B.Tech.

IN

ELECTRONICS & COMMUNICATION ENGINEERING

CURRICULUM AND SYLLABUS

(Applicable from 2024 onwards)

Department of Electronics & Communication Engineering

NATIONAL INSTITUTE OF TECHNOLOGY MANIPUR

Langol Road, Lamphelpat, Imphal, Manipur - 795004

COURSE STRUCTURE OF B.Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

Sl. No.	Course Components	No. of Course	Credits
1.	Basic Science Courses (BSC)	06	21
2.	Engineering Science Courses (ESC)	07	25
3.	Departmental Core Courses (DCC)	19	75
4.	Departmental Elective Courses (DEC)	04	12
5.	Open Elective Courses (OEC)	04	12
6.	Skill Enhancement Courses (SEC)	03	08
7.	Ability Enhancement Mandatory Course (AEMC)	04	18+8*
8.	Value Addition Courses (VAC)	04	03
	Total	51	174+8*

PROGRAMME STRUCTURE

Semester I

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	CH 1101	Engineering Chemistry	BSC-1	3	0	2	4
2.	ME 1101	Engineering Mechanics	ESC-1	3	1	0	4
3.	MA 1101	Engineering Mathematics-I	BSC-2	3	1	0	4
4.	PH 1101	Engineering Physics-I	BSC-3	3	0	2	4
5.	HS 1101	Communication Skills	SEC-1	3	0	0	3
6.	ME 1149	Engineering Drawing	ESC-2	0	1	4	3
7.	IC 1191	Induction Programme*	VAC-1				0
8.	IC 1192	Extra Academic Activity-I*	VAC-2				0
		Total		15	3	8	22

Semester II

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	CS 1201	Introduction to Computing	ESC-3	3	0	4	5
2.	EE 1201	Basic Electrical Engineering	ESC-4	3	0	2	4
3.	MA 1201	Engineering Mathematics-II	BSC-4	3	0	0	3
4.	EC 1201	Basic Electronic Circuits	ESC-5	3	0	0	3
5.	CE 1201	Environmental Engineering	ESC-6	3	0	0	3
6.	ME 1249	Engineering Workshop	ESC-7	0	1	4	3
7.	IC 1291	Extra Academic Activity-II*	VAC-3				0
		Total		15	2	10	21

*Value Addition Courses (VAC) will be floated by Department of Humanities and Social Sciences (HSS).

Semester III

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	MA 2301	Engineering Mathematics III	BSC-5	3	0	0	3
2.	EC 2301	Signals & System	DCC-1	3	1	0	4
3.	EC 2302	Analog Communication	DCC-2	3	1	2	5
4.	EC 2303	Analog Electronic Circuits	DCC-3	3	0	2	4
5.	EE 2331	Network Analysis and Synthesis	DCC-4	3	0	2	4
6.		Open Elective-I	OEC-1	3	0	0	3
		Total		18	0	6	23

Semester IV

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	MA 2401	Probability and Random Process	BSC-6	3	0	0	3
2.	EC 2401	Digital Electronics	DCC-5	3	0	2	4
3.	EC 2402	Digital Communication	DCC-6	3	0	2	4
4.	EC 2403	Introduction to Semiconductor Devices	DCC-7	3	1	0	4
5.	EE 2431	Control Systems	DCC-8	3	0	2	4
6.		Open Elective - II	OEC-2	3	0	0	3
7.	*EC2439	Minor Project	AEMC-1	0	0	16	8
		Total		18	0	6+16*	22+8*

*NOTE: Minor Project (EC294) is to be opted by the students who wants to leave the program after IV Semester with UG Diploma in Electronics and Communication Engineering**.**

Semester V

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	EC 3501	Introduction to Microprocessors	DCC-9	3	0	2	4
2.	EC 3502	Electromagnetic Theory	DCC-10	3	0	0	3
3.	EC 3503	Digital Signal Processing	DCC-11	3	0	2	4
4.	EC 3504	IC Applications	DCC-12	3	0	2	4
5.	EE 3531	Industrial Electronics	DCC-13	3	0	0	3
6.	EC 35XX	Departmental Elective-I	DEC-1	3	0	0	3
		Total		18	0	8	21

PROGRAMME STRUCTURE

Semester VI

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	EC 3601	VLSI Design	DCC-14	3	0	2	4
2.	EC 3602	Artificial Neural Network & Its Applications	DCC-15	3	0	2	4
3.	EC 3603	Electronics and Electrical Measurement & Instrumentation	DCC-16	3	0	2	4
4.	EC 3604	Antenna and Wave Propagation	DCC-17	3	0	2	4
5.	EC 36XX	Departmental Elective-II	DEC-2	3	0	0	3
6.		Open Elective III	OEC-3	3	0	0	3
			Total	18	0	6	22

Semester VII

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	HS 4701	Industrial Management	SEC-2	2	0	0	2
2.	EC 4701	RF and Microwave Engineering	DCC-18	3	0	2	4
3.	EC 4702	Computer Networks	DCC-19	3	0	2	4
4.	EC 47XX	Departmental Elective-III	DEC-3	3	0	0	3
5.	EC 4738	Internship	VAC-4	0	0	6	3
6.	EC 4739	Project work-I	AEMC-2	0	0	12	6
			Total	12	0	20	22

Semester VIII

Sl. No.	Course Code	Course Name	Course Category	L	T	P	Credits
1.	HS 4801	Soft Skills	SEC-3	2	0	0	2
2.	EC 48XX	Departmental Elective-IV	DEC-4	3	0	0	3
3.		Open Elective-IV	OEC-4	3	0	0	3
4.	EC 4835	Seminar	AEMC-3	0	0	8	4
5.	EC 4836	Project Work-II	AEMC-4	0	0	16	8
			Total	9	0	22	20
*For those students carrying out project work in Industries/Organizations							
1.	EC4837	Industrial Project		3	1	12	10
2.	EC4838	Project Seminar		0	0	10	5
3.	EC4839	Comprehensive viva		0	0	10	5
			Total	3	1	32	20

List of Basic Science Courses

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	MA 1101	Engineering Mathematics-I	3	1	0	4
2.	CH 1101	Engineering Chemistry	3	0	2	4
3.	PH 1101	Engineering Physics-I	3	0	2	4
4.	MA 1201	Engineering Mathematics-II	3	0	0	3
5.	MA 2301	Engineering Mathematics III	3	0	0	3
6.	MA 2401	Probability and Random Process	3	0	0	3
		Total				21

List of Engineering Science Courses

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	ME 1101	Engineering Mechanics	3	1	0	4
2.	ME 1149	Engineering Drawing	0	1	4	3
3.	CS 1201	Introduction to Computing	3	0	4	5
4.	EC 1201	Basic Electronic Circuits	3	0	0	3
5.	CE 1201	Environmental Engineering	3	0	0	3
6.	ME 1249	Engineering Workshop	0	1	4	3
7.	EE 1201	Basic Electrical Engineering	3	0	2	4
		Total				25

List of Skill Enhancement Courses

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	HS 1101	Communication Skills	3	0	0	3
2.	HS 4701	Industrial Management	2	0	0	2
3.	HS 4801	Soft Skills	3	0	0	3
		Total				08

List of Ability Enhancement Mandatory Course

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	*EC2439	Minor Project	0	0	16	8*
2.	EC 4739	Project work-I	0	0	12	6
3.	EC 4835	Seminar	0	0	8	4
4	EC 4836	Project Work-II	0	0	16	8
		Total				18+8*

*For UG Diploma in Electronics and Communication Engineering

List of Value Addition Courses

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	IC 1191	Induction Programme				0
2.	IC 1192	Extra Academic Activity-I	0	0	2	0
3.	IC 1291	Extra Academic Activity-II	0	0	2	0
4.	EC 4738	Internship	0	0	6	3
		Total				03

List of Departmental Cores Courses

Sl. No.	Course Code	Course Name	L	T	P	Credits
1.	EE 2331	Network Analysis and Synthesis	3	1	0	4
2.	EC 2302	Signals & System	3	1	0	4
3.	EC 2303	Analog Communication	3	1	2	5
4.	EC 2304	Analog Electronic Circuits	3	0	2	4
5.	EC 2401	Digital Electronics	3	0	2	4
6.	EE 2431	Control Systems	3	0	2	4
7.	EC 2403	Digital Communication	3	0	2	4
8.	EC 2404	Introduction to Semiconductor Devices	3	1	0	4
9.	EC 3501	Introduction to Microprocessors	3	0	2	4
10.	EC 3502	Electromagnetic Theory	3	0	0	3
11.	EC 3503	Electronics and Electrical Measurement & Instrumentation	3	0	2	4
12.	EC 3504	Digital Signal Processing	3	0	2	4
13.	EC 3505	IC Applications	3	0	2	4
14.	EC 3601	VLSI Design	3	0	2	4
15.	EC 3602	Artificial Neural Network & Its Applications	3	0	2	4
16.	EE 3531	Industrial Electronics	3	0	0	3
17.	EC 3604	Antenna and Wave Propagation	3	0	2	4
18.	EC 4701	RF and Microwave Engineering	3	0	2	4
19.	EC 4702	Computer Networks	3	0	2	4
		Total				75

List of Departmental Electives

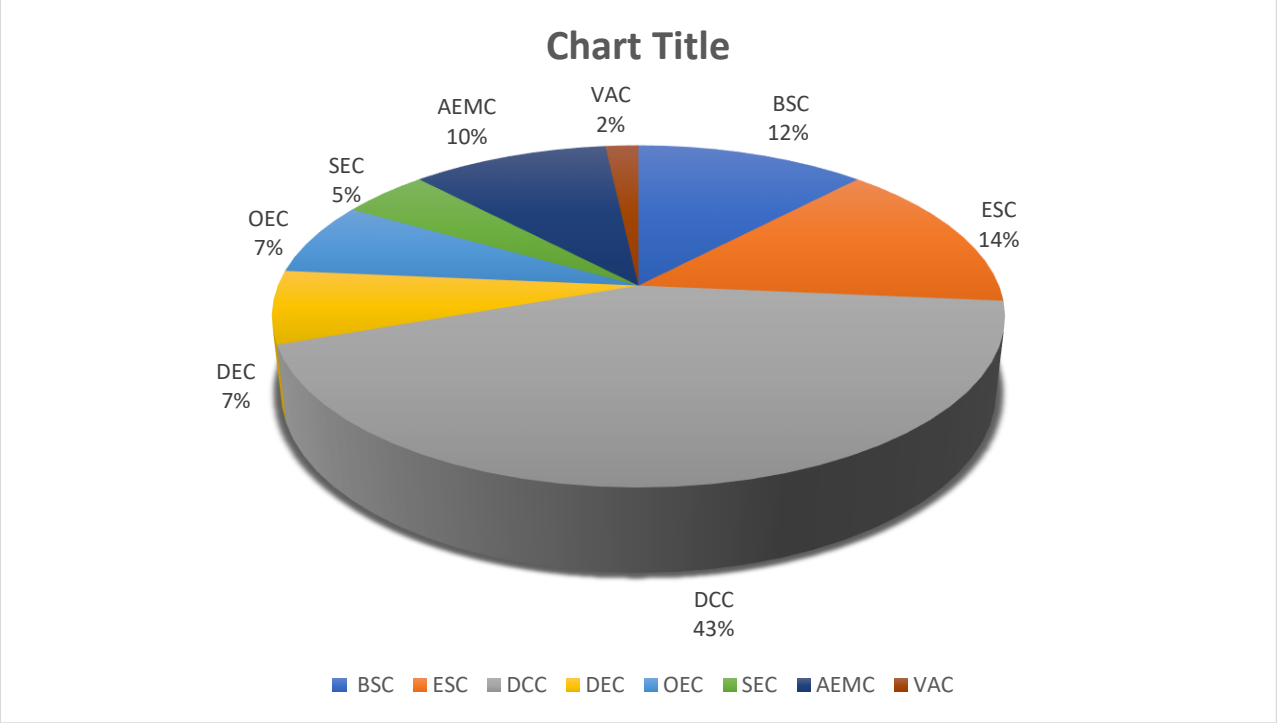
Sl. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	EC 3571	Optical Fiber Communication	3	0	0	3	Elective I
2.	EC 3572	Information Theory and Coding	3	0	0	3	
3.	EC 3573	Semiconductor Device Modelling	3	0	0	3	
4.	EC 3574	Wireless and Adhoc Networks	3	0	0	3	
5.	EC 3671	Advanced Microprocessor	3	0	0	3	Elective II
6.	EC 3672	Computer Organization and Architecture	3	0	0	3	
7.	EC 3673	Satellite Communication	3	0	0	3	
8.	EC 3674	Introduction to Artificial Intelligence and Machine learning	3	0	0	3	
9.	EC 3675	VHDL and Verilog	3	0	0	3	
10.	EC 4771	Digital Image Processing	3	0	0	3	Elective III
11.	EC 4772	Internet of Things	3	0	0	3	
12.	EC 4773	Digital IC Design	3	0	0	3	
13.	EC 4774	Embedded System	3	0	0	3	
14.	EC 4775	Low Power VLSI	3	0	0	3	
15.	EC 4871	FPGA Based Physical Design	3	0	0	3	Elective IV
16.	EC 4872	Low Power Devices and System	3	0	0	3	
17.	EC 4873	Semiconductor IC Technology	3	0	0	3	
18.	EC 4874	Radar Engineering	3	0	0	3	
19.	EC 4875	Optimization Techniques	3	0	0	3	

