schemes, Examples of Interrupt Handlers, Co-processor instructions.

UNIT III 10hrs

EMBEDDED C PROGRAMMING FOR ARM: ARM Development Environment Embedded Software, Overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bit-fields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC.
CACHE AND MEMORY MANAGEMENT AND PROTECTION: Memory Technologies, Hierarchical Memory Organization, Virtual Memory. Cache Memory, Mapping Functions. Cache Design, Unified or split cache, multiple level of caches, ARM cache features. Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU). Physical Vs Virtual Memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM).

UNIT IV 12hrs

ARM PERIPHERALS AND VERSIONS: AMBA Overview, Typical AMBA Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. Overview of ARM Versions: ARMv5, ARMv6, ARM v7 (Cortex family R: Real time A: Application and M: Microcontroller), ARM big.LITTLE Technology, ARMv8.
Case study: Designing new Architecture for Sustainable Computing. Smart Microcontroller Architecture for the Internet of Things.

Reference Books:

1. M. A. Mazidi, ARM Assembly Language Programming & Architecture, Kindle edition
2. William Hohl, Christopher Hinds, Arm Assembly Language, Fundamentals and Techniques, CRC Press, 2nd edition.
3. Andrew N. Sloss, Dominic Symes, Chris Wright, Arm System Developer's Guide, Designing and Optimizing Software, Elsevier
4. Steve Furber, Arm System-on-chip Architecture, Pearson publication, 2nd Edition
5. Lyla Das, Embedded Systems, Pearson publication

Course outcomes
At the end of the course, student will be able to:
CO1: Explain the architecture and programming model of ARM 7TDMI
CO2: Learn and analyze assembly language programs for ARM microcontroller
CO3: Develop an Embedded C language program for interfacing I/O devices with ARM microcontroller and use it
CO4: Exemplify the memory management system of ARM and different versions of ARM. Design an ARM-based system to solve real-life challenges.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECOEXX NANOELECTRONICS

L	T	P	Credits	Total contact hours
3	0	0	3	42

Pre-requisite: Semiconductor basics and MOS devices.

Brief Description about the course

The objective of this course is to familiarize students with nanoelectronics and nanoscale structures and electron transport phenomenon in semiconductors and nanostructures. The course also covers introduction to 2D materials & 2D based nano devices and their applications in current scenario.

UNIT I: Introduction to nanoelectronics: From classical electronics to nanoelectronics. Electrons in traditional low-dimensional structures: Electrons in quantum wells, Electrons in quantum wires, Electrons in quantum dots. Materials for nanoelectronics: semiconductors, carbon nanomaterials nanotubes. Introduction to particles and waves, Classical particles, Classical waves, Wave-particle duality. **10 hrs**

UNIT II: Electrons in low-dimensional structures: electrons in quantum wells, electrons in quantum wires, electrons in quantum dots.
Introduction to Wave mechanics, Schrodinger wave equation, Atoms and atomic orbitals, Crystal lattices: Bonding in crystals, Electron energy bands, Semiconductor heterostructures, Inorganic-organic heterostructures, Carbon nanomaterials: nanotubes and fullerenes **12 hrs**

UNIT III: Introduction to growth and fabrication of nanostructures: Nanolithography, etching. Techniques for characterization of nanostructures. Spontaneous formation and ordering of nanostructures. Electron transport in semiconductors and nanostructures. Time and length scales of the electrons in solids. Density of states of electrons in nanostructures. Electron transport in nanostructures. **12 hrs**

UNIT IV: Nanoelectronic devices. Resonant-tunnelling diodes. Field-effect transistors. Single-electron-transfer devices. Quantum- dot cellular automata.
Recent 2D materials-based nano-devices (CNTFET, MTJs, SPINFET etc.) and their applications. 10 hrs

Text Books/ References:

1. S. Datta, "Lessons from Nanoelectronics: A New Perspective on Transport (Lessons from Nanoscience: A Lecture Notes Series)", World Scientific, 2012.
2. V. Mitin, V. Kochelap, and M. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2008.
3. C. P. Poole and F. J. Owens, "Introduction to nanotechnology", John Wiley & Sons, 2003.
4. C. Dupas, P. Houdy, M. Lahmani Nanoscience: Nanotechnologies and Nanophysics, Springer, 2004.
5. Akhlesh Lakhtakia, Nanometer structures: theory, Modelling, and simulation, ASME Press, 2004.
6. S. E. Lyshevski, Nano- and micro-electromechanical systems fundamentals of nano and microengineering, 2nd Edition, CRC Press, 2004.
7. http://idol.union.edu/~malekis/ESC24/ESC24MainPage/NanoMainPage.htm
8. http://mrsec.wisc.edu/edetc/index.html
9. www.nanohub.org (Supriyo Datta and Mark Ludstrom lectures)
10. Research articles from Springer, IEEE, Wiley, ACS, RSC, etc.

Course Outcomes:

At the end of this course, students will be able to:

CO1 Acquire fundamentals knowledge of nanoelectronics.

CO2 Learn about different fabrication techniques for nanostructures.

CO2 Gain knowledge on different nanoelectronic devices and their applications.

CO3 Discover different 2D materials based nanodevices (MTJs, CNTFETs, SPINFET, etc.) and their applications.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPEXX ASICs & FPGAs

Pre-requisite:

Course Code	ECPEXX
Course Title	ASICs & FPGAs
Number of Credits	3
Prerequisites (Course code)	Digital Design, HDL
Course Type	PE

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives

This course enables students to gain practical design methodologies for developing applications for FPGAs and ASICs. Students will learn the fundamentals for FPGA and ASIC design through software coding techniques in VHDL, and develop the skills necessary to solve critical digital design problems efficiently. Using commercial CAD tools, students will learn how to implement RTL VHDL designs, verify their application through simulation, and optimize performance by exploiting parallelism in their architecture.

UNIT I 8hrs

OVERVIEW OF ASIC AND PLD: Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices : ROMs and EPROMs – PLA – PAL. Gate Arrays – CPLDs and FPGAs

UNIT II 12hrs

ASIC PHYSICAL DESIGN: System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning - placement – Routing : global routing - detailed routing - special routing - circuit extraction – DRC

UNIT III 12hrs

LOGIC SYNTHESIS, SIMULATION AND TESTING: Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation.

UNIT IV 12hrs

FPGA: Field Programmable gate arrays- Logic blocks, routing architecture, Design flow technology - mapping for FPGAs, Xilinx XC4000 - ALTERA's FLEX 8000/10000, ACTEL's ACT-1,2,3 and their speed performance Case studies: Altera MAX 5000 and 7000 - Altera MAX 9000 – Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs

SOC DESIGN: Design Methodologies – Processes and Flows - Embedded software development for SOC – Techniques for SOC Testing – Configurable SOC – Hardware / Software codesign Case studies: Digital camera, Bluetooth radio / modem, SDRAM and USB.

Case study: Advancement in FPGA, ASIC architectures towards sustainable computing.

Reference Books:

1. M. J. S. Smith, Application Specific Integrated Circuits, Addison -Wesley Longman Inc., 1997
2. S. Trimberger, Field Programmable Gate Array Technology, Edr, Kluwer Academic Publications, 1994.
3. John V. Oldfield, Richard C Dore, Field Programmable Gate Arrays, Wiley Publications, 1995.
4. P. K. Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall, 1994.
5. Parag. K. Lala, Digital System Design using Programmable Logic Devices, BSP, 2003.
6. S. Brown, R. Francis, J. Rose, Z. Vransic, Field Programmable Gate Array, Kluwer Pubin, 1992.
7. J. Old Field, R. Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, 1995
8. Farzad Nekoogar and Faranak Nekoogar, from ASICs to SOCs: A Practical Approach, Prentice Hall PTR, 2003.
9. Wayne Wolf, FPGA-Based System Design, Prentice Hall PTR, 2004.
10. R. Rajsuman, System-on-a-Chip Design, and Test. Santa Clara, CA: Artech House Publishers, 2000.
11. F. Nekoogar, Timing Verification of Application-Specific Integrated Circuits (ASICs). Prentice Hall PTR, 1999.

Course outcomes

At the end of the course, student will be able to:

CO1: Understand the basic strategies for hardware design using VHDL and understand the building blocks that are available to digital designers.

CO2: Differentiate VHDL code for hardware simulation and synthesis, use commercial CAD tools to synthesize and simulate RTL VHDL designs.

CO3: Write RTL VHDL designs that exploit parallel processing architectures, apply design flow methodologies & optimization techniques for a given problem

CO4: Analyze and solve timing-related problems based on synthesis timing reports, demonstrate a working RTL design with all aspects in the projects

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Cryptography

Pre-requisite: none

L	T	P	Credits	Total contact hours
3	0	0	3	37

Course Learning Objectives

The objective of this course is to familiarize the students with cryptography and its applications. Topics will include historical cryptography, encryption, authentication, public key cryptography and key distribution.

Course Content

UNIT I

FUNDAMENTAL OF CRYPTOGRAPHY: Introduction to security, classification of security attacks, security mechanisms and services, Historical Ciphers, Shannon's perfect security, Symmetric key encryption: stream ciphers: RC4, Block ciphers: DES, 3DES, AES, IDEA, Modes of operation, Symmetric-Key Distribution, Public Key Encryption Algorithms: RSA, elliptic curve cryptography, Primality Testing and Factoring, Public key distribution, Public Key Infrastructure. Attacks on symmetric key and asymmetric key ciphers. 10hrs

UNIT II

AUTHENTICATION: Attacks on Public Key Schemes, Signature Scheme, MAC and Hash Functions, properties and requirements of digital signatures, MAC and HASH, Kerberos, Entity authentication: weak Authentication, Challenge-Response identification (strong authentication).

9 hrs

UNIT III

KEY DISTRIBUTION: Key management, D-H key exchange algorithm, attacks on D-H algorithm, Elliptic curve cryptography (ECC) 9 hrs

UNIT IV

PRACTICAL APPLICATIONS: E-MAIL security, PKI, SSL/TLS, HTTPS, IPV6 and IPSEC, Proxies and Firewalls, Wireless network security, Overview of light weight cryptography, Case Studies on Cryptography and security: Single Sign On(SSO), Secure Inter-branch Payment Transactions, Secret Splitting, Secure Multiparty Calculation. 9 hrs

TEXT BOOKS:

1. Douglas Stinson, "Cryptography Theory and Practice", 2nd Edition, Chapman & Hall/CRC.
2. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
3. W. Stallings, "Cryptography and Network Security", Pearson Education.

Course outcomes

At the end of the course, the students will be able to:

CO1 Understand the concept and need of cryptography.
CO2 Implement and design symmetric and asymmetric key algorithms.
CO3 Implement various key distribution and authentication techniques.
CO4 Comprehend and analyze cryptographic primitives in real time applications.
CO5 Analyze security challenges in wireless networks and its preventive measures.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Data Science

Pre-requisite: …….

L	T	P	Credits	Total contact hours
3	0	0	3	40

i) Brief Description about the course

a. Introduce R/ phython as a programming language
b. Introduce the mathematical foundations required for data science
c. Introduce the first level data science algorithms
d. Introduce a data analytics problem solving framework

ii) Unit - I

Course philosophy and introduction to R and python
Linear algebra for data science: Algebraic view and Geometric view - vectors, matrices, product of matrix & vector, rank, null space, distance, projections, eigenvalue decomposition

Unit – II

Statistics: descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates, Optimization

Unit - III
Simple linear regression and verifying assumptions used in linear regression. Multivariate linear regression, model assessment, assessing importance of different variables, subset selection

Unit – IV
Classification using logistic regression, Classification using kNN and k-means clustering. Application in biometric system, digit recognition, character recognition, biomedical images etc.

Text Books / Reference

1. Data science from scratch - First principles with Python, Joel Grus, OâReily, 2015
2. Machine Learning, Tom Mitchell, McGrawhill, 1997
3. Machine Learning Refined: Foundations, Algorithms, and Applications, Jeremy Watt, Reza Borhani, Aggelos K. Katsaggelos, Cambridge University Press, 2nd Edition, 2020

Course Outcomes

CO 1 Describe a flow process for data science problems (Remembering)

CO 2 Develop R codes for data science solutions (Application)

CO 3 Correlate results to the solution approach followed (Analysis)

CO 4 Assess the solution approach (Evaluation) and construct use cases to validate approach and identify modifications required (Creating)

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX IMAGE PROCESSING

Pre-requisite: Digital communication

L	T	P	Credits	Total contact hours
3			3	42

Brief Description about the course:

Image processing is a rapidly growing field that deals with the use of digital images to various fields of life including medical, automation, etc. This course provides an in-depth introduction to the fundamental concepts, techniques, and tools used in image processing. The course covers the topics such as image acquisition, image processing, image compression, steganography, and digital watermarking. Students will learn how to apply these techniques to identify image tampering, detect forged images, and authenticate the origin of digital images.

Course Learning Objectives

The student should be able to understand and apply the various concepts of Digital Image Processing.

Course Contents

UNIT I (10L)

Introduction: The Origin of Digital Image Processing, Problems and Applications, Fundamental steps in image processing, Components of an image processing system. Transforms and their properties. Two Dimensional DFT, DCT. Hadamard, Slant, Haar and KL, Transforms and their properties

Image Perception: Image models, sampling & quantization, neighbors of a pixel, connectivity, labeling of connected components.

UNIT- II (10L)

Intensity Transformation and Spatial Filtering: Basic intensity transformation functions, Histogram processing, spatial filters, homomorphic filtering, generation of spatial marks. Fuzzy techniques for Intensity Transformation and Spatial Filtering.

Image Restoration and Reconstruction: "Noise models, Restoration in the presence of Noise only, Frequency domain filtering, Inverse filtering, Wiener filtering, Geometric mean filtering. Image reconstruction from projections.

Image Compression: Redundancy models, error free compression, Lossy compression, Some basic compression methods, Image compression standards.

UNIT-III (6L)

Color Image Processing: Color Models, Pseudocolor Image Processing, Bacics of full color image processing, color transformations, segmentation, smoothing and sharpening, Noise in color Images. VMF,VDF,etc.
Morphological Image Processing: Erosion, Dialation, Opening, Closing, Some basic morphological algorithms, Gray scale morphology.

UNIT-IV (10L)+6L

Image Segmentation: Detection of Discontinuity, Edge detection, Boundary detection, Thresholding, Regional oriented segmentation uses of motion in segmentation.
Representation and Description: Representation, Regional descriptors, Boundary descriptors, Image analysis, Pattern and their classes, Decision theoretical methods, Structural methods, Interpretation.
Copy paste attacks, its challenges and identification.
Noise removal from images depending on its nature.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, 3rd Edition, 2016.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson 2002.
3. Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2000.
5. Hany Farid, ‘Photo Forensics’ The MIT Press, 2016.

Course outcomes

At the end of the course student will be able to:
CO1: Understand and apply the Image filtering, Restoration, segmentation, etc.
CO2: Apply the vector approach to handle the color images.
CO3: Apply the ‘Morphological operation’ for various applications.
CO4: Develop the understanding about digital image forensics.

Electronics and Communication Engineering
ECPE….: Wireless Technologies

Pre-requisite:
Communication Engineering
Digital modulation

L	T	P	Credits	Contact hours
3	0	0	3	40

About the Course

This course provides the basic understanding of wireless LAN standards, 5G and 6G wireless networks. Key enabling technologies of 5G and 6G wireless networks are analyzed. New applications and services are explored.

Course Contents:

Unit – I (8)
Wireless Communication**:** Evolution- 1G to 5G, overview of wireless channel, cellular concept, 4G, LTE, LTE-LTE-A, Architecture, 3GPP specifications, Capabilities,

Unit – II (9)
Wireless LAN fundamentals, IBSS, BSS, ESS, IEEE 802.11 standards, CSMA/CA, PCF, WLAN design considerations
Bluetooth, RFID-types, UWB, and their applications
Security and privacy in WLANS

Unit-III (11)
5G networks: New Radio (NR), SA, NSA, NOMA, 5G Technologies- small cells, massive MIMO, beam formation, mmWaves, 5G applications- eMBB, URLLC, mMTC, D2D communications, V2X communications;
Use cases in IoT

Unit – IV (12)
6G- network architecture, basic building blocks, 6G research activities, visible light communication, energy harvesting, intelligent reflecting surface, wireless powered communication networks, Time Switching, Applications in IoT services

Text Books:

1. R. Vannithamby and S. Talwar, *Towards 5G: Applications, Requirements and Candidate Technologies.*, John Willey & Sons, West Sussex, 2017.
2. Martin Maier, Amin Ebrahim Zadeh," Towards 6G: A New Era of Convergence, Wiley-IEEE Press
3. Paulo Sergio Rufino Henrique, Ramjee Prasad, *6G: The Road to the Future Wireless Technologies 2030* River Publishers Series,
4. Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basics of WLANS, 5G, and 6G wireless networks
2. To evaluate the performance of wireless technologies in varied channel conditions
3. To design the 5G and 6G networks
4. To develop 5G and 6G powered applications and services

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Advanced Mobile Communication

Prerequisites (Course code)	**:**	**ECPC 34**		
L	T	P	Credits	Total contact hours
3	0	0	3	3

Course Title: Advanced Mobile Communication

Course Description: This course covers advanced topics in mobile communication systems. Topics include wireless channel modeling, advanced multiple access techniques, advanced topics in mobile communication, and their applications in 4G, 5G and beyond systems.