List of Open Electives

Sl. No.	Course Code	Course Name	L	T	P	Credits	Elective Category
1.	EC 2350	Swayam NPTEL/ MOOCs courses	3	0	0	3	Elective I
2.	EC 2351	Introduction to Nano Science and Nano Technology	3	0	0	3	
3.	EC 2352	Microelectronics and VLSI Technology	3	0	0	3	
4.	EC 2353	Modern Communication Technologies	3	0	0	3	
5.	EC 2450	Swayam NPTEL/ MOOCs courses	3	0	0	3	Elective II
6.	EC 2451	Introduction to Photonics	3	0	0	3	
7.	EC 2452	Nano-Fabrication Techniques	3	0	0	3	
8.	EC 2453	Wireless Sensor Networks	3	0	0	3	
9.	EC 3550	Swayam NPTEL/ MOOCs courses	3	0	0	3	Elective III
10.	EC 3651	RF Integrated Circuits	3	0	0	3	
11.	EC 3652	Green Technologies	3	0	0	3	
10.	EC 3653	Data Communication and Networking	3	0	0	3	
11.	EC 3654	Electronic Materials and their Applications	3	0	0	3	

12.	EC 4850	Swayam NPTEL/ MOOCs courses	3	0	0	3	Elective IV
13.	EC 4851	Advanced Semiconductor Devices	3	0	0	3	
14.	EC 4852	Image and Video Processing	3	0	0	3	
15.	EC 4853	MEMS	3	0	0	3	
16.	EC 4854	5G Communications and MIMO	3	0	0	3	
17.	EC 4855	VLSI Physical Design	3	0	0	3	
18.	EC 4856	Machine Learning and Pattern Recognition	3	0	0	3	
19.	EC 4857	Biophotonics	3	0	0	3	
20.	EC 4858	Hardware Description Languague	3	0	0	3	

Credit Distribution



Course Code: EE 2331	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	Y	N

Type of Course	Theory and Practical
Course Title & Code	Network Analysis and Synthesis (EC 2331)
Course Objectives	● To introduce the fundamentals of network analysis using matrices ● To analyze two-port network and circuits ● To perform network synthesis

Course Outcomes		**Cognitive Levels**
CO1	To understand the various laws and theorems related to electric networks.	Knowledge/Comprehension (Level-I/Level-II)
CO2	To apply the graph theory and network theorems in circuit analysis.	Application (Level-III)
CO3	To analyse and evaluate the networks in transformed domain	Analysis/Evaluation (Level-IV/V)
CO4	To analyse and synthesize the two port network functions.	Analysis/Synthesis (Level-IV/Level-VI)

Semester	**III**	**Summer**		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48

Prerequisite course codes with course names	Basic Electronic Circuits (EC 1201)

Text Books		
1.	Title	Network Analysis
	Author	M.E. Van Valkenburg
	Publisher	Prentice Hall
	Edition	3rd Edition
2.	Title	Network Analysis and Synthesis
	Author	Franklin F. Kuo
	Publisher	Wiley
	Edition	2nd Edition

Reference Books		
1.	Title	Engineering Circuit Analysis
	Author	W. H. Hayt and J E Kemmerly
	Publisher	TMH
	Edition	8th Ed.

Course Contents	**UNIT I:** Introduction: KCL, KVL, Network theorems: Superposition, Reciprocity, Thevenin's, Norton's, Millman's, Maximum Power Transfer theorems. And its application in the analysis of networks.	**12**
	UNIT II: Network Functions and Response Analysis: Concept of complex frequency, driving point and transfer functions for one port and two port network, poles & zeros of network functions, Restriction on Pole and Zero locations of network function, Impulse response and complete response, Time domain behavior form pole-zero plot	**12**
	UNIT III: Poly-Phase Circuits: Introduction to polyphase system, Generation of three-phase voltages, Interconnection of 3 phase sources and loads, Star-to-Delta and Delta-toStar transformation, Voltage, current and power in a star and delta connected system, three phase balanced and unbalanced circuits.Two Port networks: Two port parameters, relationships among different network parameters, inter connections of networks.	**12**
	UNIT IV: Network Synthesis: Realizability concept, Hurwitz property, positive realness, properties of positive real functions, properties of one port immittance functions and their synthesis, Foster and Cauer forms, RLC synthesis, Introduction to two port network synthesis.	**12**

Course Assessment	Total Marks =100 Theory (80 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%
	Practical (20 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%

Course Code: EC 2302	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	Y	N
Type of Course	Theory Course		
Course Title & Code	Signal & Systems (EC 2302)		
Course Objectives	● To understand the Classification and Representation of Signals and systems.		

	● To gain an understanding of systems (both continuous and discrete), including linear and time-invariant (LTI) systems, and their properties. ● To cover the fundamental concepts of sampling theory, aliasing, and reconstruction of signals from their samples. ● To analyse the impulse and step responses of systems and how these responses impact system behaviour.

Course Outcomes		**Cognitive Levels**
CO1	To analyze various types of signals and describe system characteristics	Analysis/Comprehension (Level IV/Level-II)
CO2	To analyze systems that process signals.	Knowledge/Analysis (Level-I/Level-IV)
CO3	To perform time-domain analysis	Application/Analysis (Level-III/Level-IV)
CO4	To conduct frequency-domain analysis	Synthesis/Evaluation (Level-V/Level-VI)

Semester	**III**	**Summer**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	48
Prerequisite course codes with course names	Basic knowledge of Integration, Differentiation, Complex Numbers				

Text Books		
1.	Title	Fundamentals of Signals and Systems
	Author	Michael Roberts, Govind Sharma
	Publisher	McGraw Hill Education
	Edition	2nd Edition
2.	Title	Signals and Systems
	Author	A.V. Oppenheim, A.S. Willsky and H.S. Nawab
	Publisher	Prentice Hall of India
	Edition	2nd Edition

Reference Books		
1.	Title	Signals and Systems
	Author	Barry Van Veen,Simon Haykin
	Publisher	Wiley
	Edition	2nd Edition

Course Contents	**UNIT I**: Introduction: Definitions of signals and systems, standard signas-step, ramp, pulse, impulse, real and complex exponentials and sinusoids, classification of signals-continuous time and discrete time signals, Periodic and Aperiodic signals, Deterministic and Random Signals, Energy and	**14**

	Power Signals, classification of systems-CT systems and DT systems, linear and nonlinear, time-variant and time-invariant, causal and non-causal, stable and unstable.	
	UNIT II: Linear Time Invariant Continuous Time Systems:Impulse response, continuous integrals, differential equation, Fourier and Laplace transforms in analysis of CT systems, systems connected in series/parallel	**10**
	UNIT III: Analysis of Continuous Time: Fourier Series for periodic signals-Fourier Transform-properties-Laplace transforms and properties	**10**
	UNIT IV: Analysis of Discrete Time Signals & Linear Time Invariant Discrete Time Systems: Impulse response, difference equations, convolution sum, Discrete Fourier Transform and Z transform, analysis of Recursive and Non-recursive systems, DT systems connected in series and parallel, Baseband signals sampling-Fourier Transform of discrete time signals (DTFT), properties of DTFT, Z-transform and properties	**14**
Course Assessment	Total Marks=100 Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2303	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	Y	N
Type of Course	Theory Course along with Practical		
Course Title & Code	Analog Communication (EC 2303)		
Course Objectives	● Familiarization with modulation and demodulation schemes for analog communications (AM, FM and PM). ● Understanding of Noise encountered during communication. ● Evaluation of the impact of noise on the various modulation schemes.		

Course Outcomes		**Cognitive Levels**
CO1	Identify and understand different modulation and demodulation schemes for analog communications (AM, FM and PM).	Knowledge/ Comprehension (Level I/Level-II)
CO2	Evaluate fundamental communication system parameters, such as bandwidth, power and signal to noise ratio, noise figure, sampling frequency.	Application (Level-III)

CO3	Design analog communication systems to meet desired application requirements.	Analysis (Level-IV)
CO4	Elucidate the design tradeoffs and performance of communications systems.	Synthesis/ Evaluation (Level-VI/Level-V)

Semester	**III**		**Summer**		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	1	2	5	48
Prerequisite course codes with course names	Engineering Mathematics – II (MA 1201)				

Text Books			
1.	Title	Modern Digital and Analog Communication Systems	
	Author	B.P.Lathi	
	Publisher	Oxford University Press, New Delhi.	
	Edition	Latest edition	
2.	Title	An Introduction to Analog and Digital Communication,	
	Author	Symon Haykins	
	Publisher	John Willy and Sons, New York	
	Edition	Latest Edition	
Reference Books			
1.	Title	Communication Systems	
	Author	A. B. Carlson	
	Publisher	McGraw Hill	
	Edition	Latest Edition	
Course Contents	**UNIT I: Signal Transmission** Signal transmission and filtering: response of LTI systems, transfer functions, distortionless transmission, linear and non linear distortions. Ideal filters, real filters and quadrature filters. Hilbert transform. Correlation and		10

	spectral density -correlation of power and energy signals, spectral density functions.	
	UNIT II: Linear Continuous Wave Modulation Linear CW modulation: bandpass systems and signals, AM, DSB signals and spectra. Tone modulation and phasor analysis. Modulators and transmitters. SSB and VSB signals and their spectra. Synchronous and envelope detection. Exponential CW modulation: FM and PM signals, narrowband FM and PM. Tone, multitone and periodic modulation. Wideband FM, direct and indirect FM, capture effect, detection.	16
	UNIT III: Probability and Noise Probability and Random variables: principles, conditional probabilities and statistical independence. Random variables and probability functions. Statistical averages. Probability models: Binomial and Poisson distribution. Gaussian and Rayleigh PDF. Random processes: principles, ensemble averages and correlation functions. Stationary and Ergodic process. Noise: types, sources, frequency domain representation of noise, spectral components of noise, equivalent BW, additive white Gaussian noise and signal to noise ratio.	14
	UNIT IV: Sequential Logic Circuits Noise in CW modulation: system models, predetection S/N, quadrature components. Linear modulation with noise, synchronous and envelope detection, threshold effect.	8
Course Assessment	Total Marks =100 Theory (80 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%
	Practical (20 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%

Course Code: EC 2304	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	Y	N
Type of Course	Theory and Practical		

Course Title & Code	Analog Electronic Circuits (EC2304)				
Course Objectives	● To make the students understand the fundamentals of basic electronic circuits such as Diodes, BJTs and FETs. ● To introduce the PLL and its applications.				
Course Outcomes				**Cognitive Levels**	
CO1	Illustrate about diodes, rectifiers, and BJT and FET amplifiers.			Knowledge/Comprehension (Level I/Level-II)	
CO2	Discuss biasing, low frequency models and frequency response for BJT and FET amplifiers.			Knowledge/Comprehension (Level I/Level-II)	
CO3	Illustrate differential amplifiers and their characteristics.			Knowledge/Comprehension (Level I/Level-II)	
CO4	Discuss feedback concepts, power amplifiers, and oscillator circuits.			Knowledge/Comprehension (Level I/Level-II)	
Semester	**III**		**Summer**		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Basic Electronics Circuit (EC 102)				
Text Books					
1.	Title	Microelectronic Circuits Theory and Application			
	Author	Sedra and Smith			
	Publisher	Oxford publication			
	Edition	7th Edition			
2.	Title	Electronic Circuit Analysis and Design			
	Author	Donald A. Neamen			
	Publisher	Irwin Publications			
	Edition	3nd Edition			

<table>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="2">Design with Operational Amplifiers and Analog Integrated Circuits</td></tr>
<tr><td>Author</td><td colspan="2">Sergio Franco</td></tr>
<tr><td>Publisher</td><td colspan="2">Tata
McGraw Hill Book Company</td></tr>
<tr><td>Edition</td><td colspan="2">3rd Edition</td></tr>
<tr><td rowspan="4">Course Contents</td><td colspan="2">UNIT I:
Small signal equivalent circuits of diode, Simple diode circuits, clipping, clamping, rectifier, Voltage multiplier, Zener diode and voltage regulator. Review of BJT operation and its characteristics, need of biasing and different types of biasing circuits for BJT & FET, stability analysis, small signal Amplifier analysis of BJT & FET, estimation of voltage gain, input resistance, output resistance etc.</td><td>12</td></tr>
<tr><td colspan="2">UNIT II:
Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples. Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency</td><td>12</td></tr>
<tr><td colspan="2">UNIT III:
Basic operation of differential Amplifier, Different configuration of differential Amplifier, Calculation of gain, impedance etc. Biasing of differential Amplifier, calculation of differential gain, common mode gain, CMRR.</td><td>12</td></tr>
<tr><td colspan="2">UNIT IV:
Review of the basic concept for oscillation, Barkhausen criterion, LC Oscillators, RC phase shift oscillator and Wien bridge oscillator, Colpitts, Hartley and Crystal oscillator, PLL as negative feedback system,building blocks of PLL, applications of PLL</td><td>12</td></tr>
<tr><td>Course Assessment</td><td>Total Marks =100
Theory (75 Marks)
Evaluation will be done for 100 marks and 75% of the marks secured will be considered.</td><td colspan="2">Continuous Evaluation 20%
Mid Semester 30%
End Semester 50%</td></tr>
<tr><td></td><td>Practical (25 Marks)</td><td colspan="2">Continuous Evaluation 20%
Laboratory Examination 50%
Viva Voce 30%</td></tr>
</table>

	Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	

Course Code: EC 2401	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	N	Y	N		
Type of Course	Theory and Practical				
Course Title & Code	Digital Electronics (EC2401)				
Course Objectives	● To introduce the concept of number system and logic gates ● To design the combinational and sequential logic circuits and to develop the characteristics of TTL/CMOS logic families. ● To understand memory devices such as SRAM/DRAM organization.				
Course Outcomes					Cognitive Levels
CO1	To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.				Knowledge (Level I)
CO2	To introduce the concept of digital and binary systems				Comprehension (Level-II)
CO3	To be able to design and analyse combinational logic circuits.				Application/Analysis (Level-III/Level-IV)
CO4	To be able to design and analyse sequential logic circuits.				Synthesis/Evaluation (Level-VI/Level-V)
Semester	IV		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Basic Electronic Circuits (EC1201) Engineering Physics-I (PH101)				
Text Books					
1.	Title	Digital Electronics			
	Author	WH Gothmann			
	Publisher	PHI			
	Edition	2nd Edition			
Reference Books					
1.	Title	Digital Logic & Computer Design			
	Author	M Morris Mano			
	Publisher	Pearson			

	Edition	5^{th}, 2011	
2.	Title	Digital Design, Principles and Practices	
	Author	J. F. Wakerly	
	Publisher	Pearson Education	
	Edition	4^{th}, 2005	
Course Contents	UNIT I: Number System and Boolean Algebra Introduction to number systems, binary, Integer and floating-point- numbers, octal, hexadecimal and decimal number system and their conversion. Arithmetic Operations: Binary addition & subtraction; 1's and 2's complement, subtraction using 2's complement; binary codes, addition and subtraction operations on binary-coded numbers; Algorithms for performing multiplication and division.		12
	UNIT II: Combinational Logic Circuits Basic Logic Operations, AND, OR, NOR, NAND, EX-OR, EX-NOR Gates, Boolean expressions and their minimization using algebraic identities; Karnaugh map representation and minimization of Boolean functions using K-map; Don't care conditions, NAND and NOR logic implementations, two-level realizations using gates – AND-OR, OR-AND, NAND-NAND and NOR-NOR structures. Combinational Circuits using MSI Modules: Adders, subtractors, BCD arithmetic, serial adder, carry look-ahead adder, Multi-bit adder, Multiplexers, De-multiplexers, Decoders, Multiplexer-based realization of K-maps; Combinational circuit design using multiplexers and gates.		18
	UNIT III: Sequential Logic Circuits Latches and Flip-flops; Ripple counters using T flip-flops; Synchronous counters; Shift Registers; Ring and MLS counters; Sequence generator using J-K / D flip-flops, Finite state machines, propagation delay, setup and hold time, critical path delay.		12
	UNIT IV: Memories and Programmable Logic ROM, SRAM, DRAM, PLA, PAL Logic Families: ROM, SRAM, DRAM, PLA, PAL		6
Course Assessment	Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%	

<table>
<tr><td rowspan="2">Course Code:
EE 2431</td><td>Open Elective Course: (Y/N)</td><td>Departmental Core Course: (Y/N)</td><td>Departmental Elective Course: (Y/N)</td></tr>
<tr><td>N</td><td>Y</td><td>N</td></tr>
<tr><td>Type of Course</td><td colspan="3">Theory and Practical</td></tr>
<tr><td>Course Title & Code</td><td colspan="3">Control System (EC2431)</td></tr>
<tr><td>Course Objectives</td><td colspan="3">● To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
● To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system
● Formulate different types of analysis in frequency domain to explain the nature of stability of the system.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.</td><td>Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept.</td><td>Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="2">Analysis: Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control. Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.</td><td>Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.</td><td>Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td>Semester</td><td colspan="2">IV</td><td>Winter</td></tr>
<tr><td rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td><td>48</td></tr>
</table>

Prerequisite course codes with course names	Signals and systems (EC 203)		
Text Books			
1.	Title	'Control Systems Engineering',	
	Author	J. Nagrath, M. Gopal,	
	Publisher	New Age International Publishers, 2008.	
	Edition	4th Edition	
2.	Title	'Modern Control Engineering',	
	Author	K. Ogata,	
	Publisher	Prentice Hall, 2010.	
	Edition	3rd Edition	
Reference Books			
1.	Title	Automatic Control Systems	
	Author	B. C. Kuo,	
	Publisher	8/e, Wiley, 2002.	
	Edition	3rd Edition	
Course Contents	UNIT I: SYSTEMS COMPONENTS AND THEIR REPRESENTATION Control System: Terminology and Basic Structure-Feed forward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system.		12
	UNIT II: TIME RESPONSE ANALYSIS Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI, PID control systems		12
	UNIT III: FREQUENCY RESPONSE AND SYSTEM ANALYSIS Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot — Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation		12

	UNIT IV: CONCEPTS OF STABILITY ANALYSIS Concept of stability-Bounded — Input Bounded — Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.	12
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%

Course Code: EC 2403	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory and Practical		
Course Title & Code	Digital Communication (EC 2403)		
Course Objectives	● To introduce the theory of sampling, its advantages and reconstruction techniques. ● To introduce the concept of Matched filters, their applications along with the concept of channel noise. ● To learn important aspects of information theory and concept of coding.		

Course Outcomes		Cognitive Levels
CO1	Interpret and understand the building blocks of a typical digital communication system.	Knowledge/Comprehension (Level I/Level-II)
CO2	Compute probability of error and hence the inter symbol interference from eye diagram.	Application (Level-III)
CO3	Derive expressions for the power spectrum of digital modulated signals.	Analysis (Level-IV)
CO4	Design an encoder and decoder for a typical error control coding scheme.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	IV	Winter

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Analog Communication (EC 2303) Digital Electronics (EC 2401)				

Text Books		
1.	Title	Digital Communications,
	Author	Simon Haykin
	Publisher	John Wiley and Sons
	Edition	Latest Edition
2.	Title	Digital Communications,
	Author	Proakis ,
	Publisher	McGraw Hill
	Edition	Latest Edition

Reference Books		
1.	Title	Communication Systems, ,
	Author	A. B. Carlson
	Publisher	McGraw Hill
	Edition	Latest Edition

Course Contents		
	UNIT I: Sampling and Pulse Modulation Sampling theorem, types. PAM, PPM, PDM and PCM systems. TDM and FDM systems and their comparison. Cross talk and guard times. Practical sampling and aliasing. Baseband digital transmission: digital PAM signals, transmission limitations. Power spectra and digital PAM, spectral shaping by precoding. Signal coding Techniques, PCM Generation and Reconstruction, Quantization Noise, Non-uniform Quantization and companding. DPCM, DM, ADM and ADPCM; Linear Predictive Coding. Transmission of base band signal over Band Limited system-RZ and NRZ format.	12
	UNIT II: Matched Filter and Geometric Representation of Signals	12

	Matched filter, Error rate due to Noise, ISI, Nyquist criteria for distortionless baseband binary transmission, Optimum Linear Receiver, Adaptive Equalization. Geometric representation of signals – Gram-Schmidt Orthogonalisation procedure, Vector Noise Channel, Likelihood functions, Maximum Likelihood decoding, Correlation receiver, Probability of Error, Frame patterns, Bit and Frame synchronization carrier recovery.		
	UNIT III: Information Theory Definition of information, Self and Mutual information, Entropy and Information rate. Discrete memoryless source and coding, Discrete channel capacity, Shannon-Hartley equation for channel capacity, Markov chains. Principles of Error Detection and Correction methods, Channel Coding – Linear Block Codes, Cyclic Codes, Convolutional Coding, Automatic request for retransmission systems.		12
	UNIT IV: Digital CW Modulation Principles, Block schematics and Comparative Study of ASK, FSK and PSK systems, Introduction to Quadrature Carrier and M-ary systems, Modems and standards, Modern Digital Communication Technologies- ISDN, BISDN etc. Cellular digital Radio, Spread Spectrum techniques and Personal communication Networks.		12
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination Viva Voce 30%	

Course Code: EC 2404	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory Course		
Course Title & Code	Introduction to Semiconductor Devices (EC2404)		
Course Objectives	• This course aims to study the fundamentals of semiconductor devices and its applications. • This course provides the detailed understanding of the physics, design, operation, and limitations of important solid state electronic and		

<table>
<tr><td colspan="2"></td><td colspan="6">optoelectronic devices used by electrical and telecommunications engineers.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="6">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">To apply the basic laws of solid-state physics to understand the properties of semiconductor materials</td><td colspan="5">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">To analyse and model different types of semiconductor junctions, including homo junctions and heterojunctions.</td><td colspan="5">Application/ Analysis (Level-III/Level-IV)</td></tr>
<tr><td>CO3</td><td colspan="2">To analyse and model the physics of Metal-Oxide-Semiconductor systems and MOSFETs.</td><td colspan="5">Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">To evaluate the current, voltage, capacitance etc. characteristics of the semiconductor device.</td><td colspan="5">Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">IV</td><td colspan="4">Winter</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td colspan="2">Total Teaching Hours</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td colspan="2">48</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="6">Basic Electronics Circuit (EC 1201)
Engineering Physics-I (PH 1101)</td></tr>
<tr><td colspan="8">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="6">Solid State Electronic Devices</td></tr>
<tr><td>Author</td><td colspan="6">Ben G Streetman and S. K. Banerjee</td></tr>
<tr><td>Publisher</td><td colspan="6">Pearson</td></tr>
<tr><td>Edition</td><td colspan="6">7th Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="6">Semiconductor Physics and Devices- Basic Principles</td></tr>
<tr><td>Author</td><td colspan="6">Donald A. Neamen</td></tr>
<tr><td>Publisher</td><td colspan="6">McGraw Hill</td></tr>
<tr><td>Edition</td><td colspan="6">4th Edn., 2021.</td></tr>
<tr><td colspan="8">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="6">Physics of Semiconductor Devices</td></tr>
<tr><td>Author</td><td colspan="6">Sm Sze</td></tr>
<tr><td>Publisher</td><td colspan="6">John Wiley & Sons</td></tr>
<tr><td>Edition</td><td colspan="6">3rd Edn., 2008</td></tr>
<tr><td>Course Contents</td><td colspan="6">UNIT I: Introduction to Quantum Theory of Solids
Basic principles of quantum mechanics, Schrodinger equation and its applications, Atoms and formation of energy bands, electrical conduction in solids, density of states functions, bonding forces and energy bands in solids.</td><td>12</td></tr>
</table>