UNIT-I

Overview of mobile communication systems, Evolution of mobile communication systems, Review of wireless channels, Background and quick review of wireless channels: propagation losses, multipath propagation, time- variant channels, 4G and 5G system architecture and protocols.

UNIT-II

Non orthogonal multiple access:

Non orthogonal multiple access: Introduction to NOMA, Performance analysis of NOMA in uplink and downlink, imperfectness in NOMA, spectral efficiency and energy efficiency, state of the art in NOMA. Advantages and disadvantages of NOMA, MIMO-NOMA, Cooperative NOMA

Unit-III

D2D Communication: Introduction of D2D communication, state of the art, Limitations and research issues in D2D Communication, Different applications of D2D communication in 5G

Unit-IV

Millimeter and THz wave communication:

Introduction, state of the art, security issues, Standardization, Limitations and research issues in mm and THz wave communication.

REFERENCES:

1. Theodore S Rappaport- “Wireless Communications- Principles And Practice,” (Review of wireless propagation models).

2. Lingyang Song , Dusit Niyato, Zhu Han, Ekram Hossain-“ Wireless Device-to-Device Communications and Networks”, Cambridge University Press.

3. Chen Xu, Lingyang Song, and Zhu Han,- “Resource Management for Device-to-Device Underlay Communication”, Springer Publishing Company.

4. Kao-Cheng Huang Zhaocheng Wang-“Millimeter Wave Communication Systems”, John Wiley & Sons.

5. Recent literature on 5G and 6G technologies.

Course outcomes:

At the end of the course, the students will be able to:

CO1: Understand the 5G and 4G architecture and protocols

CO2: Evaluate the performance of NOMA systems.

CO3: Find research issues in D2D communication.

CO4: Find the research issues in Millimeter and THz wave communication.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECOE—COMMUNICATION SYSTEMS

Pre-requisite: None.

L	T	P	Credits	Total contact hours
3	-	-		42

Brief Description about the course

The course will provide the fundamentals concepts of signals, Fourier Transform and Modulation and Demodulation schemes. The effect of noise on AM and FM receivers will also be discussed.

Unit - I 9 hrs.

Introduction
Signals: Continuous Signals, Discrete Signals, Digital Signals, Random Signals. Fourier Transform, Properties of Fourier Transform, Fourier Transforms of signals used in communications.

Unit – II 12 hrs.

Amplitude Modulation
Concept of Modulation, Amplitude modulation: Double-Sideband Suppressed Carrier, Double-Sideband Full Carrier, Single Sideband and vestigial sideband modulation; Demodulation: Carrier Recovery in AM, Coherent Demodulation, Envelope Detector, Square-Law Demodulator; Integrated Super heterodyne Receiver.

Unit - III 12 hrs.

Angle Modulation
Frequency Modulation, Phase Modulation, Narrow Band Angle Modulation, Wideband FM, Modulators, Demodulators. Sampling, Pulse amplitude modulation, Pulse width modulation, Pulse position modulation.
Brief introduction about Digital modulation.

Unit – IV 9 hrs.

Performance Analysis of Receivers under AWGN
Effects of Noise in Analog Modulation Systems. Case study of AM and FM Receivers. Analog and Digital Receiver performance in AWGN.

Text Books / Reference Books

1. S. Haykin, “Communication Systems,” John Wiley & Sons, 5th Ed., 2009.
2. B.P. Lathi and Z. Ding, “Modern Digital and Analog Communication Systems,” 4th Ed., Oxford University Press, 2009.
3. Louis E. Frenzel, “Principles of Electonic Communication Systems,” 3rd Ed., Tata McGraw-Hill, 2008.
4. Dennis Roddy and John Coolen, “Electronic Communications,” 4th Ed., Pearson, 2008.
5. J. G. Proakis and M. Salehi, “Fundamentals of Communication Systems,” Prentice Hall, 2004.
6. Leon W. Couch, Digital and Analog Communication Systems, 4th Ed., Macmillan Coll Div., 1993.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of signals and Fourier transforms.

CO2: Understand the basics of Amplitude and Frequency Modulation and demodulations.

CO3: Apply Fourier transform to get the spectrum of different modulated signals and decide the requirement of bandwidth.

CO4: Analyze the effect of noise in AM and FM receivers.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

NATIONAL INSTITUTE OF TECHNOLOGY

KURUKSHETRA - 136119

B.TECH 5TH SEMESTER

DSP Lab (ECLR-31)

1. (a) Generate square wave of frequency (input from keyboard); from its harmonics of sinusoidal components.
   (b) Use the pause function from MATLAB to demonstrate the effect of addition of harmonics to its fundamental frequency.
2. Find the inverse Z-transform of the following:

$$X(z)=\frac{\left(1-1.22346z^{-1}+z^{-2}\right)\left(1-0.437833z^{-1}+z^{-2}\right)\left(1+z^{-1}\right)}{\left(1-1.433509z^{-1}\right)\left(1-1.293601z^{-1}+0.556929z^{-2}\right)\left(1-0.612159z^{-1}\right)}$$

3. (a) Compute Circular convolution of x(n)= {1,2,1,0,2,1}; n >=0 and y(n)= {2,4,0,1,1,0}; n>=0
   (b) A signal sequence x (n) = {1, 1, 1} is applied to a system with an unknown impulse response h (n). The observed output is y(n)= {1,4,8,10,8,4,1}. Write a program to find h (n).
4. A linear phase, bandpass FIR filter is required to meet the following specification:

Passband	12-16 kHz
Transition width	2 kHz
Passband ripple	1 db
Stopband attenuation	45 db
Sampling Frequency	50 kHz

   Estimate the filter length and use the optimal method to determine the filter coefficient and hence plot the magnitude-frequency response. Compare the pass bands stopband ripples of the filter with the specified values.
5. Design an IIR filter with following specifications:

Lower passband	0-50 Hz
Upper passband	450-500 Hz
Stop band	200-300 Hz
Passband ripple	3 db
Stopband attenuation	20 db
Sampling frequency	1 kHz

6. Implement the above filters using SIMULINK and verify the performance.
7. Implement an FIR filter on the DSP kit by using the FDA tool and code composer studio.
8. Implement an IIR filter on the DSP kit by using the FDA tool and code composer studio.

Electronics and Communication Engineering
ECPE….: Wireless Technologies

Pre-requisite:
Communication Engineering
Digital modulation

L	T	P	Credits	Contact hours
3	0	0	3	40

About the Course

This course provides the basic understanding of wireless LAN standards, 5G and 6G wireless networks. Key enabling technologies of 5G and 6G wireless networks are analyzed. New applications and services are explored.

Course Contents:

Unit – I
Wireless Communication**:** Evolution- 1G to 5G, overview of wireless channel, cellular concept, 4G, LTE, LTE-LTE-A

Unit – II
Wireless LAN fundamentals, IBSS, BSS, ESS, IEEE 802.11 standards, CSMA/CA, PCF, WLAN design considerations
Bluetooth, RFID-types, UWB, and their applications
Security and privacy in WLANS

Unit-III
5G networks: New Radio (NR), SA, NSA, NOMA, 5G Technologies- small cells, massive MIMO, beam formation, mmWaves, 5G applications- eMBB, URLLC, mMTC, D2D communications, V2X communications;
Use cases in IoT

Unit – IV
6G- network architecture, basic building blocks, 6G research activities, visible light communication, energy harvesting, intelligent reflecting surface, wireless powered communication networks, Time Switching, Applications in IoT services

Text Books:

1. R. Vannithamby and S. Talwar, *Towards 5G: Applications, Requirements and Candidate Technologies.*, John Willey & Sons, West Sussex, 2017.
2. Martin Maier, Amin Ebrahim Zadeh," Towards 6G: A New Era of Convergence, Wiley-IEEE Press
3. Paulo Sergio Rufino Henrique, Ramjee Prasad, *6G: The Road to the Future Wireless Technologies 2030* River Publishers Series,
4. Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basics of WLANS, 5G, and 6G wireless networks
2. To evaluate the performance of wireless technologies in varied channel conditions
3. To design the 5G and 6G networks
4. To develop 5G and 6G powered applications and services

Electronics and Communication Engineering Department
ECOE: Wireless Communication

Pre-requisite: NA

L	T	P	Credits	Contact Hours
3	0	0	3	40

About the Course

This course provides fundamental aspects of digital communication and idea of frequency reuse in cellular networks. Wireless networks being deployed in real-life scenarios are introduced. Emphasis is given to understand how to build applications and services using 4G and 5G standards for digital transformation.

Course Contents:

Unit – I (8)
Information in binary format, information transfer, introduction to and history of cellular communication, cellular concept, frequency reuse

Unit – II (9)
Wireless channel-models, path loss, shadowing, diversity in wireless communication, channel capacity, mechanism of high-rate data transmission, interference management and system capacity, outage, scheduling, and its effect on capacity, link budget

Unit – III (10)
Wireless LANs, IEEE 802.11 standards, Bluetooth, RFID, ZigBee
Cellular networks and its services, 4G, LTE standards, Delivery of multimedia services,

Unit – IV (13)
5G wireless networks, applications and services, role of 5G in digital transformation and IIoT
Deployment of 5G networks in India
Environmental impact of 5G networks, 5G networks and sustainability, 5G enabled sustainability networks

Text / References Books:

1. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson
2. Erik Dahlman, "4G, LTE-Advanced Pro and The Road to 5G"

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basic cellular concept and frequency reuse of mobile cellular, challenges of wireless channel
2. Analyze the system capacity
3. To evaluate sustainability issues
4. To develop sustainable solutions for digital transformation

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECEL09: IoT

Pre-requisite:

L	T	P	C	Total
3	0	2	4	45

Course Contents:

Unit – I

Next

Unit – II

Next

Unit – III

next

Unit – IV

Sustainable technologies

Use cases- AI /ML enabled surveillance network for traffic management; AI camera to record traffic violations

Text / References Books:

a. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson

b. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGraw Hill Education

c. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.

d. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

5. Understand the evolution of mobile communication standards developed over the years.
6. Perform computations and solve numerical problems on different frequency division

multiple access techniques.

7. Assess how softwarization of network functions helps in scalability and ease of operations
8. Evaluate the use of advanced techniques in cellular communications.

Electronics and Communication Engineering

Quantum Communication

Pre-requisite:
Linear algebra, Probability Theory

L	T	P	Credits	Contact Hours
3	0	0	3	40

This course provides a comprehensive overview of quantum communication. The objective is to make the students understand the fundamental concepts of quantum communication.

Course Contents:

Unit – I (8)
Introduction: Classical networks, overview, Maxwell's equations revisited. Applications of polarization in Quantum Networks.

Unit – II (10)
Photon Polarization, General Quantum Variables and Qubits, Applications of quantum variables in Quantum Networks
Composite Quantum Systems – Applications of quantum systems in Quantum Networks.
Quantum Entanglement, its importance for Quantum Communications.

Unit – III (10)
Experimental Quantum Teleportation of Qubits, engineering sources of Entangled Photons, The No Cloning Theorem,

Unit – IV (12)
Quantum Cryptography, The Benett –Brassard Protocol for Quantum key distribution. Eckert's Protocol for Quantum key distribution using entanglement.
Quantum Teleportation – An Application of composite qubits and entanglement.

Text books:

1. Michael Nielson, Isaac Chuang, "Quantum Computation and Quantum Information"
2. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory"

Course Outcomes
The students will demonstrate the ability

1. Understand quantum communication
2. Analyse quantum cryptography
3. Evaluate the performance of quantum communication
4. Application of quantum teleportation

Electronics and Communication Engineering

EC…xxx Quantum Computing

Pre-requisite:
Linear Algebra, Probability Theory

L	T	P	Credits	Contact Hours
3	0	0	1	40

Course Contents:

Unit – I
Review of Quantum Mechanics and Motivation for Quantum Computation, Qubit: The qubit state – matrix and Bloch sphere representation – computational basis – unitary evolution, multi-qubit states – No cloning theorem – Superdense coding – Pure states to Bell states – Bell inequalities.

Unit – II
Protocols with multi –qubits: Swapping – Teleportation – gates: CNOT – Toffoli gate – NAND – FANOUT – Walsh Hadamard, Measurement: Projective operators – General, Projective and POVM measure, Ensemble: Density operators – pure and mixed ensemble – time evolution,

Unit – III
Composite systems: Partial trace – Reduced density operator – Schmidt decomposition – Purification – bipartite entanglement.
Classical computing using qubits – Quantum parallelism – Deutsch's algorithm – Deutsch Josza algorithm, Quantum circuits: Basic gates – ABC decomposition – Gray codes – Universal gates, discrete logarithm, Role of prime factoring in classical cryptography, search algorithms.

Unit – IV
Quantum error correcting codes, Physical realization of qubits

Textbooks and Reference:

1. Quantum Computation and Quantum Information, M.A. Nielsen and I.L. Chuang, Cambridge University Press.
2. Quantum Information and Computation, CIT Lecture Notes by J. Preskill
3. Quantum Theory : Concepts and Methods, Asher Peres, Kluwer Academic Publishers

Course Outcomes
Ability to
5. Understand quantum computing
6. Analyse the qubits
7. Evaluate the performance of quantum computing systems
8. Application of quantum error correcting codes

Electronics and Communication Engineering

ECEL09: Advanced Mobile Communications

Pre-requisite:

L	T	P	C	Total
3	0	2	4	45

Course Contents:

Unit – I

Mobile Communications Overview: Evolution from 1G to 5G, Analog voice systems in 1G, digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G(EDGE); IMT2000, 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates, IMT Advanced, 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+), IMT2020, enhancementsin comparison to IMT Advanced.

Unit – II

Introduction to 5G Communication: 5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, channels and signals/waveforms in 5G, carrieraggregation, small cells, dual connectivity.

Unit – III

5G Network: New Radio (NR), Standalone and non-standalone mode, non-orthogonal multiple access (NOMA), massive MIMO, beam formation, PHY API Specification, flexible frame structure, Service Data Adaptation Protocol (SDAP), centralized RAN, open RAN, multi-access edge computing (MEC); Introduction to software defined networking (SDN), network function virtualization (NFV), network slicing; restful API for service-based interface, private networks.

Unit – IV

Current state and Challenges ahead: 5G penetration in developed countries; deployment challengesin low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements, large cell usage, LMLC, possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul / backhaul solutions: LEOs, HAP/UAV.

Text / References Books:

e. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson

f. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGraw Hill Education

g. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.
h. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

9. Understand the evolution of mobile communication standards developed over the years.
10. Perform computations and solve numerical problems on different frequency division multiple access techniques.
11. Assess how softwarization of network functions helps in scalability and ease of operations
12. Evaluate the use of advanced techniques in cellular communications.

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ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECEL19: Cyber Security

Pre-requisite:

L	T	P	C	Total
3	0	2	4	45

Course Contents:

Unit – I

Cyber Security Concepts: Cyber Risks, Breaches, attacks, Exploits, Social Engineering, FootPrinting, Scanning, etc.

Unit – II

Cryptography and Cryptanalysis: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management,VPN Security.

Unit – III

Infrastructure and Network Security: Introduction to System Security, Server Security, OSSecurity, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Introduction to Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management,

Unit – IV

Cyber Security Vulnerabilities & Safe Guards: Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness.

Unit – V

Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, AntiSpywares, System tuning tools, Anti Phishing.

Unit – VI

Security in Evolving Technology: Biometrics, Mobile Computing and Hardening on androidand ios, IOT Security, Web server configuration and Security. Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

Text / References Books:

1. Jeeva Jose & Vijo Mathew, Introduction to Security of Cyber-Physical Systems, Khanna BookPublishing Company, 2023.
2. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
3. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
4. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
5. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
6. V.K. Pachghare, "Cryptography and Information Security", PHI Learning

Reference Websites:

http://www.ignou.ac.in/upload/Announcement/programmed

etails.pdf

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basic concept of cyber security and its importance.
2. Analyze and distinguish various security threats and attacks that are prevalent now.
3. Find different ways for safety of assets and systems by increasing the strength of securityparameters.
4. Perform simple simulations of cyber security attacks and ways to mitigate those.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

EC-26 Mobile Communication & Networks

Pre-requisite:

L	T	P	C	Total
3	0	2	4	45

Course Contents:

Unit – I

Cellular concepts- Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G 3G, 4G and 5G cellular mobile standards.

Unit – II

Signal propagation- Propagation mechanism, reflection, refraction, diffraction and scattering,large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small-scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.Antennas: antennas for mobile terminal, monopole antennas, PIFA, base station antennas andarrays.