	Semiconductor under Equilibrium: Charge carriers in semiconductors, carrier concentrations, dopant atoms and energy levels, intrinsic and extrinsic semiconductors; charge neutrality, Fermi energy level.	
	UNIT II: Semiconductor under non-equilibrium Carrier transport, Carrier drift, diffusion, graded impurity distribution, Hall Effect, scattering in semiconductors, velocity- electric field relations, high field transport charge injection and quasi-Fermi levels. Non-Equilibrium Excess Carriers in Semiconductors: Carrier generation and recombination, characteristics of excess carriers, excess carrier lifetime, introduction to surface effects.	12
	UNIT III: Semiconductor Junction P-N junction under equilibrium - Energy band diagram - Current under forward bias - Reverse bias - IV characteristics - Charge storage and transient behaviour - Junction capacitance - Junction break down - small signal model of P-N diode, Metal-Semiconductor contacts - non-rectifying (ohmic) contacts - Schottky diodes. Photonic Devices: Light emitting diodes, semiconductor lasers, photo detectors, solar cells, power devices etc.	12
	UNIT IV: Field – Effect Transistors Metal-Oxide-Silicon System: Ideal MOS structure - Accumulation, Depletion, Inversion - Energy band diagram under bias - Threshold voltage - C-V characteristics - Effects of work function difference, Oxide and interface charges. MOSFET: Structure - Types - Threshold voltage - DC characteristics - Channel length modulation - Subthreshold conduction - Small signal models of MOSFET - Short channel effects (SCEs) - Introduction to advanced MOS devices.	12
Course Assessment	Total Marks =100 Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3501	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory and Practical		
Course Title & Code	Introduction to Microprocessors (EC3501)		
Course Objectives	● To make the students understand the basics of Microprocessor architectures (8085 and 8086) ● To understand the basics of interfacing, Memory Systems and I/Os ● To introduces the Microcontroller and its applications.		

Course Outcomes		Cognitive Levels
CO1	To understand the basics of Microprocessor.	Knowledge/Comprehension (Level I/Level-II)
CO2	Develop assembly language programs.	Synthesis/Evaluation (Level-VI/Level-V)
CO3	Learn about various I/O chips, different interrupts, and interfacing.	Analysis (Level-IV)
CO4	To get familiar with microcontroller and its applications.	Application (Level-III)

Semester	V	Summer

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48

Prerequisite course codes with course names	Digital Electronics (EC 2401)

Text Books		
1.	Title	Microprocessor Architecture, Programming and Applications with the 8085
	Author	Ramesh Gaonkar
	Publisher	Prentice Hall
	Edition	5th Edition
2.	Title	The INTEL Microprocessors
	Author	Barry B. Brey
	Publisher	Pearson
	Edition	8th Edition

Reference Books		
1.	Title	Computer Architecture, A Quantitative Approach
	Author	John L. Hennessy David A. Patterson

	Publisher	Elsevier	
	Edition	5th Edition	
Course Contents	UNIT I: Evolution of digital computer, evolution of microprocessor. Microprocessor architecture: 8-bit (8085) and 16-bit (8086).		8
	UNIT II: Addressing modes of microprocessors, instruction set of 8-bit (8085) and 16-bit microprocessors (8086)		10
	UNIT III: Instruction cycle, timing diagram, Subroutine, assembly language programming. Types of memories and their organizations (RAM, ROM, stack, secondary etc.)		12
	UNIT IV: Interrupt, DMA, Principle of data transfer (synchronous and asynchronous). Serial data communication, RS-232 standard. Peripheral interface: PPI, DMA controller, interrupt controller, programmable timer, USART. Microcontroller(8051) and its applications .		18
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%	

Course Code: EC 3502	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory Course		
Course Title & Code	Electromagnetic Theory (EC3502)		
Course Objectives	● The intention of this course is to familiarize the students with concepts pertaining electric and magnetic fields and their applications. ● To correlate with the concept of vector calculus and real-time observation of the proposed course. ● To learn the field distribution inside and outside the materials.		
Course Outcomes			Cognitive Levels

CO1	To understand the various operations of vector calculus	Knowledge/Comprehension (Level I/Level-II)
CO2	To understand the mathematics backgrounds the EM laws.	Application (Level-III)
CO3	To understand the electric and magnetic field distributions over the materials.	Analysis (Level-IV)
CO4	To understand the propagation of waves in different mediums.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Engineering Physics – I (PH 1101)				

Text Books		
1.	Title	Principle of Electromagnetics
	Author	M.N.O. Sadiku and S.V. Kulkarni,
	Publisher	Oxford
	Edition	6th Edition
2.	Title	Microwave Engineering
	Author	David. M. Pozar,
	Publisher	John Wiley
	Edition	4th Edition.
Reference Books		
1.	Title	Electromagnetic Waves
	Author	R.K. Shevgaonkar
	Publisher	Tata McGraw Hill
	Edition	1st Edition
2.	Title	Electromagnetic waves & Radiating Systems
	Author	E.C. Jordan & K.G. Balmain
	Publisher	Prentice Hall
	Edition	2nd Edition

Course Contents	UNIT I: Vector Calculus Basics of Vectors, Definition of potential difference and potential, Potential of point charge and system of charges. Potential gradient, Energy density in electrostatic field. Poisson's and Laplace's equations. Poynting Vector, Boundary conditions at Media Interface. Coordinate Systems and Transformation: Cartesian, Cylindrical and Spherical Coordinates.	10

	UNIT II: Electrostatic and Magnetostatic Fields Introduction, Electric Fields due to Continuous Charge Distributions, An Electric Dipole and Flux Lines, Energy Density in Electrostatic Fields, Maxwell's Equations for Static EM Fields, Gauss's law, Biot- Savart, Stoke's theorem and Amperes circuital laws and their applications. Significance of curl and divergence. Magnetic flux density, Scalar and Vector magnetic potential.	12
	UNIT III: Magnetics, Materials and Field Distributions Properties of Materials, Convection and Conduction Currents, Polarization in Dielectrics, Dielectric Constant and Strength, Isotropic, and Homogeneous Dielectrics, A Magnetic Dipole, Magnetization in Materials, Classification of Magnetic Materials and Magnetic Boundary Conditions, Magnetic Energy, Force on Magnetic Materials, Current Continuity.	8
	UNIT IV: Wave Propagation Characteristics Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Free Space and in Good Conductors. Power and the Poynting Vector, Reflection of a Plane Wave at Normal Incidence and at Oblique Incidence.	6
Course Assessment	Total Marks=100 Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3503	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory and Practical		
Course Title & Code	ELECTRONICS AND ELECTRICAL MEASUREMENT & INSTRUMENTATION (EC 3503)		
Course Objectives	● To introduce Basic measurement techniques of Electronics and Electrical studies ● To Learn in detail the various measurement techniques. ● To learn handling of large volume of measurement data and interpretation. ● To learn new digital techniques of measurement and instrumentation		

Course Outcomes		Cognitive Levels
CO1	To understand the basic fundamentals of electronics and electrical measurement and instrumentation in detail.	Knowledge/Comprehension (Level I/Level-II)
CO2	To understand and evaluate large volume large volume of measurement data and interpretation.	Application (Level-III)
CO3	To understand various measurement and instrumentation techniques	Analysis (Level-IV)

CO4	To implement measurement and/instrumentation for any industrial and laboratory requirements				Synthesis/Evaluation (Level-VI/Level-V)
Semester	VI			Summer	
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Basic Electronic Circuits (EC 1201)				
Text Books					
1.	Title	A course in Electrical and Electronic Measurements and Instrumentation			
	Author	A.K. Sawhney			
	Publisher	Dhanpat Rai & Co.			
	Edition	19th Revised Edition, 2011			
2.	Title	Electronic Measurements and Instrumentation			
	Author	RK Rajput			
	Publisher	S Chand			
	Edition	2009			
Reference Books					
1.	Title	Electronic Instrumentation & Measurement			
	Author	David A Bell			
	Publisher	Oxford University Press			
	Edition	3rd Edition,2013			
Course Contents	UNIT I: Introduction Significance of Measurement, Methods of Measurement Classification of Instruments, Analog, Digital, and Smart Instruments				10
	UNIT II: Basic Measurement Techniques Construction and principle of operation of Moving coil, Moving Iron, dynamometer, Wattmeter, Electro-static Instruments, Thermal and Rectifier type deflecting instruments, extension of instrument ranges using shunts, multipliers and instrument transformers				10
	UNIT III: Statistics in Measurement Definition of accuracy, precision, Fidelity, speed of response,non-linearity, techniques of linearization, classification of errors				10

	UNIT IV: Measurement of Electronic and electrical quantities Measurements of Resistances, AC Bridges, Measurement of power & Energy. Sensors & Transducers, Digital Instrumentation, Frequency domain instruments.	18
Course Assessment	Total Marks=100 Continuous Evaluation 20% Mid Semester 30% End Semester 50%	Continuous Evaluation 20% Mid Semester 30% End Semester 50%
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%

Course Code: EC 3504	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	N	Y	N		
Type of Course	Theory and Practical				
Course Title & Code	Digital Signal Processing (EC 3504)				
Course Objectives	● To introduce DTFT, Z- Transforms, DFT, FFT and its computation ● To introduce the design techniques for digital filters and its realization. ● To discuss word length issues, multi rate signal processing and DSP applications.				
Course Outcomes				Cognitive Levels	
CO1	To understand signal processing systems using basic concepts.			Knowledge/Comprehension (Level I/ Level-II)	
CO2	To identify the fundamentals of multi rate signal processing and its applications.			Application (Level-III)	
CO3	To specify and design FIR and IIR type digital filters.			Analysis (Level-IV)	
CO4	To compute DFT using FFT algorithms and derive DFT properties.			Synthesis/Evaluation (Level-VI/Level-V)	
Semester	V		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Signal and Systems (EC 2302)				

<table>
<tr><td colspan="4">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="2">Digital signal processing:Principles, Algorithms, Applications</td></tr>
<tr><td>Author</td><td colspan="2">Proakis, John G</td></tr>
<tr><td>Publisher</td><td colspan="2">Pearson Education India 2007.</td></tr>
<tr><td>Edition</td><td colspan="2">4rd Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="2">Discrete-time Signal processing</td></tr>
<tr><td>Author</td><td colspan="2">Alan V Oppenheim and Ronald W Schafer</td></tr>
<tr><td>Publisher</td><td colspan="2">Pearson.</td></tr>
<tr><td>Edition</td><td colspan="2">3rd edition</td></tr>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="2">Understanding Digital Signal Processing</td></tr>
<tr><td>Author</td><td colspan="2">Richard G Lyons</td></tr>
<tr><td>Publisher</td><td colspan="2">Pearson</td></tr>
<tr><td>Edition</td><td colspan="2">1St Edition</td></tr>
<tr><td rowspan="4">Course Contents</td><td colspan="2">UNIT-I :Frequency Domain Analysis of Discrete Time Signal and System
Review of Discrete-time Fourier Transform, Frequency response of discrete time systems, Z-Transform.</td><td>12</td></tr>
<tr><td colspan="2">UNIT II: Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)
DFT, relationship of DFT to other transforms, FFT, DIT and DIF algorithms, Linear filtering using DFT and FFT.</td><td>11</td></tr>
<tr><td colspan="2">UNIT III: Filter Design Techniques and realization
Frequency response of FIR filter, Design of FIR Digital filters, Window method, Park-McClellan's method, Frequency Sampling Method, Design of IIR Digital Filters, Butterworth, Chebyshev and Elliptic Approximations, Lowpass, Bandpass, Bandstop and High pass filters, Mapping formulas, Frequency transformations, Direct form realization of FIR and IIR systems, Lattice structure for FIR and IIR systems, Finite-word length effects. Limit cycle oscillations.</td><td>14</td></tr>
<tr><td colspan="2">UNIT IV: Multirate Signal Processing
Concepts, design of practical sampling rate converters, Decimators, interpolators. Polyphase decompositions.</td><td>11</td></tr>
<tr><td>Course Assessment</td><td>Total Marks =100
Theory (75 Marks)
Evaluation will be done for 100 marks and 75% of the marks secured will be considered.</td><td colspan="2">Continuous Evaluation 20%
Mid Semester 30%
End Semester 50%</td></tr>
</table>

	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%

Course Code: EC 3505	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	N	Y	N		
Type of Course	Theory and Practical				
Course Title & Code	IC Applications (EC 3505)				
Course Objectives	● To introduce Op-Amp basic characteristics, AC and DC parameters. ● To introduce Op-Amp linear as well as non-linear applications. ● To introduce the use of Op-Amp in designing various filters.				
Course Outcomes					Cognitive Levels
CO1	To understand the Basics of Op-Amp and its parameters.				Knowledge/Comprehension (Level I/Level-II)
CO2	To understand and design power amplifiers and oscillators using ICs				Application (Level-III)
CO3	To analyze the performance of IC amplifiers with respect to noise, bandwidth, and gain				Analysis (Level-IV)
CO4	To explore the basics of IC testing, debugging, and troubleshooting				Synthesis/Evaluation (Level-VI/Level-V)
Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Analog Electronic Circuits (EC 2304)				
Text Books					
1.	Title	Op-Amps and Linear Integrated Circuits			
	Author	Ramakant A. Gayakwad			
	Publisher	Pearson			
	Edition	2nd Edition			
2.	Title	Design with OperationalAmplifiers and Analog Integrated Circuits			
	Author	Sergei Franco			
	Publisher	McGraw-Hill			

	Edition	2nd Edition	
Reference Books			
1.	Title	Integrated Electronics: Analog and Digital Circuits&Systems	
	Author	Millman & Halkias	
	Publisher	McGraw-Hill	
	Edition	1st Edition	
Course Contents	UNIT I: Introduction to Operational Amplifiers The Basic Operational Amplifier &Its Schematic Symbol, Block Diagram Representation of Op-Amp, Power Supply Requirements of an Op-Amp, Evolution of Op-Amp, Specification of a Typical Op-Amp (741).		12
	UNIT II: The Practical Op-Amp Input Offset Voltage, Input Bias Current, Input Offset Current, Total Output Offset Voltage, Thermal Drift, Error Voltage, Variation of Op-Amp Parameter with Temperature and Supply Voltage. Supply Voltage Rejection Ratio (SVRR), CMRR-Measurement of Op-Amp Parameters, Frequency Response Compensator Networks, Frequency Response of Internally Compensated Op-Amp and Non-Compensated Op-Amp, High Frequency Op-Amp Equivalent Circuit, Open Loop Voltage Gain as a Function of Frequency, Slew Rate, Causes of Slew Rates and Its Effects in Application.		12
	UNIT III: Operational Amplifier Configurations & Linear Applications Open Loop Op-Amp Configurations - The Differential Amplifier, Inverting Amplifier, Non-Inverting Amplifier, Negative Feedback Configurations - Inverting and Non-Inverting Amplifiers, Voltage Followers &High Input Impedance Configuration, Differential Amplifiers, Closed Loop Frequency Response &Circuit Stability, Single Supply Operation of Op-Amp, Summing, Scaling and Averaging Amplifier, Voltage to Current &Current to Voltage Converters, Integrators &Differentiators, Logarithmic &Anti Logarithmic Amplifiers.		12
	UNIT IV: Active Filters & Oscillators Advantages of Active Filters, Classification of Filters, Response Characteristics of Butterworth, 73 Chebyshev, Causal Filters, First Order and Second Order Butterworth Filter- Low Pass and High Pass types. Band Pass &Band Reject Filters. Oscillator Principles, Types of Oscillators – Phase Shift, Weinbridge& Quadrature. Square Wave, Triangular Wave and Saw Tooth Wave Generators, Voltage-Controlled Oscillator.		12
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks)	Continuous Evaluation 20% Laboratory Examination 50%	

	Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Viva Voce 30%

Course Code: EC 3601	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	Y	N
Type of Course	Theory and Practical		
Course Title & Code	VLSI Design (EC 3601)		
Course Objectives	● To learn Basic CMOS circuits and CMOS Process technology ● To Design and Analyze Digital systems. ● To learn techniques of chip design using programmable devices.		

Course Outcomes		**Cognitive Levels**
CO1	To understand the fundamentals of various IC fabrication methods	Knowledge/Comprehension (Level I/Level-II)
CO2	To learn the fundamentals and design basic VLSI circuits	Application (Level-III)
CO3	Express the Layout of simple MOS circuit using Lambda based design rules	Analysis (Level-IV)
CO4	To implement/model VLSI Circuits using CAD tools	Synthesis/Evaluation (Level-VI/Level-V)

Semester	V		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Digital Electronics (EC 2401), Analog Electronic Circuits (EC 2304)				

Text Books		
1.	Title	Basic VLSI Design
	Author	Douglas AP, Kamran E.
	Publisher	PHI Learning
	Edition	3rd Edition ,2011
Reference Books		
1.	Title	Digital Integrated Circuits, Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic
	Author	Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic
	Publisher	Prentice Hall
	Edition	2nd Edition,2003

2.	Title	CMOS VLSI Design: Circuits and Systems Perspective	
	Author	N Weste and D. Harris	
	Publisher	Addison Wesley	
	Edition	4th Edition, 2010	
Course Contents	UNIT I: Introduction Introduction to VLSI Design methodologies, VLSI Design flow,design hierarchy, concepts of regularity, modularity and locality, VLSI design styles, design quality, packaging technology, computer-aided design technology.		12
	UNIT II: MOSFET fabrication: Basic steps of fabrication, CMOS p-well and n-well processes, layout design rules, BiCMOS fabrication process, Full-custom mask layout design.		12
	UNIT III:Basic VLSI Design MOS Devices, CMOS Inverter, Combinational logic, layout, design rules, Manufacturing process, Simulation; CAD tools, Low Power design strategies CMOS inverter - the dynamic view, Logic Styles; Dynamic CMOS logic, CMOS combinational, sequential logic circuits.		12
	UNIT IV: Circuit Realization Circuit characterization and performance estimation: Resistance, capacitance estimation, Switching characteristics, Delay Models. Power Dissipation, Packaging, Scaling of MOS transistor dimensions. CMOS subsystem design (incrementor / decrementor, shift register, comparator, etc.)		12
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voce 30%	

Course Code: EC 3602	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory with Practical Course		
Course Title & Code	Artificial Neural Networks and its Applications (EC3602)		

Course Objectives	● To understand the theoretical foundations of artificial neural networks ● To understand different kinds of Neural Networks based on architectures and learning rules ● To understand the basic concept of deep neural networks (DNN) and its different kinds with working principle ● To understand the various tuning parameters and optimization methods				
Course Outcomes					Cognitive Levels
CO1	To understand the building blocks of a Convolution Neural Network, to design one from scratch.				Knowledge/Comprehension (Level I/Level-II)
CO2	To apply neural networks to real-world applications in fields such as image recognition, speech recognition, natural language processing, robotics, and healthcare				Application (Level-III)
CO3	To understand different types of pre-trained networks and to modify them for various applications.				Analysis (Level-IV)
CO4	To evaluate the performance of neural network models using metrics such as accuracy, precision, recall, F1 score, and ROC curves				Synthesis/Evaluation (Level-VI/Level-V)
Semester	VI		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	2	4	48
Prerequisite course codes with course names	Engineering Mathematics-I (MA 1101), Digital Signal Processing (EC3504)				
Text Books					
1.	Title	Computer Vision and Image Processing			
	Author	Adrian Low			
	Publisher	B.S. Publications, 2005.			
	Edition	2nd Edition			
2.	Title	Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications			
	Author	S. Rajasekaran, and G. A. Vijayalakshmi Pai			
	Publisher	Prentice Hall of India, 2007			
	Edition	1st Edition			
3.	Title	Introduction to Neural Networks using MATLAB 6.0			
	Author	1. S.N.Sivanandam, S.Sumathi, S.N.Deepa,			
	Publisher	TMH, 2006			
	Edition	1st Edition			

<table>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="2">Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering</td></tr>
<tr><td>Author</td><td colspan="2">Nikola K. Kasabov</td></tr>
<tr><td>Publisher</td><td colspan="2">MIT Press, 1998</td></tr>
<tr><td>Edition</td><td colspan="2">1st Edition</td></tr>
<tr><td rowspan="4">Course Contents</td><td colspan="2">UNIT I: Essentials of Artificial Neural Networks (ANN):

Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, Adaptive Networks – Feed Forward Networks (Back Propagation)– Supervised Learning Neural Networks, Radial Basis Function Networks, Reinforcement Learning, Unsupervised Learning Neural Networks.</td><td>12</td></tr>
<tr><td colspan="2">UNIT II: Convolutional Neural Network (CNN):
Basic structure of CNN, Analyzing different layers of CNN- Input Layer, Convolutional Layers (1D/2D), Batch Normalization Layers, Activation Layers, Fully Connected Layers, Optimization Methods-SGDM, ADAM; Building CNN from scratch.</td><td>12</td></tr>
<tr><td colspan="2">UNIT III: Pre-trained Networks:
Google-Net, Res-Net, Alex-Net; Modifying structures of Pre-trained Networks with applications in object detection and semantic segmentation, Layer replacement and truncation;</td><td>12</td></tr>
<tr><td colspan="2">UNIT IV: Applications of ANN:
Transfer learning and Ensemble approach in signal modulation classification, signal (ECG, EEG) classification, Image Classification, super resolution, Segmentation, Noise Removal</td><td>12</td></tr>
<tr><td>Course Assessment</td><td>Theory (75 Marks)
Evaluation will be done for 100 marks and 75% of the marks secured will be considered.</td><td colspan="2">Continuous Evaluation 20%
Mid Semester 30%
End Semester 50%</td></tr>
<tr><td></td><td>Practical (25 Marks)
Evaluation will be done for 50 marks and 50% of the marks secured will be considered.</td><td colspan="2">Continuous Evaluation 20%
Laboratory Examination 50%
Viva Voice 30%</td></tr>
</table>

<table>
<tr><td rowspan="2">Course Code:
EE 3531</td><td>Open Elective Course: (Y/N)</td><td>Departmental Core Course: (Y/N)</td><td>Departmental Elective Course: (Y/N)</td></tr>
<tr><td>N</td><td>Y</td><td>N</td></tr>
<tr><td>Type of Course</td><td colspan="3">Theory Course</td></tr>
<tr><td>Course Title & Code</td><td colspan="3">Industrial Electronics (EC3531)</td></tr>
<tr><td>Course Objectives</td><td colspan="3">● To gain a comprehensive understanding of industrial automation and control systems, including their components, architectures, and functions
● To Identify and explain the operation of electronic components commonly used in industrial applications, such as diodes, transistors, thyristors, and integrated circuits
● To learn the principles and applications of power semiconductor devices, including diodes, thyristors (SCRs), MOSFETs, and IGBTs
● To understand power electronic circuits and their use in converting and controlling electrical power in industrial systems</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">Understanding of power electronic devices and circuits, including rectifiers, inverters, converters, and voltage regulators, as well as their applications in industrial settings</td><td>Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">Understanding how industrial electronic components and systems integrate with broader industrial automation and control systems, including SCADA (Supervisory Control and Data Acquisition) systems and DCS (Distributed Control Systems)</td><td>Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="2">Proficiency in using electronic instruments for measuring and analyzing signals in industrial environments, including oscilloscopes, multi-meters, signal generators, and data acquisition systems</td><td>Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">Ability to diagnose and troubleshoot faults in industrial electronic systems, as well as perform routine maintenance tasks to ensure system reliability and performance.</td><td>Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">VI</td><td>Winter</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="4">Analog Electronic Circuits (EC2304), Network Analysis and Synthesis (EE2331), and Introduction to semiconductor devices (EC2404)</td></tr>
<tr><td colspan="6">Text Books</td></tr>
<tr><td>1.</td><td>Title</td><td colspan="4">Power Electronics: Converters, Applications, and Design</td></tr>
</table>