Unit – III

Multiple access schemes-FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity Altamonte scheme.

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average snr, average symbol/bit error rate. System examples-GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 3G, 4G and 5G mobile communications.

Text/ Reference Books

1. Erik Dahlman , 4G, LTE-Advanced Pro and The Road to 5G
2. Sassan Ahmadi, 5G NR: Architecture, Technology, Implementation, and Operation of3GPP New Radio Standards Hardcover – 1 June 2019
3. Vijay K. Garg, “Wireless Communication and Networking”, Elsevier, Morgan

Kaufmann,Reprinted 2012.
4. Vijay K. Garg, J.E.Wilkes, “Principle and Application of GSM”, Pearson Education, FifthImpression 2008
5. T.S.Rappaport, “Wireless Communications Principles and Practice”, PHI, II Edition, 2006.
6. William Lee ,”Mobile Cellular Telecommunications: Analog and Digital Systems”, McGraw HillEducation

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand cellular concepts and signal propagation in mobile communication.
2. Perform small simulations and plot results on modulation techniques.
3. Analysis performance of different generations of mobile communications.
4. Solve numerical problems on different multi-access and modulation schemes of mobilecommunications.

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ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECOEXX LOGIC DESIGN AND ANALYSIS USING VERILOG

Pre-requisite:

Course Code	ECOEXX
Course Title	LOGIC DESIGN AND ANALYSIS USING VERILOG
Number of Credits	
Prerequisites (Course code)	Digital Design
Course Type	OE

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives

This course aims to provide students with the understanding of the different technologies related to HDLs, construct, compile and execute Verilog HDL programs using provided software tools. Design digital components and circuits that are testable, reusable, and synthesizable. Students are provided with access to the CAD tools to use hardware description language to model, analyze and design various digital circuits/systems.

UNIT I 8hrs

INTRODUCTION TO HDL (VERILOG): Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface, Module, Simulation and Synthesis Tools, Test Bench. Language Constructs and conventions: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks.

UNIT II 12hrs

GATE LEVEL MODELLING**:** Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Additional Examples, Design of Flipflops with Gate Primitives, Delays, Strengths and Contention Resolution, Net Types, Design of Basic Circuits.
BEHAVIOURAL MODELLING: Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, Examples, Assignments with Delays, Wait construct, Multiple Always Blocks, Designs at Behavioural Level, Blocking and Non-blocking Assignments, The case statement, Simulation Flow. If and

if-else constructs, assign-design construct, repeat construct, for loop, the “disable” construct, while loop, forever loop, parallel blocks, force-release construct, Event.

UNIT III 12hrs

MODELLING AT DATAFLOW LEVEL: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators. Switch Level Modelling: Introduction, Basic Transistor Switches, CMOS Switch, Bi-directional Gates, Time Delays with Switch Primitives, Instantiations with Strengths and Delays, Strength Contention with Tri-reg Nets
FUNCTIONS, TASKS,USER-DEFINED PRIMITIVES: Introduction, Function, Tasks, User- Defined Primitives (UDP), FSM Design (Moore and Mealy Machines). System Tasks, Functions and Compiler Directives: Introduction, Parameters, Path Delays, Module Parameters, System Tasks and Functions, File-Based Tasks and Functions, Compiler Directives, Hierarchical Access.

UNIT IV 10hrs

SYNTHESIS OF DIGITAL LOGIC CIRCUIT DESIGN: Introduction to Synthesis, Synthesis of combinational logic, Synthesis of sequential logic with latches and flip-flops, Synthesis of Explicit and Implicit State Machines. Describing Clock driven Finite-State Machines, Asynchronous driven Finite State Machines, Switch level modeling. HDL modeling of DSS; CORDIC. System Design using ASM Chart, Design and Synthesis of Datapath Controllers. Clocked Sequential Finite State Machines, Asynchronous Sequential Finite State Machines, Sequential Design using LSI & MSI circuits**.**
Case study: Understand the role of electronics in sustainable development. Design & analysis of digital system towards sustainable computing.

Text Book:

1. T. R. Padmanabhan, B. Bala Tripura Sundari, Design Through Verilog HDL, John Wiley & Sons, INC., Publication, 2004.
2. Michael, D. Ciletti, Advanced digital design with the Verilog HDL, Pearson Education India, 2002

Reference Books:

1. Samir Palnitkar, Verilog HDL Pearson Education, 2nd Edition, 2009.
2. J. Basker, A Verilog HDL Primer, Star Galaxy Publishing, 3rd Edition.
3. Zainalabdien Navabi, Verilog Digital System Design, TMH, 2nd Edition.

Course Outcomes

At the end of the course, students will be able to:

CO1: Explain different design constraints in Verilog HDL

CO2: Categorize different modelling styles

CO3: Model the combinational and sequential circuits using Verilog HDL
CO4: Illustrate the Synthesis of Digital Logic Circuit Design

ECPC xx Microelectronics and VLSI Design

Pre-requisite: ECPC-21 (Electronics Device and Circuits) and ECPC-26 (Analog Electronics)

L	T	P	Credits	Total contact hours
3	1	0	4	4

Brief Description of the Course:

Course Learning Objectives
Enable the students to understand fabrication process sequence of silicon semiconductor devices and IC's.

Course Content

UNIT I **Hrs 8**
Crystal Growth: MGS, EGS, Czochralspi crystal Puller, Silicon shaping, Wafer Preparation. Epitaxy, Oxidation, Litho Graphy and Reactive Plasma Etching

UNIT II **Hrs 10**
Di-electric and Poly-Silicon Film Deposition, Diffusion, Ion Implantation and Metallization, Assembly & Packaging, Isolation Techniques, N-MOS IC fabrication Process Sequence.

UNIT III **Hrs 8**
MOS Design Process : Stick Diagram & Design rules. Physical design of IC's Layout rules & circuit abstractor, Cell generation, Layout environments, Layout methodologies.

UNIT IV **Hrs 10**
Basic Circuit Concepts: Sheet resistance concept, Area Capacitances, Inverter Delays, cascaded inverters as drivers, Propagation Delays.
Scaling of MOS Devices: Scaling Factors, Limitations of scaling.
Subsystem design and layout: switch logic, gate logic, Two-input nMOS and CMOS gates.

Reference Books:
1. S. M. Sze, VLSI Technology, Mc Graw Hill.
2. S. K. Ghandhi, VLSI Fabrication Principles.
3. Pucknell DA & Eshraghian K, Basic VLSI Design, PHI.

Course outcomes
At the end of the course student will be able to
1. Understand the Crystal Growth, Oxidation and LithoGraphy techniques in silicon device.
2. Understand Deposition techniques and fabrication process silicon ICs.
3. Understand various design process, rules and layout methodologies of ICs.
4. Understand the basic circuit concepts, scaling issues and subsystem design of various logics.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPC42 MICROWAVE THEORY AND DEVICES

Pre-requisite: ECPC21 (Electronic Devices and Circuits), ECPC24 (Fields and waves)

L	T	P	Credits	Total contact hours
3	-	-	3	42

Brief description about the course

The purpose of this course is to provide a comprehensive introduction to microwaves and principles of microwave devices.

Unit - I 10 hrs.

Introduction to Microwaves History and Applications, Review of Electromagnetics and Transmission Lines: Maxwell's equations, coaxial lines, rectangular and circular waveguides, microstrip lines.

Introduction to Microwave Measurements: Slotted Line, Tunable Detector, VSWR Meter, Power Meter, Spectrum Analyzer, Network Analyzer, Measurement of frequency, Power, Phase shift, VSWR and Impedance.

Unit – II 10hrs.

Microwave Components: S parameters, H, E and EH (Magic) plane Tee junction, Directional Couplers: Single Hole and Two Hole, Scattering Matrix of Directional Couplers, Waveguide Joints, Faraday Rotation: ferrite circulators, isolators and phase shifters, Microwave Attenuators.

Unit - III 10hrs.

Design considerations for microwave tubes, principle of operation of multi-cavity and reflex klystron, magnetron and traveling wave tube, Equivalent voltages and currents.

Unit – IV 12hrs.

Principles of Gunn diode, Tunnel Diode, IMPATT, TRAPPAT, BARRIT, PIN Diode and Schottky barrier diode, Microwave BJT, MESFET, HEMT and their applications.

Study of advanced microwave applications in industry and medical science: Microwave Imaging, Food Processing, Chemical Heating etc.

Text Books / Reference

1. ‘Microwave Engineering’ by David M. Pozar, John Wiley & Sons
2. ‘Microwave Devices and Circuits’ by Liao S.Y., Pearson Prentice Hall

3. ‘Foundations for Microwave Engineering’ by Robert E. Collin, Wiley-IEEE Press

Course Outcomes

CO1: Understand the basic concepts and applications of microwave systems.

CO2: Analyze, test and use various passive microwave components for different applications.

CO3: Understand the working of Klystron, TWT and Magnetron

CO4: Understand the principle of various microwave devices and their applications

ECLR-43 Microwave Lab			
	L	**T**	**P**
	0	**0**	**3**
Course Objectives	This lab aims to get familiarize the students about the various microwave components, the characteristics of reflex Klystron tube and Gunn diode and communication antennas used in microwave range. It includes their design, gain, directivity, polar pattern, VSWR and various other characteristics. Further in this lab students will attain the knowledge about operation of various Plane-Tee and designing of Microstrip Patch Antenna.		
Course Outcomes	At the end of the course, the students will be able to: 1) Gain knowledge and understanding of microwave analysis methods. 2) Be able to apply analysis methods to determine circuit properties of passive/active microwave devices. 3) Know how to model and determine the performance characteristics of a microwave circuit or system using computer aided design methods. 4) Have knowledge of basic communication link design; signal power budget, noise evaluation and link carrier to noise ratio. 5) Have knowledge of how transmission and waveguide structures and designing of Microstrip Patch Antenna.		

List of Experiments:

1. To study the microwave components.
2. To study the characteristics of the reflex Klystron tube and to determine its electronic tuning range.
3. To determine the frequency and wavelength in a rectangular waveguide working in TE 10 mode.
4. To determine the standing wave ratio and reflection coefficient.
5. To study the I-V characteristics of Gunn diode.
6. To study the magic tee, isolator and attenuator.
7. To measure the coupling coefficient and directivity of a wave guide directional coupler
8. To measure the polar pattern and the gain of a waveguide horn antenna.
9. Design of Rectangular Microstrip Patch Antenna with Coaxial Probe using HFSS.
10. Design of Rectangular Microstrip Patch Antenna using Stripline Feed using HFSS.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX: **Deep Learning**

Pre-requisite: …….

L	T	P	Credits	Total contact hours
3	0	0	3	

i) Brief Description about the course

The course focuses on fundamental principles, underlying mathematics, and implementation details of deep learning techniques. This includes the concepts and methods used to optimize these highly parameterized models (gradient descent and backpropagation, and more generally computation graphs), the modules that make them up (linear, convolution, and pooling layers, activation functions, etc.), and common neural network architectures (convolutional neural networks, recurrent neural networks, etc.). Applications ranging from computer vision to natural language processing and decision-making (reinforcement learning) are included.

ii) Unit - I

Introduction to Deep Learning, Deep Feedforward Networks, Decision Surfaces, Gradient Based learning - Hidden Units - Back-propagation, and other Differential Algorithms, Regularization for Deep Learning, Optimization for training Deep Models, Batch Optimization.

8 hrs.

Unit – II

Convolution operation - Motivation - Pooling - Convolution and Pooling as strong prior, Efficient convolution algorithms, Unsupervised features, Adam Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Residual Network, Skip Connection Network, Fully Connected CNN.

12 hrs.

Unit - III

Sequence Modeling: Recurrent and Recursive Nets, LSTM Networks, Autoencoders, Regularized Auto encoders, Semantic Segmentation, Greedy Layer-wise Unsupervised Pre-Training - Transfer learning and Domain Adaptation, Deep Generative Models. Applications: Image Denoising and Object Detection

12 hrs.

Unit – IV

Introduction to Keras and Tensorflow – Deep Learning for computer vision, Deep Learning for Text and Sequences, Generative Deep Learning – Text Generation with

LSTM, Generating images with variational autoencoders – Generative Adversarial Networks (GAN)

8 hrs.

Text Books / Reference

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, “Deep Learning”, The MIT Press.
2. Francois Chollet, “Deep Learning with Python”, Manning Publications.
3. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, First Edition, O'Reilly Media, 2017.

Course Outcomes

CO 1: Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.

CO 2: Incorporate transfer of knowledge in machine learning algorithms.

CO 3: Implement deep learning algorithms and solve real-world problems.

CO 4: Implementation of Deep Learning techniques using Python.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX IMAGE FORENSICS

Pre-requisite: Digital Image Processing

L	T	P	Credits	Total contact hours
3			3	42

Brief Description about the course:
Image forensics is a rapidly growing field that deals with the analysis of digital images to determine their authenticity, integrity, and origin. This course provides an in-depth introduction to the fundamental concepts, techniques, and tools used in image forensics. The course covers the topics such as image acquisition, image processing, image compression, steganography, and digital watermarking. Students will learn how to apply these techniques to identify image tampering, detect forged images, and authenticate the origin of digital images.

Course Contents

UNIT - I (10L)
Introduction: Overview of image forensics, History of image forensics, Applications of image forensics. Image Acquisition: Types of digital images, Image formation and properties, Image acquisition devices, Image file formats.

UNIT - II (10L)
Image Processing Techniques: Image enhancement and restoration, Noise reduction, Image segmentation, Feature extraction, Image analysis. Image Compression Techniques: Lossless and lossy compression, Image compression algorithms, Evaluation of compression quality, Impact of compression on image forensics.

UNIT - III (10L)
Image Tampering and Forgery Detection: Types of image tampering and forgery, Image forensics tools and techniques for detection, Analysis of compression artifacts and inconsistencies, Detection of splicing and copy-paste operations. Steganography: Principles of steganography, Steganography techniques and tools, Detection of hidden information in digital images.

UNIT - IV (10L+2 L)
Digital Watermarking: Principles of digital watermarking, Types of digital watermarks, Watermark embedding and extraction, Authentication of digital images. Evaluation of Image Forensics Techniques: Metrics for evaluating image forensics techniques, Benchmark datasets, Performance evaluation of image forensics tools. Case Studies and Applications: Real-world applications of image forensics, Case studies of image tampering and forgery detection, Analysis of recent image forensics research.

Reference Textbooks :

1. "Introduction to Digital Forensics" by Brian Carrier (2014)
2. "Digital Forensics for Legal Professionals: Understanding Digital Evidence From The Warrant To The Courtroom" by Lars Daniel (2017)
3. "Handbook of Digital Forensics and Investigation" by Eoghan Casey (2010)
4. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods (2018)
5. "Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods" by Tony F. Chan and Jianhong (Jackie) Shen (2005)
6. "Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab" by Chris Solomon and Toby Breckon (2011)
7. "Digital Watermarking and Steganography" by Ingemar J. Cox, Matthew L. Miller, and Jeffrey A. Bloom (2007)
8. "Practical Handbook on Image Processing for Scientific and Technical Applications" by Bernd Jahne (2004)
9. "Image Analysis, Classification and Change Detection in Remote Sensing: With Algorithms for ENVI/IDL and Python" by Morton J. Canty (2018)
10. "Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition" by Stuart H. James, Jon J. Nordby, and Suzanne Bell (2013)
11. The textbook "Digital Image Forensics: There is More to a Picture than Meets the Eye" by Springer (2012).

Course Outcomes:

Upon completion of this course, students will be able to:
CO1: Understand the fundamental concepts and principles of image forensics.
CO2: Analyze and detect image tampering and forgeries.
CO3: Implement steganography techniques to hide information in digital images.
CO4: Evaluate the effectiveness of image forensics techniques.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPExx BIO- MEDICAL SIGNAL PROCESSING

Pre-requisite: ECPC-23,ECPC-31,ECLR-23

L	T	P	Credits	Total contact hours
3	0	0	3	36-42

Course Description:

The course deals with biomedical signal basics, different types of biomedical signals, and biomedical recording system applications. The main objective is to help students acquire knowledge on different types of biomedical signal characteristics and analysis.

Unit-I

Signal processing: Review of Discrete time signals and systems – LTI systems – Response of LTI systems – Convolution – Difference equation representation of discrete systems Z transform – Transform analysis of LTI system – DFT. STFT – Introduction to wavelets – CWT and DWT with Haar wavelet.

Unit-II

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis, Biomedical signals – The Brain and its potentials. Electrophysiological origin of brain waves. Electroencephalogram (EEG), signal and its characteristics, Electrocardiogram (ECG) signal origin and characteristics and Electromyogram (EMG) signal and its characteristics. ECG lead system, ECG signal characteristics; Non-Stationarities in ECG signal, EEG lead system, EEG signal characteristics. Types of noise in bio signals.