	Author	Ned Mohan, Tore M. Undeland, and William P. Robbins	
	Publisher	John Wiley and Sons	
	Edition	3rd Edition	
2.	Title	Fundamentals of Electrical Drives	
	Author	G.K. Dubey	
	Publisher	Narosa Publishing House	
	Edition	2nd Edition	
Course Contents	UNIT I: General Introduction: General Introduction of Power Electronics, Scope and Application, Power Semiconductor Devices- Power diodes; power transistors - SCRs - Triac - GTO; Power MOSFETs - IGBTs- Principles of operation and characteristics, device specifications and ratings, methods of turning on SCR- gate triggering circuit, methods of turning off SCR- commutation circuits; Protection and gate drive circuits.		9
	UNIT II: Controlled Rectifiers: Control rectifiers (AC to DC converter): Single phase converters- Principle of phase control, half wave-controlled rectifier load, fully controlled bridge converter, half controlled (semi) converter, Effect of single-phase full converter with source inductance, Dual converter, 3-phase half wave-controlled rectifier, 3-phase fully controlled bridge converter, 3-phase semi converter.		9
	UNIT III: Choppers and Inverters: D.C. Choppers: Principle of operation, control techniques, step down chopper, buck, boost & buck-boost regulator, voltage commutated chopper, current commutated chopper. Inverter: Series inverter, parallel inverter, single phase bridge inverter, concept of VSI and CSI, 3-phase bridge inverter (120° and 180° conduction mode), concept of PWM inverter.		9
	UNIT IV: AC Voltage Controllers: Principle of on-off controller, Principle of phase control, Single-Phase bidirectional controllers with resistive loads, single-phase controllers with inductive loads, 3-phse half-wave controllers, 3-phse full-wave controllers; Cyclo converters: Single- phase cyclo-converters-mid-point type and bridge type cyclo converter, Three-phase cyclo-converters-Three-phase to single converter, Three-phase to three phase cyclo-converters-Mid-point and Bridge type Applications: UPS, Zero voltage switch, Zero current switch.		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

<table>
<tr><td rowspan="2">Course Code:
EC 3604</td><td>Open Elective Course: (Y/N)</td><td>Departmental Core Course: (Y/N)</td><td>Departmental Elective Course: (Y/N)</td></tr>
<tr><td>N</td><td>Y</td><td>N</td></tr>
<tr><td colspan="2">Type of Course</td><td colspan="2">Theory and Practical</td></tr>
<tr><td colspan="2">Course Title & Code</td><td colspan="2">Antenna and Wave Propagation (EC3604)</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="2">● To introduce the practical idea on the different antenna parameters for real time knowledge.
● To improve the knowledge on the EM radiation techniques of various antennas and their maximum range of coverage
● To learn the EM wave transmission and receiving system in free space, sky wave and for ground wave communication.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">To understand the radiation techniques of various radiator.</td><td>Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">To design the various antenna and conforming the fundamental performance for various applications.</td><td>Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="2">To get clear idea about the design, performance and analysis.</td><td>Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">To understand the performance of the antenna as a wave radiator for various communication systems.</td><td>Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">VI</td><td>Winter</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td><td>48</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="3">Electromagnetic Theory (EC 303)</td></tr>
<tr><td colspan="5">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="3">Antennas</td></tr>
<tr><td>Author</td><td colspan="3">J.D. Kraus</td></tr>
<tr><td>Publisher</td><td colspan="3">Tata McGraw Hill</td></tr>
<tr><td>Edition</td><td colspan="3">2nd Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="3">Antenna Theory - Analysis and Design</td></tr>
<tr><td>Author</td><td colspan="3">C.A. Balanis</td></tr>
<tr><td>Publisher</td><td colspan="3">John Wiley</td></tr>
<tr><td>Edition</td><td colspan="3">3rd Edition</td></tr>
<tr><td colspan="5">Reference Books</td></tr>
<tr><td rowspan="2">1.</td><td>Title</td><td colspan="3">Antennas and Radio Wave Propagation</td></tr>
<tr><td>Author</td><td colspan="3">R.E. Collins</td></tr>
</table>

	Publisher	Tata McGraw Hill	
	Edition	4th Edition	
2.	Title	Broadband MicroStrip Antennas	
	Author	G. Kumar and K.P. Roy	
	Publisher	Artech House	
	Edition	30 November 2002	
Course Contents	UNIT I: Fundamental concept of Antenna parameters Physical concept of radiation, Radiation pattern, near and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, radiation resistance, radiating average power efficiency, Friis transmission equation, surface current distribution for finite dipoles.		14
	UNIT II: Radiation Technique and Field distributions Infinitesimal dipole, Half Wave Dipole ($\lambda/2$), finite-length dipole and, ($\lambda/4$) monopole antenna. Concept of Smart Antennas, Characteristics of Loop antenna, Helical antenna Log-periodic, Yagi-Uda antenna and Horn Antenna. Basic characteristics and design of microstrip antennas: Planar monopole antenna, rectangular and circular patch antennas, feeding methods.		14
	UNIT III: Array Antenna Two element array concept, array factor, N element linear array: uniform amplitude and spacing, End-fire array, broadside array and Binomial Array. Basic Concepts of Smart Antennas.		10
	UNIT IV: Wave Propagation Concept of Ground wave propagation, Sky wave propagation and space wave propagation Duct propagation, Maximum Usable Frequency (MUF), Skip distance, Tropospheric Scatter propagation, Critical frequency, Fadings.		10
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voice 30%	

Course Code: EC 4701	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N

<table>
<tr><td colspan="2">Type of Course</td><td colspan="5">Theory and Practical</td></tr>
<tr><td colspan="2">Course Title & Code</td><td colspan="5">RF and Microwave Engineering (EC 4701)</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="5">● To understand about the devices those are directly involve generating microwave signal.
● To understand the transmission process of X-band EM waves.
● To improve the knowledge about the microwave signal amplification, division, addition and measurement techniques.</td></tr>
<tr><td colspan="5">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="4">Student should able to identify the basic microwave devices.</td><td colspan="2">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="4">Student should able to differentiate microwave devices for different frequency bands application under the microwave frequency range.</td><td colspan="2">Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="4">Student should able to understand the working principle of the microwave devices.</td><td colspan="2">Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="4">Student should able to implement the new microwave devices and also able to measure power and frequency bands</td><td colspan="2">Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">VII</td><td colspan="3">Summer</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td><td>48</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="5">Antenna and Wave Propagation (EC3604)</td></tr>
<tr><td colspan="7">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">Principle of Electromagnetics</td></tr>
<tr><td>Author</td><td colspan="5">M.N.O. Sadiku and S.V. Kulkarni,</td></tr>
<tr><td>Publisher</td><td colspan="5">Oxford</td></tr>
<tr><td>Edition</td><td colspan="5">6th Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="5">Microwave Engineering</td></tr>
<tr><td>Author</td><td colspan="5">David. M. Pozar,</td></tr>
<tr><td>Publisher</td><td colspan="5">John Wiley</td></tr>
<tr><td>Edition</td><td colspan="5">4th Edition</td></tr>
<tr><td colspan="7">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">Fundamental of Microwave Engineering</td></tr>
<tr><td>Author</td><td colspan="5">R.E. Collins</td></tr>
<tr><td>Publisher</td><td colspan="5">Wiley</td></tr>
<tr><td>Edition</td><td colspan="5">2nd Edition</td></tr>
<tr><td>2.</td><td>Title</td><td colspan="5">Microwave Devices and Circuits, Pearson</td></tr>
</table>

	Author	S. Y. Liao	
	Publisher	Pearson	
	Edition	3rd Edition, 2003	
Course Contents	UNIT I: Microwave Generation A Short History of Microwave Engineering, IEEE standard microwave frequency bands and its applications, concept of microwave communication systems. Microwave Tubes: Klystron, TWT and Magnetron, Microwave Amplifier, Oscillators and Mixers design. Microwave Semiconductor Devices.		14
	UNIT II: Fundamental Concepts OF Transmission line Introduction, Transmission Line Parameters, The Loss-less, Distortion-less, Lossy Transmission Lines, Microstrip Transmission Lines. Plane Waves in a Lossless, Lossy and Good Conductor Mediums Applications of Transmission Lines: The Quarter-Wave Transformer, stubs, Smith Chart.		14
	UNIT III: Microwave Waveguides and Applications Introduction, Maxwell's Equation, EM wave equations, Rectangular Waveguides, Transverse Magnetic (TM) Modes, Transverse Electric (TE) Modes, Wave Propagation in the Guide, Power Transmission and Attenuation, scattering parameters., Directional Coupler, Power Divider, combiner, Attenuator, cavity resonator.		12
	UNIT IV: Microwave Measurements Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal.		8
Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voice 30%	

Course Code: EC 4702	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	Y	N
Type of Course	Theory and Practical		
Course Title & Code	Computer Networks (EC 4702)		

<table>
<tr><td>Course Objectives</td><td colspan="5">● To introduce the fundamental concepts of computer networks, including the OSImodel, TCP/IP suite, network layers, and addressing schemes.
● To learn about different network architectures including LANs, WANs MANs and understand their design principles.
● To study various network topologies such as bus, star, ring, mesh, and hybrid.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="4">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">To understand the issues and challenges at all levels of abstraction in the architecture of a computer network.</td><td colspan="3">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">To understand how to Develop networked applications.</td><td colspan="3">Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="2">To realize protocols at different layers of a network hierarchy.</td><td colspan="3">Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">To recognize network for real time application.</td><td colspan="3">Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td>VII</td><td colspan="3">Summer</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td><td>48</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="4">Computer organization and Architecture (EC 322)</td></tr>
<tr><td colspan="6">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="4">Computer networks</td></tr>
<tr><td>Author</td><td colspan="4">A.S Tanenbaum</td></tr>
<tr><td>Publisher</td><td colspan="4">Prentice Hall of India, New Delhi. 2001.</td></tr>
<tr><td>Edition</td><td colspan="4">3rd Ed.</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="4">Data Communication and Networking</td></tr>
<tr><td>Author</td><td colspan="4">Behrouz A. Forouzan</td></tr>
<tr><td>Publisher</td><td colspan="4">McGraw Hill Education</td></tr>
<tr><td>Edition</td><td colspan="4">4th Edition</td></tr>
<tr><td colspan="6">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="4">Data and Computer communications</td></tr>
<tr><td>Author</td><td colspan="4">W.Stallings</td></tr>
<tr><td>Publisher</td><td colspan="4">Prentice Hall of India, New Delhi.2001.</td></tr>
<tr><td>Edition</td><td colspan="4">5th Edition</td></tr>
<tr><td></td><td colspan="4">UNIT-I: Introduction Concepts</td><td>12</td></tr>
</table>

Course Contents	Applications of Networks, Network structure and architecture, The reference OSI reference model, services, Network Topology Design - Delay Analysis, Back Bone Design, Local Access Network Design, Physical Layer	
	UNIT II: Physical Layer Transmission Media, Switching methods, ISDN, Terminal Handling Medium Access sub layer: Medium Access sub layer - Channel Allocations, LAN 8 protocols - ALOHA protocols - Overview of IEEE standards - FDDI.	12
	UNIT III: Data Link Layer Elementary Data Link Protocols, Sliding Window protocols, Error Handling. Network Layer: Point - to Pont Networks, routing, Congestion control Internetworking 8 -TCP / IP, IP packet, IP address, IPv6.	12
	UNIT IV: Transport Layer, session, presentation and applications layer Design issues, connection management, session Layer-Design issues, remote procedure call. Presentation Layer-Design issues, Data compression techniques, File Transfer, Access and Management, Electronic mail, Virtual Terminals, Other application.	12

Course Assessment	Total Marks =100 Theory (75 Marks) Evaluation will be done for 100 marks and 75% of the marks secured will be considered.	Continuous Evaluation 20% Mid Semester 30% End Semester 50%
	Practical (25 Marks) Evaluation will be done for 50 marks and 50% of the marks secured will be considered.	Continuous Evaluation 20% Laboratory Examination 50% Viva Voice 30%

Course Code: EC 3571	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Optical Fiber Communication (EC 3571)		
Course Objectives	● To introduce basics of signal propagation through optical fibers. ● To introduce the fiber impairments, optical components and devices. ● To learn all design considerations of optical fiber systems.		
Course Outcomes			Cognitive Levels
CO1	To be able to recognize and classify the structures of Optical fiber and types.		Knowledge/Comprehension (Level I/Level-II)

CO2	To discuss the channel impairments like losses and dispersion.	Analysis (Level-IV)
CO3	Classify the Optical sources and detectors and to discuss their principle.	Application (Level-III)
CO4	Familiar with Design considerations of fiber optic systems.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	V		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Electromagnetic Theory (EC 3502)				

Text Books			
1.	Title	Optical Fiber Communications	
	Author	Gerd KeiserGerd Keiser	
	Publisher	McGraw-Hill Education, 2010	
	Edition	4th Edition	
2.	Title	Introduction To Fiber Optics	
	Author	ajoy ghatak, k. Thyagarajan	
	Publisher	Cambridge University Press, 1998	
	Edition	1st Edition	
Reference Books			
1.	Title	Fiber Optic Communication Systems	
	Author	G.P. Agrawal	
	Publisher	Wiley, 2002	
	Edition	3rd Edition	
2.	Title	Optical Communication Systems	
	Author	John Gowar	
	Publisher	Prentice Hall. 2001	
	Edition	2nd Edition	
Course Contents	UNIT I: Overview of Optical Fibers Introduction to vector nature of light, propagation of light, Ray model, wave model.Optical Fibers: Structure, Types, Waveguiding. Step-index and graded index optical fibers. Modal analysis. Classification of modes. Single Mode Fibers.		9
	UNIT II: Signal Degradation In Optical Fibers Attenuation. Pulse dispersion. Material and waveguide dispersion. Polarization Mode Dispersion. Absorption, scattering and bending losses. Dispersion Shifted Fibers, Dispersion Compensating Fibers.		9

	UNIT III: Optical Power Launching and Coupling Source To Fiber Power Launching. Lensing schemes for coupling improvement. Fiber-to-fiber joints. Splicing techniques.Connectors. Optical fiber connectors.	9
	UNIT IV: Optical sources and Fiber Optics Systems Laser fundamentals. Semiconductor Laser basics. LEDs. PIN and Avalanche photodiodes.Analog and digital modulation. Noise in detection process. Bit error rate. Optical receiver operation. Power Budget and Rise time Budget.Optical amplifiers. WDM.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3572	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Information Theory and Coding (EC3572)		
Course Objectives	● To understand information theoretic behavior of a communication system. ● To understand various source coding techniques for data compression ● To understand various channel coding techniques and their capability. ● Build and understanding of fundamental concepts of data communication and networking.		

Course Outcomes		Cognitive Levels
CO1	Summarize various theorems related to information channels	Knowledge/Comprehension (Level I/Level-II)
CO2	Illustrate various encoding techniques related to information channels	Application (Level-III)
CO3	Analyze information using various encoding techniques	Analysis (Level-IV)
CO4	Monitor performance of encoding techniques in the application of data transmission	Synthesis/Evaluation (Level-VI/Level-V)

Semester	V	Summer

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Digital Communication (EC 2403)				

Text Books		
1.	Title	"Information and Coding Theory",
	Author	G. A. Jones and J. M. Jones,
	Publisher	Springer, 2000.
	Edition	3rd Edition
2.	Title	"Introduction to Coding Theory",
	Author	J. H. van Lint,
	Publisher	Springer, 1999.
	Edition	3rd Edition

Reference Books		
1.	Title	"Elements of Information Theory", and
	Author	Cover Thomas,
	Publisher	Wiley 2006.
	Edition	3rd Edition

Course Contents	UNIT 1:Definitions, Uniquely Decodable Codes, Instantaneous Codes, Krafts Inequality, McMillan's Inequality, Optimal Codes, Binary Huffman Codes, r-ary Huffman codes, Information and Entropy, Properties of Entropy Function, Entropy and Average Word-Length, Shannon-Fano Coding, Shannon's First Theorem, Information Channels, Binary Symmetric Channel, System Entropies, System Entropies for Binary Symmetric Channel, Extension of Shannon's First Theorem to Information Channels, Mutual Information, Mutual Information for the Binary Symmetric Channel, Hamming Distance, Shannon's Second (Fundamental) Theorem, Converse of Shannon's Theorems.	9
	UNIT II: Review: Algebra, Krawtchouk Polynomials, Combinatorial Theory, Probability Theory. Linear Codes: Block Codes, Linear Codes, Hamming Codes, Majority Logic Coding, Weight Enumerators, The Lee Metric, Hadamard Codes, Golay Codes (Binary and Ternary), Reed Muller Codes, And	9

	Kerdock Codes.Bounds on Codes: Gilbert Bound, Upper Bound, Linear Programming Bounds, Hamming's Sphere –Packing Bound, Gilbert Varshamov Bound, Hadamard Matrices and Codes. Cyclic Codes: Generator Matrix, Check polynomial, Zeros of	
	UNIT III Cyclic Codes, BCH Codes, Reed-Solomon Codes, Quadratic Residue Codes, Generalized Reed-Muller Codes. Perfect Codes and Uniformly Packed Codes: Lloyd's Theorem, Characteristic Polynomial of a Code, Uniformly Packed Codes, Nonexistence Theorems.	9
	UNIT IV Quaternary Codes, Binary Codes Derived from codes over Z4, Galois Rings over Z4, Cyclic Codes over Z4. Goppa Codes. Algebraic Curves, Divisors, Differentials on a Curve, Riemann – Roch Theorem, Codes from Algebraic Curves. Arithmetic Codes: AN Codes, Mandelbaum – Barrows Codes, Convolutional Codes.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3573	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Semiconductor Device Modelling (EC3573)		
Course Objectives	● To introduce students to the physics of semiconductors and the inner working of semiconductor devices. ● To provide students the insight useful for understanding new semiconductor devices and technologies.		

Course Outcomes		Cognitive Levels
CO1	To analyze MOS and its operation on the basis of physical operation	Knowledge/Comprehension (Level I/Level-II)
CO2	To develop a physics-based knowledge on the basic fundamentals in the course	Application (Level-III)
CO3	To relate a 2nd order effect or deviation from ideal behavior in circuit level to device physics concept learnt in the course	Analysis (Level-IV)
CO4	To understand, articulate and demonstrate new ideas given in research literature of the field	Synthesis/Evaluation (Level-VI/Level-V)

Semester	V	Summer			
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours

	3	0	0	3	36
Prerequisite course codes with course names	Introduction to Semiconductor Devices (EC 208)				
Text Books					
1.	Title	Operation and Modeling of the MOS Transistor			
	Author	Yannis Tsividis			
	Publisher	Oxford University Press			
	Edition	3rd Edition			
2.	Title	MOSFET models for VLSI Circuit Simulation			
	Author	N. Arora			
	Publisher	Springer-Verlag			
	Edition	1st Edition			
Reference Books					
1.	Title	Introduction to Semiconductor Device Modeling			
	Author	C. Snowden			
	Publisher	World Scientific			
	Edition	1986			
Course Contents	UNIT I: Two Terminal MOS Structure Contact Potential: Overview, flat-band voltage, potential and charge balance, channel charge, accumulation, depletion, inversion, threshold voltage, small signal capacitances.				9
	UNIT II: Three Terminal MOS Structure Effect of channel-body potential, body effect, inversion regions, contacting the inversion layer, region of inversion: approximate limits, threshold voltage, V_{CB} control point of view, pinch-off voltage.				9
	UNIT III: Four Terminal MOS Transistor Complete charge-sheet model, simplified charge-sheet model, strong and weak inversion approximation to the channel current, effective surface mobility, field dependence of the surface mobility, breakdown.				9
	UNIT IV: Small Dimensional Effects Long- and short-channel MOS transistor, carrier velocity saturation, channel length modulation, charge sharing, DIBL, threshold voltage rolls-off, narrow channel effects, punch through, hot-carrier effects, GIDL, scaling: constant field and constant voltage scaling, non-scaling effects, modern scaling.				9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%				

<table>
<tr><td rowspan="2">Course Code:
EC 3574</td><td>Open Elective Course: (Y/N)</td><td>Departmental Core Course: (Y/N)</td><td>Departmental Elective Course: (Y/N)</td></tr>
<tr><td>N</td><td>N</td><td>Y</td></tr>
<tr><td>Type of Course</td><td colspan="3">Theory Course</td></tr>
<tr><td>Course Title & Code</td><td colspan="3">Wireless and Ad-hoc Network (EC3574)</td></tr>
<tr><td>Course Objectives</td><td colspan="3">● To introduce fundamental principles of Ad-hoc Networks and comprehensive understanding of Ad-hoc network protocols.
● Outline current and emerging trends in Ad-hoc Wireless Networks.
● Analyze energy management in ad-hoc wireless networks.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">To understand concept of Ad-hoc Wireless Networks, Ad-hoc wireless Internet, issues in Ad-hoc wireless</td><td>Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">To choose appropriate protocol for various applications</td><td>Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="2">To design their own wireless network and examine security measures present at different levels and analyze energy consumption and management.</td><td>Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="2">To evaluate the existing network and improve its quality of service</td><td>Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">V</td><td>Summer</td></tr>
<tr><td rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="3">Digital Communication (EC206), Data Communication and Networking (EC353)</td></tr>
<tr><td colspan="5">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="3">Ad-hoc Wireless Networks</td></tr>
<tr><td>Author</td><td colspan="3">C. Siva Ram Murthy & B. S. Manoj</td></tr>
<tr><td>Publisher</td><td colspan="3">Pearson Education, 2011</td></tr>
<tr><td>Edition</td><td colspan="3">2nd Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="3">Ad-hoc Wireless Networking</td></tr>
<tr><td>Author</td><td colspan="3">Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du</td></tr>
<tr><td>Publisher</td><td colspan="3">Kluwer Academic Publishers, 2004.</td></tr>
<tr><td>Edition</td><td colspan="3">1st Edition</td></tr>
<tr><td colspan="5">Reference Books</td></tr>
<tr><td rowspan="2">1.</td><td>Title</td><td colspan="3">Ad-hoc Wireless Network</td></tr>
<tr><td>Author</td><td colspan="3">OzanK. Tonguz and Gianguigi Ferrari</td></tr>
</table>

	Publisher	John Wiley, 2007.	
	Edition	1st Edition	
Course Contents	UNIT-I: Introduction to Ad-hoc Wireless Networks: Introduction, Issues in Ad-hoc Wireless Networks, Ad-hoc Wireless Internet; MAC Protocols for Ad-hoc Wireless Networks: Introduction, Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols, Contention-Based Protocols with Reservation Mechanisms, Contention-Based Protocols with Scheduling Mechanisms, MAC Protocols that Use Directional Antennas.		9
	UNIT II: Routing Protocols for Ad-hoc Wireless Networks Introduction, Issues in Designing a Routing Protocol for Ad-hoc Wireless Networks; Classification of Routing Protocols; Table Driven Routing Protocols; On-Demand Routing Protocols, Hybrid Routing Protocols, Hierarchical Routing Protocols and Power-Aware Routing Protocols.		9
	UNIT III: Multicast Routing in Ad-hoc Wireless Networks Introduction, Issues in Designing a Multicast Routing Protocol, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols, Classifications of Multicast Routing Protocols, Tree-Based Multicast Routing Protocols and Mesh-Based Multicast Routing Protocols		9
	UNIT IV: Transport Layer and Security Protocols for Ad-hoc Networks Introduction, Issues in Designing a Transport Layer Protocol; Design Goals of a Transport Layer Protocol; Classification of Transport Layer Solutions; TCP over Transport Layer Solutions; Other Transport Layer Protocols for Ad-hoc Networks; Security in Ad-hoc Wireless Networks, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management and Secure Touting Ad-hoc Wireless Networks. Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions; Need for Energy Management in Ad-hoc Wireless Networks, Classification of Energy Management Schemes.		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 3671	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Advanced Microprocessor (EC 3671)		

<table>
<tr><td colspan="2">Course Objectives</td><td colspan="5">● To make the students understand the basics of advanced Microprocessor (80286, 80386 and 80586)
● To have knowledge of RISC Processors</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="5">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">To understand the basics of advanced Microprocessors.</td><td colspan="4">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">To analyze the internal architecture and addressing modes of 80286 and 80386.</td><td colspan="4">Application/Analysis (Level III/Level-IV)</td></tr>
<tr><td>CO3</td><td colspan="2">To evaluate the working of the Pentium Processor.</td><td colspan="4">Analysis/Evaluation (Level IV/Level-V)</td></tr>
<tr><td>CO4</td><td colspan="2">To evaluate the working and applications of RISC Processors.</td><td colspan="4">Evaluation/Synthesis (Level V/Level-VI)</td></tr>
<tr><td colspan="2">Semester</td><td>VI</td><td colspan="4">Winter</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="5">Introduction to Microprocessors (EC 3501)</td></tr>
<tr><td colspan="7">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">Advanced Microprocessors and Peripherals</td></tr>
<tr><td>Author</td><td colspan="5">A.K. Ray and K.M. Bhurchandi</td></tr>
<tr><td>Publisher</td><td colspan="5">Tata Mcgraw Hill</td></tr>
<tr><td>Edition</td><td colspan="5">3rd Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="5">The INTEL Microprocessors</td></tr>
<tr><td>Author</td><td colspan="5">Barry B. Brey</td></tr>
<tr><td>Publisher</td><td colspan="5">Pearson</td></tr>
<tr><td>Edition</td><td colspan="5">8th Edition</td></tr>
<tr><td colspan="7">Reference Books</td></tr>
</table>