Unit-III

Biomedical Signal Processing: **Neurological Signal Processing**: EEG analysis – Parametric modelling – Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. **Cardiological signal processing:** ECG parameters and their estimation – Arrhythmia analysis monitoring – ECG data reduction techniques.

Unit-IV

Biomedical Signal Processing Methods and Applications: Adaptive interference / Noise cancellation: Types of noise in biomedical signals; Digital filters – IIR and FIR – Notch filters – Optimal and adaptive filters. Weiner filters – steepest descent algorithm – LMS adaptive algorithm – Adaptive noise canceller – cancellation of 50 Hz signal in ECG – Cancellation of maternal ECG in fetal electrocardiography.

Text Books:

1. D. C Reddy, "Biomedical Signal Processing, Principles and Techniques", Tata McGraw Hill Publishing Company Limited, First Edition, 2005

2. Willis J Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall India Private Limited, First Edition, 2006.
3. Rangaraj M Rangayyan “Biomedical Signal Analysis – A case study approach” IEEE press series in biomedical engineering, First Edition, 2002.
4. John G Proakis, Dimitris and G. Manolakis, “Digital Signal Processing Principles algorithms, applications” PHI Third Edition. 2006

References:

1. Myer Kutz, “Biomedical Engineering and Design Handbook, Volume I”, McGraw Hill, 2009.
2. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, “Practical Biomedical Signal Analysis Using MATLAB”, 1st Edition, CRC Press,2011
4. https://nptel.ac.in/courses/108/105/108105101

Course Outcomes: At the end of the course the student will be able to
CO1.Understand and analyze the dynamic characteristics of biomedical systems and modelling.
CO2.Specific mathematical techniques and solve problems in ECG signals.
CO3. Implement various signal processing techniques to model EEG signals.
CO4. Design and develop biomedical signal processing techniques for real time biomedical signals.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE XX COGNITIVE RADIO

Pre-requisite: ECPC25 (Communication Engineering), ECPC35 (Wireless & Mobile Communication)

L	T	P	Credits	Total contact hours
3	-	-	3	40

Cognitive Radio is a new paradigm in wireless communication system to alleviate the problem of spectrum underutilization. The course focuses on software-defined radio, cognitive radio, its functions, spectrum sensing techniques and advance topics in cognitive radio.

Unit - I 10 hrs.
Introduction to Wireless Communication: Wireless Channels, Path Loss, Shadowing, Fading, Delay Spread, Doppler Spread
Introduction to CR: Software Defined Radio, Cognitive Radio and its functions, Dynamic Spectrum Access, Underlay, Overlay and Interweave model, Concept of Primary and Secondary Users.

Unit – II 8 hrs.
Detection Theory: Hypothesis Testing, Neyman-Pearson Criteria, Likelihood Ratio Test, Receiver-Operator Characteristics (ROC), Probability of Error, Monte-Carlo Simulations.

Unit - III 12 hrs.
Spectrum Sensing: Primary User Detection Techniques, Energy Detection, Coherent Detection, Cyclostationary Feature Detection, Autocorrelation based Detection Effects of Imperfect knowledge of Noise Power, Cooperative Spectrum Sensing: OR, AND and MAJORITY rule.

Unit – IV 10 hrs.
Overview of IEEE 802.22 standard, security issues in cognitive radios, emerging applications of Cognitive radio, Cognitive Radio for Internet of Things, Smart Grid Networks, Public Safety Networks

Text Books / Reference

1 Fundamentals of Statistical Processing, Volume 2: Detection Theory' by Steven M Kay, Pearson Education India
2 'Principles of Cognitive Radio' by H. Vincent Poor, et.al, Cambridge University Press

3 ‘Fundamentals of Cognitive Radio’ by Peyman Setoodeh and Simon Haykin, John Wiley & Sons

Course Outcomes

CO 1: Understand the fundamentals of cognitive radio networks

CO 2: Understand basic principles used in detection of primary users

CO 3: Analyze various spectrum sensing algorithms

CO 4: Understand emerging applications of cognitive radio

SPEECH PROCESSING

Course Code	ECPC
Course Title	Speech Processing
Number of Credits	03
Prerequisites (Course code)	
Course Type	PE

Course Objectives:

Aim of this course is to introduce the students with models for speech signal in Time-domain and Frequency-domain. Student will also be familiarized with Homomorphic Speech processing system.

UNIT-I

Digital models for speech signals:

Mechanism of speech production & acoustic phonetics, the acoustic theory of speech production, lossless tube models, and digital models for speech signals.

UNIT-II

Time Domain Models and Digital Representation of Speech:

Time dependent processing of speech, short time energy and average magnitude, short time average zero crossing rate, discrimination between speech & silence, pitch period estimation using parallel processing, short time autocorrelation function & AMDF, pitch period estimation using autocorrelation function, Median Smoothing and Speech Processing. Sampling speech signals, Review of the statistical model for speech, Instantaneous Quantization, Adaptive Quantization, General Theory of Differential Quantization, DPCM, Direct Digital Code Conversion.

UNIT-III

Short Time Fourier analysis of Speech Signal:

Definition and properties, Design of digital filter banks, Implementation of filter bank summation method using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis-Synthesis systems.

UNIT-IV

Homomorphic Speech processing and Linear Predictive Coding of Speech: Homomorphic systems for convolution, Complex cepstrum of speech, Pitch detection, Formant estimation, The Homomorphic vocoder, Basic principles of linear predictive analysis, Computation of the gain for the model, Solution of LPC equations, Comparisons between the methods of solution of the LPC analysis equations, The prediction error signal, Frequency domain interpretation of linear predictive analysis, relation of linear predictive analysis to lossless tube models, Relations between the various speech parameters, Synthesis of speech from linear predictive parameters, application of LPC parameters.

REFERENCES:

1. Digital Processing of Speech Signals by L.R. Rabiner and R.W. Schafer,Pearson
2. Discrete-Time Speech Signal Processing Principles and Practices by Thomas F. Quatieri, Pearson
3. Chris Rowden: Speech Processing McGraw Hill.

Course outcomes

At the end of the course, the students will be able to

CO1: qualitatively describe the mechanisms of human speech production and how the articulation mode of different classes of speech sounds determines their acoustic characteristics,

CO2: apply MatLab tools to analyse speech signals in the time and frequency domains, and in terms of the parameters of a source-filter production model,

CO3: solve given problems regarding parameter estimation in source-filter production models and regarding speech analysis and synthesis using these models,

CO4: describe and implement methods and systems for efficient quantization and coding of speech signals, and solve given problems regarding these methods,

CO5: describe and implement methods for speech enhancement, and solve given problems regarding these methods,

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX
Cyber Security

Pre-requisite: Cryptography and Network Security

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description:
This course is required to create architectural, algorithmic and technological foundations for ensuring cyber security, maintenance of the privacy of individuals, the confidentiality of organizations, and the protection of sensitive information, despite the requirement that information be released publicly or semi-publicly.

Syllabus

Unit – I Basic Cyber Security Concepts (12)
Introduction to Cyber Security, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy, Nodal Authority, International convention on Cyberspace.

Unit – II Cyber Security Vulnerabilities and Cyber Security Safeguards (10)
Cyber Security Vulnerabilities – Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Poor Cyber Security Awareness. Cyber Security Safeguards – Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.

Unit – III Cyber Forensics (9)
Introduction to Cyber Forensics, Handling Preliminary Investigations, controlling an Investigation, conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time.

Unit – IV Legal and Ethical Issues (9)

Cybercrime and computer crime, Cyber Warfare, Cyber terrorism, Cyber Espionage, Intellectual property, copyright, patent, trade secret, Hacking and intrusion, Cyber laws, Roles of International Law, Privacy, identity theft, National Cyber Security Policy.

Text Books / Reference

1. B. Raghunathan, The Complete Book of Data Anonymization: From Planning to Implementation, Auerbach Pub, 2013.

2. L. Sweeney, Computational Disclosure Control: A Primer on Data Privacy Protection, MIT Computer Science, 2002.

3. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

4. Raef Meeuwisse, Cyber Security for Beginners, Cyber Simplicity Ltd., 2017.

5. William Stallings, "Cryptography and Network Security: Principles and Practice.", PrenticeHall.

6. William R. Cheswick and Steven M. Bellovin, "Firewalls and Internet Security: Repelling the Wily Hacker", Addison-Wesley.

7. Charles P. Pfleeger, "Security in Computing", Pearson Education.

8. Edward Amoroso, "Fundamentals of Computer Security Technology", Prentice-Hall.

Course Outcomes

CO 1. To understand cyber security concepts.

CO 2. Analyse Cyber Security Vulnerabilities and Cyber Security Safeguards

CO 3 Study of Cyber Forensics

CO 4 Study of Legal and Ethical Issues of cyber security

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Optical Communication Networks

Pre,requisite: ECPC 25

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

In this course, students will learn optical fiber sources and transmission techniques, the idea of optical fiber networks algorithm such as SONET/SDH and optical CDMA. Further students will explore trends of optical fiber measurement systems.

Unit-I

Introduction to Optical Fibers: Evolution of fiber optic system, Element of an Optical Fiber Transmission link, Total internal reflection, Acceptance angle, Numerical aperture, Skew rays, Ray Optics, Optical Fiber Modes and Configurations, Mode theory of Circular Wave guides, Overview of Modes, Key Modal concepts, Linearly Polarized Modes, Single Mode Fibers, Graded Index fiber structure.

Signal Degradation in Optical Fibers: Attenuation, Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides, Information Capacity determination, Group Delay, Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers, Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers, Mode Coupling, Design Optimization of SM fibers, RI profile and cut-off wavelength.

Unit-II

Fiber Optical Sources and Coupling: Direct and indirect Band gap materials, LED structures , Light source materials, Quantum efficiency and LED power, Modulation of a LED, lasers Diodes, Modes and Threshold condition, Rate equations, External Quantum efficiency, Resonant frequencies, Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers, Power Launching and coupling, Lencing schemes, Fiber -to,-Fiber joints, Fiber splicing, Signal to Noise ratio, Detector response time.

Unit-III

Fiber-Optic Receiver and Measurements: Fundamental receiver operation, Pre amplifiers, Error sources, Receiver Configuration, Probability of Error, Quantum limit, Fiber Attenuation measurements, Dispersion measurements, Fiber Refractive index profile measurements, Fiber cut, off Wavelength Measurements, Fiber Numerical Aperture Measurements, Fiber diameter measurements.

Unit-IV

Optical Networks and System Transmission: Basic Networks, SONET / SDH, Broadcast, and select WDM Networks, Wavelength Routed Networks, Non-linear effects on Network performance, Link Power budget, Rise time budget, Noise Effects on System Performance, Operational Principles of WDM Performance of WDM + EDFA system Solutions, Optical CDMA, Ultra High Capacity Networks.

Reference Books:

1. Keiser, Gerd. Optical fiber communications. Vol. 2. New York: McGraw-Hill, 2000.

2. John, M. Senior. Optical Fiber Communication-Principle and Practice. Prentice Hall, 2009.

3. Ramaswami, Rajiv, Kumar Sivarajan, and Galen Sasaki. *Optical networks: a practical perspective*. Morgan Kaufmann, 2009.

4. J.Gower. *Optical Communication System.* Prentice Hall of India, 2001.

Course Outcomes:

At the end of the course student will be able to…

CO 1 Discuss the various optical fiber modes, configurations and various signal degradation factors associated with optical fiber.

CO 2 Explain the various optical sources and optical detectors and their use in the optical communication system.

CO 3 understand basics of Fiber-Optic Receiver and Measurements**.**

CO 4 Analyze the digital transmission and its associated parameters on system performance

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPExx BIOMEDICAL ELECTRONICS

Pre-requisite: ECPC-21, ECPC-22, ECPC-26, ECPC-23, ECPC-31

L	T	P	Credits	Total contact hours
3	0	0	3	36-42

Course Description:

The course deals with bioelectric signal basics, different types of transducers, biomedical recording systems, diagnostic and therapeutic equipment, and medical imaging system measurements. The main objective is to help students acquire knowledge on types of sensors and transducers, working principles, selection procedures, and applications of biomedical electronic systems.

UNIT-1:

Physiological systems and Signals: Biology of the heart, circulatory and respiratory systems, auditory systems, physiology of nerve and muscle cells, fundamental organization of brain and spinal cord. Biosignals: Origin of bioelectric signals, electrocardiogram (ECG), phonocardiogram (PCG), encephalogram (EEG) and electromyogram (EMG).

UNIT-2:

Physiological Transducers: Electrodes: silver-silver chloride electrodes, electrodes for ECG, EEG, EMG, Microelectrodes. Performance characteristics of transducers, classification of transducers based on Electrical principle involved: Resistive position transducer, resistive pressure transducer, inductive pressure transducer, capacitive pressure transducer; Self generating inductive transducer: linear variable differential transformer (LVDT), Piezoelectric Transducer.

UNIT-3:

Recording Systems: Preamplifier, Signal conditioning: Differential amplifier, current to voltage converter, instrumentation amplifier; biomedical filters: LPF, HPF, bandpass, band stop (Notch filter); source of noise in low level measurement, Recording systems for ECG, PCG, EEG and EMG.

UNIT-4:

Diagnostic and Therapeutic Equipment: Blood pressure monitors – Electro-cardio scope – Pulse Oximeter – pH meter – Auto analyzer – Pacemakers – Defibrillator – Heart lung machine – Nerve and muscle stimulators – Dialysis machines – Surgical diathermy equipment – Nebulizer; inhalator – Aspirator – Humidifier – Ventilator and spirometry.

Medical Imaging Systems: X-ray imaging, Computed tomography, ultrasonic imaging systems, Magnetic resonance imaging system, thermal imaging systems.

Text books:

1. Principles of Biomedical Instrumentation and Measurements, Richard Aston, ISBN: 0-675-20943-9, Maxwell Macmillan International Publishing Company L.

2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment and Technology, 4thEdition. Upper Saddle River, New Jersey: Prentice-Hall, 2001.

3. John G Webster, “Medical Instrumentation Applications and Design”, John Wiley and Sons, New York, (3e), 2011.

4. R S Khandpur, “Handbook of Biomedical Instrumentation”, McGraw Hill, Delhi, (3e), 2014.

References:

1. L A Geddes, L E Baker, “Principles of Applied Medical Instrumentation”, Wiley India, New Delhi, (3e), 2008.

2.Richard Aston, “Principles of Biomedical Instrumentation and Measurement”, Merrill, New York, 1991.

3.Joseph J Carr, John M Brown, “Introduction to Biomedical Equipment technology”, Prentice Hall, New Jersey, (4e), 2003.

Course Outcomes: At the end of the course the student will be able to

CO1. Apply principles and concepts of electronics to analyze input and output signals in medical electronics

CO2. Apply principles and concepts of electronics to design filters for de-noising of medical measurements

CO3. Recognize different types of transducers, ongoing progress in improving their design, and their application in medical measurements

CO4. Apply principles and concepts of sensing and engineering to (i) design diagnostic devices for detection of markers in biofluids, and (ii) be able to evaluate quality of diagnostic devices

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

BIO SENSORS

Pre-requisite: CHIR11

L	T	P	Credits	Total contact hours
3	0	0	3	36-42

Course Learning Objectives To familiarize students with biosensor technology and their application area.

UNIT I

Description of biosensor and its general principles, Biomolecules used in biosensors and immobilization methods, immobilization of biological materials, support materials, their types and properties.

UNIT II

The properties and characteristic of biosensors, performance factors in biosensors, enzymatic biosensors, immune-biosensors.

UNIT III

DNA biosensors, Cell basis biosensors, Electrochemical biosensors, Optical biosensors.

UNIT IV

Other measurements methods, Biosensors in food analysis, Biosensors in environmental analysis.

Futuristic technologies and challenges related to Bio-sensing.

Reference Books

1. A.Mulchandani, K.R. Rogers, 1998. "Enzyme and Microbial Biosensors Techniques and Protocols", Humana Press, Totowa, New Jersey.

2. J.Cooper, T.Cass, Biosensors, Oxford university press, second edition, 2004.

3. Chen Jianrong, Miao Yuqing, He Nongyue, Wu Xiaohua, Li Sijiao, Nanotechnology and biosensors, Biotechnology Advances, Volume 22, Issue 7, September 2004, Pages 505- 518.

Course outcomes: At the end of the course student will be able to

1. Acquire knowledge about the biosensors.
2. Understand various biomolecules used in biosensors and immobilization methods
3. Design a biosensor.
4. Acquire knowledge about advantages of biosensors.

5. Understand DNA biosensors, Cell basis biosensors and Electrochemical biosensors
6. Understanding the use of Biosensors in environmental analysis.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX VLSI Testing and Verification

Pre-requisite: Digital Design

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description of the Course:

Course Learning Objective

To learn the concepts of Digital VLSI design flow specification, VLSI testing and verification.

UNIT-I Hrs 10

Introduction: Introduction to Digital VLSI Design Flow Specification, Brief of High-level Synthesis, RTL Design, Logic Optimization, Verification and Test Planning, Design Representation, Hardware Specific Transformations. Functional vs. Structural Testing, Physical faults and their modelling, Fault equivalence and dominance; fault collapsing and Checkpoint Theorem.

UNIT II Hrs 10

Fault Simulation and Testability Measures: Circuit Modeling and Algorithms for Fault Simulation, (Serial Fault Simulation, Parallel Fault Simulation, Deductive Fault Simulation, Concurrent Fault Simulation), Combinational SCOAP Measures and Sequential SCOAP Measures.

UNIT III Hrs 10

Combinational Circuit Test Pattern Generation: Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, Standard ATPG Algorithms, D-Calculus and D-Algorithm, Basics of PODEM and FAN.

UNIT IV Hrs 10

Scan Chains based Sequential Circuit Testing, Introduction to BIST architecture, BIST Test Pattern Generation, Response Compaction and Response Analysis, Memory BIST.

Text Books/References:

1. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Springer, 1st edition.
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition.
3. G. De Micheli. Synthesis and optimization of digital circuits, 1st edition.
4. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2nd Edition.
5. Bushnell and Agrawal, Essentials of Electronic Testing for Digital, Memory & Mixed-Signal Circuits, Kluwer Academic Publishers.

Course Outcomes: At the end of the course student will be able to

1. understand the difference between Design, Verification and Test.
2. understand the Physical faults and their modelling
3. understand Fault Simulation and Testability Measures.
4. identify the design for testability methods for combinational & sequential CMOS circuits.

ECPE-xx RF Microelectronics

Pre-requisite: ECPC-21 (Electronics Device and Circuits) and ECPC-26 (Analog Electronics) ECPE-xx (Analog IC Design)

L	T	P	Credits	Total contact hours
3	1	0	4	4

Brief Description of the Course:

Course Objectives: To impart knowledge on basics of IC design at RF frequencies.

1. To learn the fundamentals of RF filter design, high-frequency amplifier design and noise in RF circuits.
2. To develop the skills to design RF amplifier, phase-locked loops and RF oscillators.

UNIT-I **Hrs 6**
Active RF Components and their characteristic parameters: RF diodes, BJT, FET, HEMT. **RF Filter Design**: Filter configurations, resonators, filter realizations – Butterworth, Chebychev.

UNIT-II **Hrs 8**
High-Frequency Amplifier Design: Zeros as bandwidth enhancer, shunt series amplifier, bandwidth enhancement with fT doublers, voltage references and biasing, tuned and cascaded amplifiers, RF Power Amplifier Design.

UNIT-III **Hrs 8**
Noise in RF Circuits: types of noise, two port noise theory, Low-Noise Amplifier (LNA) – intrinsic MOSFET two port noise parameters, LNA topologies, design example, LNA Design example.

UNIT-IV **Hrs 8**
Phase-Locked Loops: PLL models, noise properties, sequential phase detectors, loop filters and charge pumps. **RF Oscillators**: tuned and negative resistance oscillators. **Mixers**: non-linear systems as mixers, multiplier based mixers.
RF amplifier design – a case study

Text Books:

1. T. H. Lee, *The Design of CMOS Radio Frequency Integrated Circuits*, CUP.
2. R. Ludwig and P. Bretchko, *RF Circuit Design*, Pearson.
3. B. Razavi, *RF Microelectronics*, PH.

References:

1. B. Leung, *VLSI for Wireless Communication*, PH.
2. B. Razavi, *Phase-Locking in High-Performance Systems*, Wiley/IEEE.
3. B. Razavi, *Monolithic Phase-Locked Loops and Clock Recovery Circuits*, IEEE Press.
4. R. E. Best, *Phase-Locked Loops : Design, Simulation and Applications*, Fifth Edition, MH.

Course Outcomes: At the end of the course student will be able to
CO1: understand the active RF components and their performance metrics.
CO2: analyse the design of a high frequency amplifiers.
CO3: understand the LNA, PLL, Oscillator design techniques.
CO4: distinguish between different types of mixers.

ECPE-xx Analog and Mixed Signal Design

Pre-requisite: ECPC-21 (Electronics Device and Circuits) and ECPC-26 (Analog Electronics) ECPE-xx (Analog IC Design)

L	T	P	Credits	Total contact hours
3	1	0	4	4

Brief Description of the Course:

Course Objectives:

1. To learn the fundamentals of data converters, noise Shaping data converters.
2. To make the students to understand the design of ADC & DAC.

UNIT-I **Hrs 6**

Data Converters:

Introduction, Characteristic Parameters, Basic DAC and ADC Architectures.
Sampling and Aliasing, SPICE models for DACs and ADCs, Quantization Noise

UNIT-II **Hrs 8**

Data Converter SNR: Clock Jitter, Improving SNR using Averaging, decimating filters for ADC's, Interpolating filters for DAC's, Band pass and high pass Sinc filters, using feedback to improve SNR.

UNIT-III **Hrs 8**

Noise Shaping data converters: First order noise shaping, Digital first order NS Modulators, Modulation Noise, Decimating and filtering the output of a NS Modulator, Integrator & Forward modulator gain, op-amp gain, Second order Noise Shaping, Noise shaping Topologies.

UNIT-IV **Hrs 8**

Implementing data converters: R-2R topologies for DAC's – Current mode, voltage mode, wide swing current mode DAC, topologies without an op-amp, effects of op-amp parameters, Implementing ADC's-Implementing S/H, Cyclic ADC, Pipeline ADC -using 1.5 bits per stage, capacitor error averaging, comparator placement, clock generation, offsets and alternative topologies, Layout of Pipelined ADC's.

Text Book:

1. R. J. Baker, CMOS Mixed Signal Cicuit Design, Wiley-IEEE Press; 2nd edition, 2008.

References:

1. A. Handkiewicz, "Mixed-Signal Systems : A Guide to CMOS Circuit Design," Wiley-IEEE, 2002.
2. B. Razavi, "Principles of Data Conversion System Design," Wiley-IEEE Press, 1995.
3. E. Sanchez-Sinencio and A. G. Andreou, "Low-Voltage/Low-Power Integrated Circuits and Systems : Low-Voltage Mixed-Signal Circuits," Wiley-IEEE Press; 1st edition, 1999.
5. Y. Tsividis, "Mixed Analog-Digital VLSI Devices and Technology," World Scientific Pub Co Inc., 2002.

Course Outcomes
At the end of the course student will be able to
CO1: appreciate the fundamentals of data converters and also optimized their performances.
CO2: Understand the SPICE models for ADC and DAC architecture.
CO3: Understand to design the filters for DAC.
CO4: Design the CMOS digital circuits and implement its layout.
CO5: Analyze and design the different structures of ADC & DAC.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECPEXX DSP ARCHITECTURE

Pre-requisite:

Course Code	ECPEXX
Course Title	DSP ARCHITECTURE
Number of Credits	03
Prerequisites (Course code)	DSP, Signal & System, Digital Design, Computer Architecture
Course Type	PE

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives

The objective of this course is to enable the students to impart the knowledge of basic DSP concepts and number systems to be used, different types of A/D, D/A conversion errors. Learn the architectural differences between DSP and General purpose processor. Learn about interfacing of serial & parallel communication devices to the processor. Implement the DSP & FFT algorithms.

UNIT I 8hrs

ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL – PROCESSING DEVICES: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing. L1, L2, L3

UNIT II 12hrs

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction, Commercial Digital Signal-processing Devices, Data Addressing Modes of TMS32OC54XX, Memory Space of TMS32OC54xx Processors, Program Control. Detail Study of TMS320C54X & 54xx Instructions and Programming, On – Chip Peripherals, Interrupts of TMS32OC54XX Processors, Pipeline Operation of TMS32OC54xx Processor. L1, L2, L3

UNIT III 12hrs

IMPLEMENTATION OF BASIC DSP ALGORITHMS: Introduction, The Q – notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters (one example in each case). Implementation of FFT Algorithms: Introduction, An FFT Algorithm for DFT Computation, Overflow and Scaling, Bit – Reversed Index. Generation & Implementation on the TMS32OC54xx. L1, L2, L3.

UNIT IV 10hrs

INTERFACING MEMORY AND PARALLEL I/O PERIPHERALS TO PROGRAMMABLE DSP DEVICES: Introduction, Memory Space Organization, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O Direct Memory Access (DMA). Interfacing and Applications of DSP Processors: Introduction, Synchronous Serial Interface, A CODEC Interface Circuit, DSP Based Bio-telemetry Receiver, A Speech Processing System, An Image Processing System. L1, L2, L3

Case study: Advance architectures for sustainable computing, issues, & performance consideration.

Text Book:

1. Avatar Singh and S. Srinivasan, Digital Signal Processing, Thomson Learning, 2004.

Reference Books:

1. Ifeachor E. C., Jervis B. W, Digital Signal Processing: A practical approach, Pearson-Education, PHI, 2002.
2. B Venkataramani and M Bhaskar, Digital Signal Processors, TMH, 2nd, 2010.
3. Peter Pirsch, Architectures for Digital Signal Processing, John Weily, 2008.

Course Outcomes

At the end of this course, students would be able to:

CO1: Comprehend the knowledge and concepts of digital signal processing techniques.

CO2: Apply the knowledge of DSP computational building blocks to achieve speed in DSP architecture or processor.

CO3: Apply knowledge of various types of addressing modes, interrupts, peripherals and pipelining structure of TMS320C54xx processor. Develop basic DSP algorithms using DSP processors.

CO4: Discuss about synchronous serial interface and multichannel buffered serial port (McBSP) of DSP device. Demonstrate the programming of CODEC interfacing.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX ADVANCED COMPUTER NETWORKS

Pre-requisite: Computer Networks

L	T	P	Credits	Total contact hours
3	-	-	3	45

Course objective:

- To understand the advanced networking concepts for next-generation network architecture and design.
- To study the various protocols at different layers and their differences from traditional protocols.
- To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Unit - I

Packet-Switched Networks: OSI and IP Models, Ethernet, Token Ring, FDDI, DQDB, Frame Relay. The Internet and TCP/IP Networks: The Internet, Internet Protocol, TCP, and UDP, Performance of TCP/IP Networks.

Unit – II

Circuit-Switched Networks: Performance of Circuit-Switched Networks, SONET, Dense Wave-Division Multiplexing, Fiber to the Home, Digital Subscriber Line, Intelligent Networks, CATV, Asynchronous Transfer Mode: Main features, Addressing, Signaling and Routing, ATM Header Structure, ATM Adaptation Layer, Management and Control, BISDN, Internetworking with ATM.

Unit - III

Wireless Networks: Introduction, The Wireless Channel, Link Level Design, Channel Access, Network Design, Wireless Networks Today, Future Systems, and Standards.

Unit – IV

Networks of Queues: closed networks, open networks, estimating parameters and distributions, Computational methods for queueing network solutions, and Security issues in the Internet architecture.

Text Books / Reference:

1. J. Walrand, and P. Varaiya, “High-performance Communication Networks,” Elsevier publication, 2nd edition, 2005.
2. Dimitri Bertsekas, and Robert Gallager, “Data Network,” Pearson publication, 2nd edition, 2015.
3. A. Leon-Garcia, and Indra Widjaja, “Communication Networks,” Mc Graw Hill, 2004
4. James Kurose and Keith Ross, “Computer Networking-a Top-Down Approach”, 7th Ed. Pearson, 2017.

Course Outcomes

CO 1: Understand advanced concepts in high-performance communication networks.

CO 2: Comprehend the study of major communication networks.

CO 3: Analyze specific protocols and control mechanisms that operate these networks.

CO 4: Analyze some of the new principles that are evolving for future networks.

ECPE 8th Sem: Quantum Communication

Pre-requisite:
Linear algebra, Probability Theory

L	T	P	Credits	Contact Hours
3	0	0	3	40

This course provides a comprehensive overview of quantum communication. The objective is to make the students understand fundamental concepts of quantum communication.

Course Contents:

Unit – I (8)
Introduction: Classical networks, overview, Maxwell's equations revisited. Applications of polarization in Quantum Networks.

Unit – II (10)
Photon Polarization, General Quantum Variables and Qubits, Applications of quantum variables in Quantum Networks
Composite Quantum Systems – Applications of quantum systems in Quantum Networks.
Quantum Entanglement, its importance for Quantum Communications.

Unit – III (10)
Experimental Quantum Teleportation of Qubits, engineering sources of Entangled Photons, The No Cloning Theorem,

Unit – IV (12)
Quantum Cryptography, The Benett –Brassard Protocol for Quantum key distribution. Eckert's Protocol for Quantum key distribution using entanglement.
Quantum Teleportation – An Application of composite qubits and entanglement.

Text books:

1. Michael Nielson, Isaac Chuang, "Quantum Computation and Quantum Information"
2. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory"

Course Outcomes
The students will demonstrate the ability
1. Understand quantum communication
2. Analyse quantum cryptography
3. Evaluate the performance of quantum communication
4. Application of quantum teleportation

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Wireless network security

Prerequisite: Wireless communication and basic cryptography

L	T	P	Credits	Total contact hours
3	0	0	3	38

The aim of the course is to develop an understanding of security threats in wireless networks. Furthermore, the course aims to help the student to develop knowledge of encryption methods and security protocols that are applied in next generation wireless networks to reduce the probability of a successful attack.

Unit 1 Introduction to wireless network security, General Computer Communication Network Architecture, Different Types of Wireless Communication Systems, Network Security and Wireless Security, Basic Network Security Concepts :Security Attacks, Security Services, Security Mechanisms, Cryptographic Systems: symmetric and asymmetric key cryptography, MAC and Hash functions, digital signatures and key management. 10hrs

Unit 2 Security for Wireless Local Area Networks, WLAN Security, Introduction to WLAN, Evolution of WLAN Security, Wired Equivalent Privacy, IEEE 802.1X Authentication Model, IEEE 802.11 security Standards. 9hrs

Unit 3 Security for Next Generation Wireless Networks, IoT security, Attacks on different layers, IoT security issues and challenges, light weight cryptography for resource constrained devices, Security in 5G Wireless Networks, Introduction to 5G Wireless Network Systems, 5G Security Requirements and Major Drives, 5G Wireless Security Architecture, 5G Wireless Security Services, 5G Key Management, Security for New Communication Techniques in 5G, Challenges and Future Directions for 5G Wireless Security 10hrs

Unit 4 Bluetooth, RFID and Zigbee security, Concept of Physical layer security, Block chains, their application and limitations, cloud security, Case studies 9hrs

Reference Books

[1] “Wireless Network Security” Osterhage Wolfgang, Taylor & Francis Ltd, 2nd Ed 2018
[2] “Security in Wireless Communication Networks” Qian, Y., Ye, F. and Chen, H.-H. (2022). https://doi.org/10.1002/9781119244400.fmatter, Wiley
[3] B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
[4] W. Stallings, "Cryptography and Network Security", Pearson Education.

Course outcomes

At the end of the course, the students will be able to:

CO1 Understand the various security issues in wireless networks

CO 2 Implement security mechanisms and protocols in wireless communication networks.

CO3 Comprehend and analyze the design principles, mechanisms, and solutions used in wireless network security

CO4 Analyze security challenges in resource constrained devices and future wireless networks

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Multiple Access Techniques

Prerequisites (Course code)	**:**	**ECPC 28**		
L	T	P	Credits	Total contact hours
3	0	0	3	3

Course Title: **Multiple Access Techniques**

Course Description: This course covers the principles and applications of multiple access techniques in wireless communication systems. Topics include frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), orthogonal frequency-division multiple access (OFDMA), Non-orthogonal frequency-division multiple access(NOMA), Rate split multiple access (RSMA) and their applications in wireless communication systems.

UNIT 1: Introduction to Multiple Access Techniques, Historical background and motivation for multiple access techniques, Overview of multiple access techniques, Frequency Division Multiple Access (FDMA), Principles of FDMA and its properties, Design of FDMA systems, Time Division Multiple Access (TDMA), Principles of TDMA and its properties, Design of TDMA systems

UNIT 2: Spread spectrum modulation, Code Division Multiple Access (CDMA), Principles of CDMA and its properties, Design of CDMA systems, Advantages of CDMA, CDMA Near Far Problem and power control, Performance of CDMA uplink and downlink scenario with multiple users, Asynchronous CDMA.

UNIT 3: Introduction of Orthogonal Frequency-Division Multiple Access (OFDMA), Multicarrier transmission, cyclic prefix in OFDM, BER for OFDM, Effect of frequency offset in OFDM, OFDM- Peak to Average Power Ratio (PAPR), SC-FDMA, Design of OFDMA systems

UNIT 4: Advanced Topics in Multiple Access Techniques, Non-orthogonal multiple access (NOMA) techniques, SNR in uplink and downlink NOMA, spectral efficiency and power efficiency in NOMA, Interference analysis and mitigation techniques, cooperative NOMA, MIMO NOMA, Rate split multiple access (RSMA),5G and beyond Emerging trends in multiple access techniques research

Recommended Textbooks:

"Wireless Communications: Principles and Practice" by Theodore S. Rappaport

"CDMA: Principles of Spread Spectrum Communication" by Andrew J. Viterbi and Jim K. Omura

"Multiple Access Communications: Foundations for Emerging Technologies" by David J. Goodman

Course outcomes:

At the end of the course, the students will be able to:

CO1: Evaluate the performance of FDMA and TDMA

CO2: Evaluate the performance of CDMA systems.

CO3: Evaluate the performance of OFDMA systems.

CO4: Find the research issues in multiple access techniques in 5G and beyond wireless networks.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Pattern Recognition

Pre-requisite: …….

L	T	P	Credits	Total contact hours
3	0	0	3	40

Course Learning Objectives:

The student should be able to understand and apply the various concepts of Pattern recognition and machine learning.

Course Content:

UNIT I

Polynomial Curve Fitting, Probability Theory Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory, Probability Distributions, Binary Variables, Multinomial Variables, The Gaussian Distribution ,The Exponential Family, Nonparametric Methods, Linear Models for Regression, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison, Linear Models for Classification, Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, Bayesian Logistic Regression.

UNIT II

Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Mixture Density Networks, Bayesian Neural Networks Dual Representations, Constructing Kernels, Radial Basis Function Networks, Gaussian Processes, Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical Models,

UNIT III

Mixture Models and EM, K-means Clustering, Mixtures of Gaussians, The EM Algorithm in General, Approximate Inference, Sampling Methods, Basic Sampling Algorithms, Markov Chain Monte Carlo, Gibbs Sampling. Principal Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models, Sequential Data, Markov Models, Hidden Markov Models, Linear Dynamical Systems, UNIT IV

Combining Models, Bayesian Model Averaging, Committees, Boosting, Tree-based Models, Conditional Mixture Models. Application of pattern recognition in biometric recognition systems, character / digit recognition etc.

Reference Books:

1. C. M. Bishop, Pattern Recognition and machine learning, springer, 2006.

2. Duda, Hart and Stork, Pattern Classification, Wiley 2006.

3. Tom M. Mitchell, Machine Learning, Mc Graw-Hill, 1997.

Course outcomes:

At the end of the course student will be able to:

1. Develop the understanding about fundamentals of pattern recognition and machine learning.

2. Apply supervised and unsupervised learning techniques.

3. Understand and apply SVM and graphical models.

4. Understand different clustering techniques.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX SENSORS

Prerequisites (Course code)	:	ECPE70

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description

In recent years, technological advances have resulted in the rapid development of a new and exciting research direction – the interdisciplinary use of sensors for data collection, systems analysis, and monitoring. These highly calibrated sensors require precision engineering techniques that play an important role in analyzing and integrating large datasets. Sensor networks in particular represent a very active area of research, including work on problems such as sensor network localization and network design. Application areas for sensors and sensor networks include environmental monitoring, military surveillance, computational neuroscience, seismic detection, and a great deal more. The fundamental problems of utilizing the collected data for efficient system operation and decision making encompasses multiple research areas, including applied mathematics, optimization, signal/image processing, as well as emerging areas that require interdisciplinary techniques from several fields of research.

Course Contents

UNIT-I

Introduction to Sensors, Definition of sensors and their importance, Basic concepts and terminology related to sensors, Classification of sensors based on various criteria
Sensor Principles and Working Mechanisms, Overview of different types of sensors (e.g., temperature, pressure, motion, light), Explanation of underlying physical and electrical principles, Sensor characteristics and specifications (accuracy, resolution, linearity, etc.)

UNIT-II

Sensor Technologies and Transducers, Review of common sensor technologies (e.g., resistive, capacitive, inductive, optical), Transducers and signal conditioning circuits, Sensor packaging and integration techniques
Sensor Interfaces and Data Acquisition, Introduction to analog-to-digital conversion, Sensor interface circuits (amplifiers, filters, multiplexers), Data acquisition systems and protocols (e.g., ADC, SPI, I2C)

UNIT-III

Sensor Applications and Systems, Sensors in various industries (automotive, aerospace, healthcare, etc.), Sensor networks and wireless sensor systems, Sensor fusion and integration with other technologies (e.g., IoT, AI)
Sensor Calibration and Testing, Importance of sensor calibration, Calibration techniques and standards, Sensor testing methodologies (accuracy, repeatability, drift)

UNIT-IV

Emerging Trends in Sensors, Overview of recent advancements in sensor technology, Nanosensors and MEMS (Micro-Electro-Mechanical Systems), Wearable and flexible sensors, Sensors for ADAS Application to various sustainable technologies, case studies from the Indian knowledge system.

Reference books

1. Sensors and Actuators, D. Patranabis, 2nd Ed., PHI, 2013.
2. Make sensors: Terokarvinen, kemo, karvinen and villey valtokari, 1st edition, maker media, 2014.
3. Sensors handbook- Sabrie soloman, 2nd Ed. TMH, 2009
4. Handbook of Modern Sensors, J. Fraden, Fourth Edition, Springer

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Optical Communication Networks

Pre,requisite: ECPC 25

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

In this course, students will learn optical fiber sources and transmission techniques, the idea of optical fiber networks algorithm such as SONET/SDH and optical CDMA. Further students will explore trends of optical fiber measurement systems.

Unit-I

Introduction to Optical Fibers: Evolution of fiber optic system, Element of an Optical Fiber Transmission link, Total internal reflection, Acceptance angle, Numerical aperture, Skew rays, Ray Optics, Optical Fiber Modes and Configurations, Mode theory of Circular Wave guides, Overview of Modes, Key Modal concepts, Linearly Polarized Modes, Single Mode Fibers, Graded Index fiber structure.

Signal Degradation in Optical Fibers: Attenuation, Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides, Information Capacity determination, Group Delay, Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers, Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers, Mode Coupling, Design Optimization of SM fibers, RI profile and cut-off wavelength.

Unit-II

Fiber Optical Sources and Coupling: Direct and indirect Band gap materials, LED structures , Light source materials, Quantum efficiency and LED power, Modulation of a LED, lasers Diodes, Modes and Threshold condition, Rate equations, External Quantum efficiency, Resonant frequencies, Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers, Power Launching and coupling, Lencing schemes, Fiber -to,-Fiber joints, Fiber splicing, Signal to Noise ratio, Detector response time.

Unit-III

Fiber-Optic Receiver and Measurements: Fundamental receiver operation, Pre amplifiers, Error sources, Receiver Configuration, Probability of Error, Quantum limit, Fiber Attenuation measurements, Dispersion measurements, Fiber Refractive index profile measurements, Fiber cut, off Wavelength Measurements, Fiber Numerical Aperture Measurements, Fiber diameter measurements.

Unit-IV

Optical Networks and System Transmission: Basic Networks, SONET / SDH, Broadcast, and select WDM Networks, Wavelength Routed Networks, Non-linear effects on Network performance, Link Power budget, Rise time budget, Noise Effects on System Performance, Operational Principles of WDM Performance of WDM + EDFA system Solutions, Optical CDMA, Ultra High Capacity Networks.

Reference Books:

1. Keiser, Gerd. Optical fiber communications. Vol. 2. New York: McGraw-Hill, 2000.

2. John, M. Senior. Optical Fiber Communication-Principle and Practice. Prentice Hall, 2009.

3. Ramaswami, Rajiv, Kumar Sivarajan, and Galen Sasaki. *Optical networks: a practical perspective*. Morgan Kaufmann, 2009.

4. J.Gower. *Optical Communication System.* Prentice Hall of India, 2001.

Course Outcomes:

At the end of the course student will be able to…

CO 1 Discuss the various optical fiber modes, configurations and various signal degradation factors associated with optical fiber.

CO 2 Explain the various optical sources and optical detectors and their use in the optical communication system.

CO 3 understand basics of Fiber-Optic Receiver and Measurements**.**

CO 4 Analyze the digital transmission and its associated parameters on system performance

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Sonar System/Under water Communication

Pre-requisite: ECPC 26, ECPC 28, ECPC 32

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course provides an outline about sonar systems, its types and their applications. The course will provide overview of signal processing and filtering options for output received from sonar systems and acoustic modems. It will discuss acoustic modems and underwater sensor networks.

Unit-I

Types of sonar systems: active and passive, sonar equations, propagation characteristics of the medium, transmission loss and spreading effects, beam forming and steering, detection threshold, square law detector, cross-correlation detector, Ambient noise: sources of ambient noise, shallow water ambient noise, effect of depth, directional characteristics of deep water ambient noise, electrical noise, machinery noise, flow noise, propeller noise, self-noise and radiated noise.

Unit-II

Correlation receivers and matched filters: Advanced Sonar Signal Processing functions, adaptive beam forming, synthetic aperture arrays, automated decision making.

Orthogonal Frequency division multiplexing: Key features, characteristics and principle of operation of OFDM, Channel coding and interleaving System model, Enhancement of spectral efficiencies, Transmission/ Reception of OFTD - OFDM Simulations.

Unit-III

Acoustic Modem: Underwater Wireless Modem, Sweep spread carrier signal, transmission characteristics in shallow water channel, separation of time varying multipath arrivals, Typical acoustics modems, characteristics and specifications, Applications, Acoustic Releases, Real time wireless current monitoring system.

Unit-IV

Underwater Sensor Network: Underwater Networking, Ocean Sampling Networks, Pollution Monitoring, Environmental Monitoring and Tactical surveillance systems, Major challenges in design of Underwater Sensor Networks, Factors that affect the UWSN, Sensor Node Architecture, GIBS, VRAP, DABSRAPT. etc.

Reference Books:

1. Urick, Robert J. *Principles of underwater sound*. McGraw Hill Book Company, New York (1975).

2. Waite, Ashley D. *Sonar for practising engineers*. Wiley, 2002.

3. Marple Jr, S. Lawrence, and William M. Carey. Digital spectral analysis with applications. Prentice Hall. Signal Processing Series 1989.

4. Oppenheim, Alan V. Applications of digital signal processing. Prentice Hall, Englewood Cliffs (1978).

5. Antoniou, Andreas. *Digital filters: analysis, design, and signal processing applications*. McGraw-Hill Education, 2018.

6. Vogel, Michael, Darryl Symonds, Ning Xiao, Tim Cook, and Charles Abbott. "Real-time deepwater current profiling system." In *MTS/IEEE Oceans 2001. An Ocean Odyssey. Conference Proceedings (IEEE Cat. No. 01CH37295)*, vol. 1, pp. 269-274. IEEE, 2001.

7. Akyildiz, Ian F., Dario Pompili, and Tommaso Melodia. "Underwater acoustic sensor networks: research challenges." *Ad hoc networks* 3, no. 3 (2005): 257-279.

8. Vasilescu, Iuliu, Keith Kotay, Daniela Rus, Matthew Dunbabin, and Peter Corke. "Data collection, storage, and retrieval with an underwater sensor network." In *Proceedings of the 3rd international conference on Embedded networked sensor systems*, pp. 154-165. 2005.

Course Outcomes:

At the end of the course student will be able to…

CO 1 understand basics of transducers and array systems used for sonar.

CO 2 comprehend the Signal processing, filtering and noise impact on sonar systems.

CO 3 Classify sonar systems and modern its versions.

CO 3 understand underwater sensor networks.

Array Signal Processing

UNIT 1

Introduction: Signal Detection and Enhancement, Signal Characterization, Tracking, Filtering vs Parameter Estimation.

UNIT 2

Apertures and Arrays: Finite continuous Apertures, Aperture Smoothing Function, Apparent Velocity, Aberrations, Co-Array for Continuous Apertures, Focusing, Spatial Sampling, Periodic Spatial sampling in One Dimension, Sampling of Multidimensional Signals, Arrays of Discrete Sensors, Regular Arrays, Grating Lobes, Irregular Arrays, Correlation sampling and the Co-Array, Sparse Linear Arrays, Random Arrays.

UNIT 3

Beamforming: Delay-and-Sum Beamforming, Near-Field and Far-Field Sources, Beamforming for Plane Waves, Beamforming for Spherical Waves, Space-Time Filtering, Array Pattern, Plane wave (far-field) array pattern, Point Focusing (near-field) array pattern, wavenumber-Frequency Response, Beampattern and Steered Response, Filter-and-Sum Beamforming, Temporal Filtering, Spatial Filtering, Spatiotemporal Filtering, Frequency-Domain Beamforming, Array Gain, Resolution, Sampling in Time, Discrete-Time Beamforming, Averaging in Time and Space.

UNIT 4

Detection Theory: Elementary Hypothesis Testing, Hypothesis Testing in Presence of Unknowns, Detection of Signals in Gaussian Noise, Detection in Presence of Uncertainties, Detection-Based Array Processing Algorithms, Signals with Unknown Parameters.**Estimation Theory:** Terminology in Estimation Theory, Parameter Estimation, Signal Parameter Estimation, Linear Signal Waveform Estimation, Spectral Estimation.

Book:

Array Signal Processing Concepts and Techniques by Don H. Johnson and Dan E. Dudgeon
Prentice Hall Signal Processing Series Alan V. Oppenheim, Series Editor

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Optical Signal Processing

Pre-requisite: ECPC 25

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

In this course, students will learn about various types of ultrafast All-Optical Signal Processing Devices, Principles of photonic devices used in optical signal processing, Semiconductor Optical Amplifier Based Ultrafast Signal Processing Devices and Wavelength Conversion Devices.

Unit-I

Introduction: Evolution of Optical Communication Systems and Device Technologies, Increasing Communication Traffic and Power Consumption, Future Networks and Technologies, Ultrafast All-Optical Signal Processing Devices: Challenges, Basics of the Nonlinear Optical Process, Overview of the Devices and Their Concepts.

Unit-II

Principal Photonic Devices for Processing: Some Processor Components, Optical Amplifiers, Noise Considerations of EDFAs and Impact on System Performance, Optical Modulators, Lithium Niobate Optical Modulators, Electro-Absorption Modulators, Operational Principles and Transfer Characteristics, Modulation Characteristics and Transfer Function, Chirp in Modulators, Electro-Optic Polymer Modulators, Modulators for Photonic Signal Processing.

Unit-III

Semiconductor Optical Amplifier Based Ultrafast Signal Processing Devices: Fundamentals of SOA, SOA as an Ultrafast Nonlinear Medium, Use of Ultrafast Response Component by Filtering, Theoretical Background, Signal Processing Using the Fast Response Component of SOA, Symmetric Mach–Zehnder (SMZ) All-Optical Gate, Fundamentals of the SMZ All-Optical Gate, Technology of Integrating Optical Circuits for an SMZ All-Optical Gate, Optical Demultiplexing, Wavelength Conversion and Signal Regeneration.

Unit-IV

Wavelength Conversion Devices: Wavelength Conversion Schemes, Physics of Four-wave Mixing in LDs or SOAs, Wavelength Conversion of Short Pulses Using FWM in Semiconductor Devices, The Future View of Wavelength Conversion Using FWM, The Future View of Wavelength Conversion Using FWM, Summary and Future Prospects.

Reference Books:

1. Ishikawa, Hiroshi, ed. *Ultrafast all-optical signal processing devices*. John Wiley & Sons, 2008.

2. Binh, Le Nguyen. *Photonic signal processing Techniques and Applications*. Taylor & Francis, a CRC title, 2019.

Course Outcomes:

At the end of the course student will be able to…

CO 1 understand basics of Non-linear optical processes and types of various types of ultrafast All-Optical Signal Processing Devices

CO 2 comprehend the basic principles of photonic devices used in optical signal processing strategies.

CO 3 understand basics of Semiconductor Optical Amplifier Based Ultrafast Signal Processing Devices

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPE—MIMO SYSTEMS

Pre-requisite: Students need prior knowledge of signals and systems, analog and digital communications, and information and coding schemes.

L	T	P	Credits	Total contact hours
3	-	-		42

Brief Description about the course

It is envisaged that the course will provide the fundamentals and basic concepts of SISO, MISO and MIMO wireless channels and their effect on the system performance.

Unit - I 8 hrs.

Introduction to multi antenna systems
A comparative analysis of single antenna and multi antenna systems. Space time wireless channels systems, Shannon's capacity formula, and Extended Capacity formula for MIMO channels. Capacity of SIMO- MISO channels. Capacity with Rice and Rayleigh channels for multi antenna systems.

Unit – II 14 hrs.

Introduction to Space time coding
Introduction, MIMO System and space time coding: Methodologies and diversity, Overview of diversity techniques of SIMO, MISO and MIMO systems. Space time block codes: Alamouti transmit technique, orthogonal space time block codes. Space time trellis codes: Encoding and decoding, Performance analysis and code design. Spatial multiplexing: V-Blast Algorithm, Space time coding with CSI knowledge, no CSI knowledge and partial CSI knowledge at the transmitter.

Unit - III 10 hrs.

Feedback Techniques and Antenna Selection in MIMO Systems

Feedback Techniques introduction, Limited feedback MIMO: System Description, channel quantization, quantized signal adaptation, Quantized signal Adaptation algorithms: Beam forming example, precoded orthogonal space time block codes, precoded spatial multiplexing. Antenna Selection: Implementing Antenna Selection: Criteria and Algorithms, Performance with non-idealities. Antenna selection with spatial correlation.

Unit – IV 10 hrs.

Real Time MIMO Signal Processing and General Issues

Implementation Concept, Channel Estimation, Adaptation to time variant channel, Data Reconstruction. Implementation, Complexity and system integration. Issues: Network planning: Introduction to network planning. Coverage and capacity enhancement methods. Base stations with downlink transmit diversity and beam forming, Deployment, Smart Antenna Planning Example.

Text Books / Reference

1. George Tsoulos; MIMO System Technology for wireless communications, Taylor & Francis Group.
2. Claude Oestges, Bruno Clerckx; MIMO wireless communications: from real world propagation to space time coding design, Elsevier
3. Volker Kuhn,Wreless Communication over MIMO Chaneels, John Wiley.

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basics of wireless channels, SIMO, MISO, MIMO systems, and different diversity schemes.

CO2: Apply different diversity techniques to compute system performance.

CO3: Classify and analyse different antenna selection algorithms for MIMO systems.

CO4: Apply network planning to enhance coverage and capacity.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX: **Mathematics for Machine Learning**

Faculty: Dr. Hemant Sharma

Pre-requisite: Linear Algebra.

L	T	P	Credits	Total contact hours
3	0	0	3	40

i) Brief Description about the course

Machine learning is a growing field at the intersection of probability, statistics, optimization, and computer science, which aims to develop algorithms for making predictions based on data. This course is an introduction to key mathematical concepts at the heart of machine learning. This course will cover basic models and mathematics for machine learning, including statistical learning theory and neural networks.

ii) **Unit - I**

Introduction: Vectors in machine learning, Vector space, Subspace, Basis and dimension, Norms and spaces, Features and models, Least squares, linear independence and orthogonality, Linear classifiers, Loss, risk.

8 hrs.

Unit – II

Vector calculus (e.g., partial derivatives, chain rule, Jacobian), Basic probability distributions, Bayes' theorem, Model selection, Cross validation, Underfitting, Overfitting, and Regularization.

10 hrs.

Unit - III

Dimensionality reduction, Principal component analysis, Linear discriminant Analysis, Singular value decomposition, Least square approximation, Linear and nonlinear regression, Bayesian linear regression, Logistic regression, Kernel methods, and Support vector machines

10 hrs.

Unit - IV

Gradient Descent, Neural networks and backpropagation, Maximum likelihood estimation, Gaussian mixture models, Unsupervised learning and clustering, AdaBoost, Decision trees, Random forests, Applications: face recognition and recommender systems.

10 hrs.

Text Books / Reference

1. Christopher M. Bishop, Pattern recognition and machine learning, Springer, 2006.
2. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, Cambridge University Press.
3. Lars Elden, Fundamentals of Algorithms Matrix Methods in Data Mining and Pattern Recognition, SIAM Publication Library

Course Outcomes

CO 1: Understanding of role of vectors and orthogonality principles in machine learning.

CO 2: Demonstration of applicability of vector calculus in optimizing machine learning models.

CO 3: In-depth analysis of dimensionality reduction techniques and linear and non-linear curve fitting methods.

CO 4: Utilization of different machine learning models in a variety of applications.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX : SPACE-TIME CODING

Pre-requisite: Information Theory and Coding, Digital Communication, Signals, MIMO Systems

L	T	P	Credits	Total contact hours
3			3	40

Brief Description about the course:

Space time coding provides the fundamental principles of space-time coding for wireless communications over multiple-input multiple-output (MIMO) channels. This course introduces the design criteria for space-time codes and contains a detailed treatment of the theory behind space-time block codes and space-time trellis codes. The course also includes practical coding methods for achieving the performance improvements of MIMO communication systems. The students will learn the theory behind space time coding and the design techniques for orthogonal and pseudo orthogonal space time codes, space time trellis codes and differential space time modulation methods with real world examples.

Course Learning Objectives

To understand the concept of coding for MIMO systems, Design of Orthogonal Space-Time Block Codes and Space-Time Trellis Codes for applications in wireless communication.

Course Content

UNIT I (10 L)

ORTHOGONAL SPACE-TIME BLOCK CODES: Spatial multiplexing gain and its trade-off with diversity. Transmission model for multiple-input multiple-output channels. Capacity of MIMO channels. Space-time code design criteria: Rank and determinant criteria, Trace criterion, Maximum mutual information criterion. Orthogonal space-time block codes. Alamouti code, Real and complex orthogonal designs.

UNIT II (10 L)

PSEUDO-ORTHOGONAL AND QUAI- ORTHOGONAL SPACE-TIME BLOCK CODES: Pseudo-orthogonal space-time block codes, Quasi-orthogonal space-time block codes. Pairwise decoding, Rotated QOSTBCs, Optimal rotation and performance of QOSTBCs, Other examples of QOSTBCs, QOSTBCs for other than four transmit antennas.

UNIT III (10 L)

SPACE-TIME TRELLIS CODES: Introduction to Space-time trellis codes, Improved STTCs, Performance analysis of STTCs, Super-orthogonal space-time trellis codes, CGD analysis, Encoding and decoding, Performance analysis of super-orthogonal space-time trellis codes Extension to more than two antennas.

UNIT IV (10 L)

DIFFERENTIAL SPACE-TIME MODULATION AND NON-ORTHOGONAL STBCs: Introduction to Differential space-time modulation, Differential encoding and decoding, Extension to more than two antennas. Non-orthogonal space-time block codes, Linear dispersion space-time block codes, Space-time block codes using number theory, Threaded algebraic space-time codes. Implementation of space-time codes in real systems and case studies.

Reference Books:

1. Hamid Jafarkhani, Space-Time Coding: Theory and Practice, Cambridge University Press, 2005.

2. Erik G. Larsson, Petre Stoica, Space-Time Block Coding for Wireless Communications, Cambridge University Press, 2008.

3. M. Jankiraman, Space-Time Codes and MIMO Systems, Artech House, 2004.

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Course outcomes

At the end of the course, student will be able to

1. Understand the concept of coding for MIMO systems.
2. Analyse the requirement of coding and apply the concept of channel coding for improvement in the performance of the system.
3. Understand and design the orthogonal space-time block codes.
4. Understand and design the Space-time trellis codes.
5. Understand various variants of Space-time codes and apply them.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX Memory Testing

Pre-requisite: Digital Design, VLSI Testing and Verification

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Learning Objectives

To understand the basics of memory testing, memory fault models and challenges associated with memory testing.

Course Content

UNIT-I Hrs 10

Introduction to Memory Testing: Memory architecture and organization, Memory faults and defects, Memory testing methodologies, Memory test equipment and software

UNIT-II Hrs 10

Memory Test Algorithms: March algorithms, Checkerboard algorithms, Walking 1's and 0's algorithms, Random access algorithms, March-C algorithms, BIST algorithms

UNIT-III Hrs 10

Memory Fault Models: Stuck-at faults, Transition faults, Bridging faults, Coupling faults, Cell faults, Address decoder faults

UNIT-IV Hrs 12

Memory Test Modes: Functional testing, Parametric testing, Diagnosis testing, Burn-in testing, Screening testing, Reliability testing, Memory Repair and Redundancy: Memory repair techniques, Memory redundancy techniques, Memory yield analysis

Text Books / Reference

1. Memory Fault Diagnosis and Tolerance: Techniques and Applications by Bhavani Shankar, Dhiraj Pradhan, and Nur A. Touba.
2. Memory Systems: Cache, DRAM, Disk by Bruce Jacob, Spencer Ng, and David Wang.
3. Memory Controllers for Real-Time Embedded Systems: Predictable and Composable Real-Time Systems by Benny Akesson and Kees Goossens.
4. Testing and Reliable Design of CMOS Circuits by David M. Harris and Mike Bushnell.
5. Defect-Oriented Testing for CMOS Analog and Digital Circuits by Xiaoqing Wen and Chun-Huat Heng

Course Outcomes:

Students will be able to:

CO1: learn memory architecture and organization

CO2: understand memory test algorithms.

CO3: learn memory fault models.

CO4: understand the memory reliability and role of memory testing.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECOEXX MEMS

L	T	P	Credits	Total contact hours
3	0	0	3	42

Pre-requisites: Semiconductor basics, Microelectronics and MOS devices.

Brief Description about the course

Research and development of MEMS builds on advances in silicon processing infrastructure for creating micron-scale machines. Unlike conventional ICs, MEMS devices have many functions, such as communication, sensing and actuation. This course will cover a wide range of topics including MEMS design and layout, bulk and surface micromachining, fabrication processes and applications, for example biosensors in medical applications, inertial transducers for navigation and

Unit I: Introduction to MEMS and Micro fabrication: MEMS Roadmap, MEMS markets, Benefits of Miniaturization, Benefits of Scaling. Micro fabrication: Basic Fabrication Processes, Oxidation, Film Deposition, Lithography, Etching, Ion Implantation, Diffusion. Micro ElectroMechanical Systems. **12 hrs**

Unit II: MEMS Devices: Pressure sensors, RF MEMS Switch, Temperature sensors, Humidity sensors. Microactuators: Electromagnetic and Thermal micro actuation. Physical Microsensors: Classification of physical sensors. Sensor Principles. Examples: Thermal sensors, Electrical Sensors, Chemical Sensors and Biosensors. **12 hrs**

Unit III: Mechanics of MEMS Materials: Stress-strain-material properties. Measurement and characterization of mechanical parameters. Microstructural Elements: bending moment and strain-flexural rigidity. **10 hrs**

Unit IV: Mechanical miniature devices. Electromagnetic actuators and sensors. RF/Electronics devices. Optical/Photonic devices. Medical devices e.g., DNA-chip, micro-arrays. **10 hrs**

Case study: BioMEMS.
Case study: Emerging MEMS technologies.

Text Books/ References:

1. **Chang Liu**, “Foundations of MEMS”, Second Edition, Prentice-Hall, 2012.
2. **Tai-Ran Hsu**, “MEMS and Microsystems Design and Manufacture”, Tata McGraw Hill, 2017.
3. **D. K. Bhattacharya** and **B. K. Kaushik**, “Microelectromechanical Systems”, Cengage, ISBN: 9788131525883, 2015.
4. **S. D. Senturia**, “Microsystem Design”, Springer, 2000.

5. **M. J. Madou**, “Fundamental of Microfabrication”, Second Edition CRC Press, 2002.
6. **N. Maluf**, “An Introduction to Microelectromechanical Systems Engineering”, vol. 13, no. 2, IOP Publishing Ltd, 2002.
7. **Md. Gad-el-Hak**, “MEMS Handbook”, Applied Mechanics Reviews, vol. 55, no. 6, 2002.

Course Outcomes:

At the end of this course, students will be able to:

CO1 Understand fundamental principles of sensing and actuation in MEMS.

CO2 Understand the principle, design, and fabrication techniques of recent devices in the MEMs industry.

CO3 Understand the basic principles and applications of micro-fabrication processes, such as photolithography, ion implantation, diffusion, oxidation, CVD, PVD, and etching.

CO4 Students will be able to consider recent advancements in the field of MEMS and devices.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX EMBEDDED SYSTEM SECURITY

Pre-requisite: CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description: In this subject, the background, foundation and basic approaches in Embedded Systems security is covered. It also introduces embedded security issue. It includes security major concerns data, design and system protection. The learning of cryptographic concepts in the context of embedded systems and their unique constraints and requirements is done.

Unit - I Introduction to Embedded Systems Security (10)
Security, Identification, Authentication and Authorization, Embedded System Security Requirements and issues, Embedded Security Trends, Security Policies, Security Threats.

Unit – II Systems Software Considerations (10)
The Role of the Operating System, Embedded Software attack and counter-measures, Multiple Independent Levels of Security, Microkemel versus Monolith, Core Embedded Operating System Security Requirements, Access Control and Capabilities, Hypervisors and System Virtualization, I/O Virtualization, Remote Management, Assuring Integrity of the TCB.

Unit – III Secure Embedded Software Development (8)
Introduction to PHASE-Principles, Minimal Implementation, Secure Development Process, Independent Expert Validation, Model-Driven Design.

Unit – IV Embedded Cryptography (12)
The One-Time Pad, Cryptographic Modes, Block Ciphers, Authenticated Encryption, Secret key Cryptography- DES, AES, Public Key Cryptography, Key Agreement, Public Key Authentication, Elliptic Curve Cryptography, Cryptographic Hashes, Message Authentication Codes, Random Number Generation, Key Management for Embedded Systems, Cryptographic Certifications, AES.

Text Books / Reference

1. Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development- David Kleidermacher, Mike Kleidermacher, Publisher Newnes.

2. Practical Embedded Security: Building Secure Resource Constrained Systems - Timothy Stapko, Publisher Newnes.

3. Cryptography: Theory and Practice - 3rd Ed. SD Stinson, CRC Press.

Course Outcomes

Students will be able to

CO 1 Have a comprehensive overview of Embedded System security.

CO 2 Develop an understanding as to why security and its management are important for any modem organization.

CO 3 Understand how an Embedded System security management system should be planned, documented, implemented and improved.

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ADVANCE MICROPROCESSOR & MICROCONTROLLER

Pre-requisite: Digital Design, Microprocessor & Microcontroller

L	T	P	Credits	Total contact hours
3			3	40

Brief Description about the course:

- To expose the students to the fundamentals of microprocessor architecture.
- To introduce the advanced features in microprocessors and microcontrollers.
- To enable the students to understand various microcontroller architectures

Unit- I hrs. 10

Intel 80386 Microprocessor: Architecture - Registers – Descriptors - Real Mode - Protected mode - Virtual 8086 mode - Paging and Segmentation - Comparison with 80486 Microprocessor. Pentium class of processors: RISC and CISC architectures - Superscalar Architecture - MMX technology – SSE – Pipelining - Branch Prediction techniques – FPU - Comparative study of features of Pentium-II, Pentium-III and Pentium-IV processors.

Unit- II hrs. 10

Intel 64 bit processors-:Overview of 64 bit processor execution environment – Memory organization – IA-32 memory models – Memory organization in 64 bit mode – Extended physical addressing in protected mode - Basic program execution registers – Operand addressing. Multicore Architectures: Concepts – Power reduction techniques in processors – Comparison of Intel Skylake, Goldmont and Ice Lake microarchitectures

Unit- III hrs. 10

8051 microcontroller: Architecture - pin configuration - addressing modes - instruction set – programming - timers – counters - Programming - interrupts- communication interfaces - interfacing with DAC, ADC, stepper motor.

Unit- IV hrs.10

PIC micro controllers: PIC family - PIC16F84A: Features - architecture – data memory organization – RAM - Program memory - ROM – instruction types and addressing modes-instruction cycle -ports - Introduction to programming PIC microcontrollers using MPLAB.

Case study: Different Processor Technology for sustainable computing.

References:

1. Lyla B. Das, The x86 Microprocessors: 8086 to Pentium, Multi cores, Atom and the 8051 Microcontroller, 2/e, Pearson Education. ISBN-13: 978-9332536821.

2. Barry B. Brey, The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit Extensions : Architecture, Programming, and Interfacing, Pearson Education India, ISBN:9788131726228.

3. Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers, Newnes Publisher, ISBN:9780080961842

4. Andrew N.Sloss, Dominic Symes and Chris Wright " ARM System Developer"s Guide : Designing and Optimizing System Software" , First edition, Morgan Kaufmann Publishers, 2004.

5. Intel x86 processors programmer's reference manuals.

Course Outcomes

On completion of this course the student will be able to:

CO 1 Familiarize 32bit, 64bit and multi core architectures.

CO 2 Learn the architecture and programming with 8O51 microcontroller.

CO 3 Explain the basic architecture and features of PIC microcontrollers.

CO 4 work with suitable microprocessor / microcontroller for a specific real world application.

ECPE 8th Sem: Quantum Communication

Pre-requisite:
Linear algebra, Probability Theory

L	T	P	Credits	Contact Hours
3	0	0	3	40

This course provides a comprehensive overview of quantum communication. The objective is to make the students understand fundamental concepts of quantum communication.

Course Contents:

Unit – I (8)
Introduction: Classical networks, overview, Maxwell's equations revisited. Applications of polarization in Quantum Networks.

Unit – II (10)
Photon Polarization, General Quantum Variables and Qubits, Applications of quantum variables in Quantum Networks
Composite Quantum Systems – Applications of quantum systems in Quantum Networks.
Quantum Entanglement, its importance for Quantum Communications.

Unit – III (10)
Experimental Quantum Teleportation of Qubits, engineering sources of Entangled Photons, The No Cloning Theorem,

Unit – IV (12)
Quantum Cryptography, The Benett –Brassard Protocol for Quantum key distribution. Eckert's Protocol for Quantum key distribution using entanglement.
Quantum Teleportation – An Application of composite qubits and entanglement.

Text books:

1. Michael Nielson, Isaac Chuang, "Quantum Computation and Quantum Information"
2. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory"

Course Outcomes
The students will demonstrate the ability

1. Understand quantum communication
2. Analyse quantum cryptography
3. Evaluate the performance of quantum communication
4. Application of quantum teleportation

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPEXX 6G Networks

Prerequisites (Course code)	**:**	**ECPC 34**		
L	**T**	**P**	**Credits**	**Total contact hours**
3	**0**	**0**	**3**	**3**

Course Title: 6G Networks

Course Description: This course covers the principles and applications of 6G networks. Topics include the requirements and challenges for 6G networks, key technologies such as terahertz communication, AI-based networking, and new network architectures, and their applications in various domains.

UNIT 1: Introduction to 6G Networks, Historical background and motivation for 6G networks, Overview of 6G network requirements and challenges, Terahertz Communication for 6G Networks, Principles of terahertz communication, Design of terahertz communication systems

UNIT 2: Artificial Intelligence-based Networking for 6G Networks, Principles of AI-based networking, Design of AI-based networking systems, New Network Architectures for 6G Networks, Principles of new network architectures (e.g., cell-free networks, network slicing), Design of new network architectures for 6G networks

UNIT 3: Applications of 6G Networks in Different Domains, Applications of 6G networks in healthcare, transportation, and smart cities, Case studies of 6G networks in different domains, Advanced Topics in 6G Networks, Intelligent edge computing for 6G networks, Quantum communication for 6G networks, Distributed ledger technology for 6G networks

UNIT 4: Performance Analysis of 6G Networks, Metrics and performance evaluation of 6G networks, Interference analysis and mitigation techniques for 6G networks, Future Directions in 6G Networks, merging trends in 6G networks research, Potential impact of 6G networks on society and the economy

Recommended Textbooks:

"6G Technology: Performance, Applications, and Challenges" by Mohammad Patwary, Mohammad Alamgir Hossain, and Atiqur Rahman

"6G Wireless Communications: Vision and Potential Techniques" by Muhammad Zeeshan Shakir, Bilal Muhammad, and Halim Yanikomeroglu

"6G Mobile Networks: Vision, Requirements and Challenges" edited by Sudhir Dixit, Ramjee Prasad, and Johan Torsner

Course outcomes:

At the end of the course, the students will be able to:

CO1: Understand the 6G networks

CO2: Understand the artificial Intelligence-based Networking for 6G Networks.

CO3: Understand the applications of 6G Networks in Different Domains

CO4: Find the future Directions in 6G Networks.

Cloud Computing

Objective:- The objectives of this subject are:

1) To provide end-to-end coverage of fundamental cloud computing topics as they pertain to both technology and business considerations.

2) To impart knowledge and understanding of technical underpinnings, supporting technologies and best practices to design, implement and deploy service and cloud computing in enterprises.

Syllabus:-

Introduction and Evolution of Computing Paradigms: Overview of Existing Hosting Platforms, Cluster Computing, Grid Computing, Utility Computing, Autonomic Computing, mesh, Introduction to Cloud Computing, Cloud Computing history and evolution, practical applications of cloud computing for various industries, economics and benefits of cloud computing.
Cloud Issues and Challenges: Cloud computing issues and challenges like Security, Elasticity, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Cost Management, Big Data.

Data Center: Classic Data Center, Virtualized Data Center (Compute, Storage, Networking and Application), Business Continuity in VDC.
Cloud Computing Architecture: Cloud Architecture model, Types of Clouds: Public Private & Hybrid Clouds, Cloud based services: Iaas, PaaS and SaaS. Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

Classification of Cloud Implementations: Amazon Web Services, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), Google AppEngine - PaaS, Windows Azure, Aneka, A Comparison of Cloud Computing Platforms.
Virtualization: Virtualization, Advantages and disadvantages of Virtualization, Types of Virtualization: Resource Virtualization i.e. Server, Storage and Network virtualization, Migration of processes, VMware vCloud – IaaS.

Cloud based Data Storage: Introduction to Map Reduce for Simplified data processing on Large clusters, Design of data applications based on Map Reduce in Apache Hadoop, Task Partitioning, Data partitioning, Data Synchronization,

Distributed File system, Data Replication , Shared access to weakly consistent to data stores.
Introduction to Python Runtime Environment: The Datastore, Development Workflow.

Applications & Case Study: Real world design constraints, Applications, Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities, participatory sensing. Data Analytics for IoT. Software & Management Tools for IoT Cloud Storage Models & Communication APIs. Cloud for IoT: Amazon Web Services for IoT.

References:-

1. Cloud Computing: A practical Approach Anthony Velte, Toby Velte and Robert Elsenpeter by Tata McGrawHill

2. Cloud Computing Principles and Paradigms, Rajkumar Buyya, James Broberg and Goscinski by John Wiley and Sons

3. Raj Kumar Buyya, James Broberg, Andrezei M. Goscinski, Cloud Computing: Principles and Paradigms, 2011

4. Michael Miller, Cloud Computing, 2008

5. Judith Hurwitz, Robin Bllor, Marcia Kaufmann, Fern Halper, Cloud computing for Dummies, 2009

6. Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

7. Granjal, J., Monteiro, E., & Silva, J. S. (2015). Security for the internet of things: a survey of existing protocols and open research issues. IEEE Communications Surveys & Tutorials, 17(3), 1294-1312.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX: **Soft Computing & Expert Systems**

Pre-requisite:

L	T	P	Credits	Total contact hours
3	0	0	3	

i) Brief Description about the course

This course covers fundamental concepts used in Soft computing, including the concepts of Fuzzy logic (FL), Artificial Neural Networks (ANNs), and optimization techniques using Genetic Algorithm (GA). Applications of Soft Computing techniques to solve a number of real-life problems are also covered.

ii) Unit - I

Fundamentals: Concept of computing systems, "Soft" compiting versus "Hard" computing, Neurons and neural networks, Artificial neural networks: single-layer perceptron, multilayer perceptron, Back propagation, modifications to back-propagation, Radial basis function networks, Recurrent neural networks, Training of neural network, Applications of neural networks.

10 hrs.

Unit – II

Fuzzy Logic: Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Adaptive Neuro-Fuzzy systems, training methods, Some applications of Fuzzy logic.

10 hrs.

Unit - III

Concept of "Genetics" and "Evolution" and its application to proablistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using GAs.

10 hrs.

Unit - IV

Combined techniques – Genetic Algorithms–Fuzzy Logic, Genetic Algorithms–Neural Networks, Neural Networks– Fuzzy Logic, Application of ANN and Fuzzy systems to non-stationary time series prediction, pattern recognition, control & communication engineering, and system identification.

8 hrs.

Text Books / Reference

1. S. Haykin, Neural Networks - A Comprehensive Foundation, Peasrson Education, India
2. Jang, Sun and Mizutani, Neuro-Fuzzy and Soft-Computing – A computational approach to learning and machine intelligence, Prentice Hall of India.
3. S. Kumar, *Neural Networks: A Classroom approach*, Tata McGraw Hill.

Course Outcomes

CO 1: Able to carry out research and development of the neural network and fuzzy logic.

CO 2: Understanding of soft computing techniques and their application in diverge fields.

CO 3: In-depth analysis on technology variations in soft computing depending on the application and involvement of neural learning, classification

CO 4: Application of neural network and fuzzy logic for different applications like time series prediction, control, etc.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECOEXX SENSORS

Prerequisites (Course code)	:	ECPE70

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description

In recent years, technological advances have resulted in the rapid development of a new and exciting research direction – the interdisciplinary use of sensors for data collection, systems analysis, and monitoring. These highly calibrated sensors require precision engineering techniques that play an important role in analyzing and integrating large datasets. Sensor networks in particular represent a very active area of research, including work on problems such as sensor network localization and network design. Application areas for sensors and sensor networks include environmental monitoring, military surveillance, computational neuroscience, seismic detection, and a great deal more. The fundamental problems of utilizing the collected data for efficient system operation and decision making encompasses multiple research areas, including applied mathematics, optimization, signal/image processing, as well as emerging areas that require interdisciplinary techniques from several fields of research.

Course Contents

UNIT-I

Introduction to Sensors, Definition and types of sensors, Sensor characteristics: sensitivity, accuracy, resolution, range, and linearity
Transducers: conversion of physical quantities to electrical signals, Passive and active sensors, Analog and digital sensors, Classification of Sensors based on measurement principles: Temperature sensors, Pressure sensors, Proximity sensors, Motion sensors, Force and load sensors, Humidity sensors, Light sensors, Gas sensors, Chemical sensors, Biosensors

UNIT-II

Sensor Signal Conditioning, Signal conditioning techniques: amplification, filtering, and linearization, Noise reduction and interference rejection, Calibration and sensor characterization, Sensor Interfaces and Data Acquisition, Analog-to-digital conversion, Serial and parallel interfaces, Microcontrollers and microprocessors for sensor integration, Data acquisition systems and software

UNIT-III

Sensor Applications in Different Engineering Streams, Sensors in mechanical engineering: Accelerometers, Strain gauges, Position and displacement sensors, Vibration sensors, Flow sensors

Sensors in electrical engineering: Current and voltage sensors, Magnetic field sensors, Hall effect sensors, Power sensors, Radiation sensors

Sensors in civil engineering: Structural health monitoring sensors, Geotechnical sensors, Environmental sensors

Sensors in biomedical engineering: ECG and EEG sensors, Blood pressure sensors, Oxygen sensors, Glucose sensors, Prosthetic sensors

UNIT-IV

Sensor Integration and IoT Applications, Wireless sensor networks, Internet of Things (IoT) and sensor integration, Sensor fusion and data integration techniques

Emerging Sensor Technologies and Trends, Nanosensors, MEMS sensors, Wearable sensors, Energy harvesting sensors, Sensor networks for smart cities

Application to various sustainable technologies, case studies from the Indian knowledge system.

Reference books

1. Sensors and Actuators, D. Patranabis, 2nd Ed., PHI, 2013.
2. Make sensors: Terokarvinen, kemo, karvinen and villey valtokari, 1st edition, maker media, 2014.
3. Sensors handbook- Sabrie soloman, 2nd Ed. TMH, 2009
4. Handbook of Modern Sensors, J. Fraden, Fourth Edition, Springer
5. Instrument transducers, H. K. P. Neubert, OUP
6. Measurement systems: application & design, E. A. Doebelin, Mc Graw Hill

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT
ECOEXX FSM CONTROLLER DESIGN

Course Code	ECOE
Course Title	FSM CONTROLLER DESIGN
Number of Credits	03
Prerequisites (Course code)	ECPC22, Computer Organization and Architecture, Familiarity with a hardware description language
Course Type	OE

L	T	P	Credits	Total contact hours
3	0	0	3	42

Course Objectives

- Using digital and sequential circuits to design FSMs
- Using Verilog HDL to design FSMs
- Performance and Power optimization of FSM
- Real time design and implementation of application specific FSM

UNIT I 7 hrs

INTRODUCTION TO FSMs: Definition of FSMs and their role in digital system design, Types of FSMs (Moore and Mealy), Examples of FSMs in real-world applications, State Diagrams and State Tables: Representing FSMs using state diagrams and state tables, Determining the number of states required for a given problem, State encoding and state assignment

UNIT II 9 hrs

LOGIC DESIGN FOR FSMs: Designing combinational logic for next-state and output functions, Karnaugh maps and Boolean algebra for logic minimization, Implementing FSMs using logic gates and multiplexers, Sequential Circuit Design for FSMs: Designing sequential circuits for state storage and transition detection, Flip-flops and latches for state storage, Timing considerations for sequential circuits.

UNIT III 12 hrs

FSM OPTIMIZATION: Optimization techniques for reducing the number of states and transitions in an FSM, State minimization algorithms (e.g., state reduction, state merging, partitioning) Code generation and optimization for FSM-based designs, FSM Design Using HDL: introduction to Verilog and FSM design, FSM coding styles (e.g., behavioral, RTL, gate-level), Simulation and synthesis of FSMs using HDL tools.

UNIT IV 14 hrs

APPLICATIONS OF FSMs: FSMs for digital control systems (e.g., PID controllers), FSMs for protocol design (e.g., communication protocols, state machines), FSMs for digital signal processing (e.g., filters, FFT), Case studies: Design of Elevator, ATM FSMs.

Text Books:

1. David Harris and Sarah Harris, Digital Design and Computer Architecture
2. Volnei A. Pedroni, Finite State Machines in Hardware: Theory and Design

Reference Books:

1. David J. Comer, Design of Sequential and State Machines.
2. Mark Zwolinski, Digital System Design with VHDL.
3. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis.

Course Outcomes

At the end of the course, the student will be able to:

CO1: understand FSM , importance and their design

CO2: understand FSM architecture, Design fundamentals

CO3: impact of states on power consumption , sate reduction techniques,

CO4: Design and implementation of real time FSMs

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ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX Internet of Things (VIII, OE)

Pre-requisite: …….

L	T	P	Credits	Total contact hours
3	0	0	3	36

i) Brief Description about the course

This course will be focused on introducing students to new trends, applications, system architecture and challenges involved in developing/deploying internet of things systems using real industrial use cases. A number of systems are getting connected to the internet, where the sensor data is analyzed to monitor and control the systems. Correctly analyzing data coming from multiple sensors, choosing the right hardware given the power and performance tradeoff, hardware heterogeneity and security are some of the challenges involved in developing IoT applications. The course will cover the real-world use cases of IoT applications and hands-on projects related to those based on the concepts learned in the class.

ii) Unit - I 08 hrs.

Overview of IoT systems: New trends, applications and challenges. IoT system architecture: Edge devices, sensors, actuators, gateway, data storage and historical analysis in the cloud.

Unit – II 10 hrs.

Sensor networks: Wireless sensor networks (WSN), localization, node mobility, energy efficiency in WSN. Communication: MQTT, wifi, Bluetooth, RFID, LoRa, communication security.

Unit - III 08 hrs.

IoT system optimization: Low power devices, energy harvesting, performance trade-off, choosing the right hardware.

Unit – IV 10 hrs.

Smart and connected devices: Raspberry-pi, Google home mini, Alexa, Echo show
Case studies: Smart cities, transportation, manufacturing, automobile.

Text Books / Reference

1. Peter Waher “Learning Internet of Things”
2. S. Misra, C. Roy, and A. Mukherjee, 2020 “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press.
3. Simone Cirani, Gianluigi Ferrari, Marco Picone, and Luca Veltri, “Internet of Things: Architectures, Protocols and Standards” WILEY.
4. Andrew Minteer, “Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices”.

Course Outcomes

On completion of this course, you should be able to:

CO 1 Understand the IoT system and its applications.

CO 2 Understand IoT system and sensor networks.

CO 3 Apply the IoT system and optimization

CO 4 Apply the IoT knowledge in smart cities, transportation and manufacturing.

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT

ECPCXX IMAGE PROCESSING APPLICATION

Pre-requisite: Engg. Maths

L	T	P	Credits	Total contact hours
3			3	42

Brief Description about the course:
Image processing is a rapidly growing field that deals with the use of digital images to various fields of life including medical, automation, etc. This course helps to understand and apply the various concepts of image processing into different fields.

Course Learning Objectives

The student should be able to understand and apply the various concepts of Digital Image Processing in real life.

Course Contents

UNIT I (10L)

Introduction, Components of an image processing system, different image formats, Image Perception: Image models, sampling & quantization, neighbors of a pixel, connectivity, labeling of connected components.

UNIT- II (10L)

Intensity Transformation and its applications, image improvement and modifications using Histogram processing. Use of Image Restoration and Reconstruction: "Noise models, Restoration in the presence of Noise only, Frequency domain filtering, Inverse filtering, Wiener filtering, Geometric mean filtering. Image reconstruction from projections.
Lossy and lossless compression for some real life applications, Some basic compression methods, Image compression standards.

UNIT-III (8L)

Color Image Processing: Color Models, Pseudocolor Image Processing, Bacics of full color image processing, color transformations, segmentation, smoothing and sharpening, Noise in color Images. VMF, VDF, etc.
Morphological Image Processing for image identification, boundary extraction, etc.

UNIT-IV (10L+4)

Image steganography, Watermarking, Super-resolution, Copy paste attack on images.
A small project on real life application depending upon the branch of the student.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, 3rd Edition, 2016.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson 2002.
3. Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2000.
5. Hany Farid, 'Photo Forensics' The MIT Press, 2016.

Course outcomes

At the end of the course student will be able to:

CO1: Understand and apply the Image filtering, Restoration, segmentation, etc.

CO2: Apply the vector approach to handle the color images.

CO3: Apply the 'Morphological operation' for various applications.

CO4: Will be able to apply the image processing concepts in his /her respective branch of Eng.