1.	Title	Computer Architecture, A Quantitative Approach	
	Author	John L. Hennessy David A. Patterson	
	Publisher	Elsevier	
	Edition	5th Edition	
Course Contents	UNIT I: Introduction to advanced microprocessors (16-bit, 32 bit & 64 bit), Internal Architecture of 80286.Signal description of 80286, Real addressing mode of 80286,80286 Bus Interface, Fetch Cycle of 80286		9
	UNIT II: Salient features of 80386, Architecture and Signal description of 80386, Register Optimization of 80386, addressing mode of 80386, data types of 80386		9
	UNIT III: Salient features of 80586(Pentium),A few relevant concepts of computer architecture, System Architecture, Branch Prediction, Enhanced Instruction set of Pentium		9
	UNIT IV: A short history of RISC Processors, Hybrid Architecture—RISC and CISC Convergence, The Advantage of RISC ,Basic features of RISC Processors, Design issues of RISC Processors		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 3672	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Computer Organization and Architecture (EC 3672)		
Course Objectives	● To gain a fundamental understanding of how computers are organized and the various components that make up a computer system. ● To cover aspects of CPU design including instruction sets, ALU operations, pipelines, and execution of machine-level instructions. ● To understand the different types of memory and storage, focusing on hierarchy, organization, management, and optimization techniques		

	● To understand how data paths and control paths are designed in microprocessors.				
Course Outcomes					Cognitive Levels
CO1	To articulate the roles and functionalities of various computer components, such as CPUs, GPUs, memory, and storage devices.				Knowledge/Comprehension (Level I/Level-II)
CO2	To apply knowledge of CPU Design.				Analysis (Level-IV)
CO3	To understand Memory Management.				Knowledge/Comprehension (Level I/Level-II)
CO4	To describe how parallel processing can be used to improve performance and the complexities it introduces into system design				Knowledge/Comprehension (Level I/Level-II)
Semester	VI		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Digital Electronics (EC202)				
Text Books					
1.	Title	Computer Organization and Design			
	Author	D. A. Patterson, J. L. Hennessy			
	Publisher	Morgan Kaufmann			
	Edition	4th Edition			
2.	Title	Computer System Architecture			
	Author	M. Mano			
	Publisher	Pearson, 1992			
	Edition	3rd Edition			
Reference Books					
1.	Title	Computer Organization			
	Author	C. Hamacher, Z. Vranesic, S. Zaky			
	Publisher	McGraw Hill Education			
	Edition	6th Edition			
Course Contents	UNIT I: Functional units of a computer: CPU, memory, I/O;				6
	UNIT II: Instruction set architecture: Instruction format, addressing modes, ISAs for common CPUs and assembly languages;				8

	UNIT III: Data representation & Processor design: Signed number representation, fixed and floating point representations; Datapath components, control unit, pipelining, and hazards;	10
	UNIT IV: Memory & Input-Output: Concept of hierarchical memory organization, cache memory, mapping functions and replacement algorithms, main memory organisation, virtual memory; I/O transfers - program controlled, interrupt driven and DMA, I/O devices - secondary storage; Introduction to multi-core architectures.	12
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3673	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Satellite Communication (EC3673)		
Course Objectives	● To introduce the Orbital Mechanism, earth station and satellite systems. ● To impart knowledge about the satellite link design and satellite navigation systems.		

Course Outcomes		Cognitive Levels
CO1	To understand the orbital and functional principles of satellite communication systems	Knowledge/Comprehension (Level I/Level-II)
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems	Application (Level-III)
CO3	Analyse and evaluate a satellite link and suggest enhancements to improve the link performance.	Analysis (Level-IV)
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.	Synthesis/Evaluation (Level-VI/Level-V)
CO5	Understand the Satellite based Navigation and different Systems.	Knowledge/Comprehension (Level I/Level-II)

Semester	VI		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	Digital Communication (EC 2403)		
Text Books			
1.	Title	Satellite Communication	
	Author	D. Roddy	
	Publisher	McGraw- Hill, 2009	
	Edition	4th Edition	
2.	Title	Satellite Communication	
	Author	T. Pratt & C.W. Bostain	
	Publisher	Wiley 2000.	
	Edition	1st Edition	
Reference Books			
1.	Title	Design of Geosynchrons Spacecraft	
	Author	B.N. Agrawal	
	Publisher	Prentice- Hall,1986.	
	Edition	1st Edition	
Course Contents	UNIT I: Orbital Mechanism Satellite orbit and orbital equations, Kepler's laws of planetary motion, Locating satellite in the orbit, Locating satellite with respect to earth, Look angle calculation, Coverage angle and slant range, Orbital perturbations, Satellite launching, Orbital effects in communication subsystem performance		8
	UNIT II: Satellites Satellite subsystems, Attitude and orbit control system, Telemetry tracking command and monitoring, Power system, communication subsystem, Satellite antennas. Earth station antenna types, Antenna gain, Antenna gain to noise temperature ratio, G/T measurement,		10
	UNIT III: Satellite Link Design Basic link analysis, Interference analysis, Terrestrial interference, Inter modulation interference, Inter-symbol interference and rain induced attenuation, Uplink power control, system availability, System design for link without frequency reuse and system design for link with frequency reuse. Frequency division multiple access, FDM-FM-FDMA, Single channel per carrier.		10
	UNIT IV: Satellite based Navigation System Principle of measuring signal transit time, Basic principles of satellite navigation, Signal travel time Determining position, The effect and correction of time error, Functional segments of GPS, Improved GPS: DGPS, SBAS, A-GPS and HSGPS.		8

Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%

Course Code: EC 3674	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	N	N	Y		
Type of Course	Theory Course				
Course Title & Code	Introduction To Artificial Intelligence and Machine Learning (EC3674)				
Course Objectives	● To understand the theoretical foundations along with the ethics of AI ● To recognize and analyze Machine Learning-based AI problems along with ethical implications ● To understand the basic concept of deep neural networks (DNN) and its different kinds with working principle ● To apply ML techniques to solve real-world problems from various domains such as healthcare, social computing, economics				
Course Outcomes				Cognitive Levels	
CO1	To understand the basic concepts of AI with its working principle.			Knowledge/Comprehension (Level I/Level-II)	
CO2	To apply AI and ML techniques to solve problems in diverse application areas, such as image recognition, natural language processing, recommendation systems, autonomous vehicles, healthcare, and finance			Application (Level-III)	
CO3	To understand the role of learning parameters and optimization techniques in the overall performance of an ML algorithm			Analysis (Level-IV)	
CO4	To evaluate the performance of ML algorithms in signal and image processing applications			Synthesis/Evaluation (Level-VI/Level-V)	
Semester	VI		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Engineering Mathematics-I (MA1101), Digital Signal Processing (EC3504),				
Text Books					
1.	Title	Machine Learning Yearning			
	Author	Adrew Ng			
	Publisher	FREE EBOOK			
	Edition				
2.	Title	Artificial Intelligence			

	Author	Elain Rich, and Kevin Knight	
	Publisher	Tata McGraw-Hill, 1993	
	Edition	2st Edition	
3.	Title	Introduction to Neural Networks using MATLAB 6.0	
	Author	2. S.N.Sivanandam, S.Sumathi, S.N.Deepa,	
	Publisher	TMH, 2006	
	Edition	1st Edition	
Reference Books			
1.	Title	Foundations of Machine Learning	
	Author	Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar	
	Publisher	MIT Press, 2018, FREE EBOOK	
	Edition	2nd Edition	
Course Contents	UNIT I: Introduction to Artificial Intelligence: Definition and history of artificial intelligence, Goals and Applications of AI, Types of AI: Narrow AI, General AI, Ethical Considerations in AI		9
	UNIT II: Problem Solving and Search Algorithms: Problem Solving Agents, State space Search, Uninformed Search Algorithms: Breath First Search (BFS), Depth First Search (DFS); Heuristic Search Algorithms: Hill Climbing		9
	UNIT III: Machine Learning Fundamentals: Introduction to machine learning, Types of machine learning: Supervised, Unsupervised, Reinforcement Learning, Basic Concepts: Features, Labels, Training, testing, Evaluation Metrics: Accuracy, Precision, Recall, F1 Score		9
	UNIT IV: Neural Networks and deep Learning: Introduction to artificial neural networks (ANN). Perceptron. Multilayer Perceptron (MLP), Training Neural Networks: Back-Propogation, Introduction to Deep Learning, Convolutional Neural Networks (CNNs) for image classification, Recurrent Neural Networks (RNNs) for sequence data, Applications of deep learning: Computer Vision, Natural Language Processing		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

<table>
<tr><td rowspan="2">Course Code:
EC 3675</td><td>Open Elective Course: (Y/N)</td><td>Departmental Core Course: (Y/N)</td><td>Departmental Elective Course: (Y/N)</td></tr>
<tr><td>N</td><td>N</td><td>Y</td></tr>
<tr><td>Type of Course</td><td colspan="3">Theory Course</td></tr>
<tr><td>Course Title & Code</td><td colspan="3">VHDL and Verilog (EC3675)</td></tr>
<tr><td>Course Objectives</td><td colspan="3">● To make the students understand HDL for designing digital circuits and systems.
● To debug and simulate digital circuits and Systems described in VHDL and Verilog.</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="2">Understand HDL for describing Hardware.</td><td>Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="2">Develop programs to design and implement the given combinational and sequential circuits.</td><td>Analysis (Level-IV)</td></tr>
<tr><td>CO3</td><td colspan="2">Use software to debug and simulate digital circuits and systems described in VHDL and Verilog.</td><td>Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td>CO4</td><td colspan="2">Describe the test bench for the given application in VHDL and Verilog.</td><td>Application (Level-III)</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="2">Winter</td></tr>
<tr><td rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td>Prerequisite course codes with course names</td><td colspan="5">Digital Electronics (EC 2401)</td></tr>
<tr><td colspan="6">Text Books</td></tr>
<tr><td rowspan="3">1.</td><td>Title</td><td colspan="4">HDL Programming (VHDL and Verilog)</td></tr>
<tr><td>Author</td><td colspan="4">Nazeih M.Botros- John</td></tr>
<tr><td>Publisher</td><td colspan="4">Weily India Pvt. Ltd</td></tr>
</table>

	Edition	2008	
2.	Title	Fundamentals of HDL	
	Author	Cyril P.R. Pearson/Sanguin	
	Publisher	Pearson Education India	
	Edition	2010	
Reference Books			
1.	Title	Advanced digital design with the Verilog HDL	
	Author	Michel D. Ciletti	
	Publisher	Pearson	
	Edition	2nd	
Course Contents	UNIT I: Introduction to Hardware Description Languages (HDL), History of VHDL, Pro's and Con's of VHDL,VHDL Flow elements:-Entity. Architecture, configuration, package, library, Data Types, operators, VHDL Modeling: - Data flow, Behavioral, Structural		9
	UNIT II: Variables, Signals and constants, Arrays, Synthesis and Simulation of MUX, DEMUX, DECODER ,ENCODER, Flip-Flop, Counter, Shift Register, MOORE ,MEALY Machines. Test bench and its applications		9
	UNIT III: Generics, Generate statements ,VHDL functions, VHDL procedures, Packages and libraries, File Processing, Examples of File Processing		9
	UNIT IV: Introduction to Verilog, Brief comparison of VHDL and Verilog, Structure of Verilog module, Operators, Data types, Modules, ports, vectors - Structural and data flow modelling, hierarchical structure, testbenches, examples - Blocking and Non- blocking assignments - Combinational and sequential circuit modeling		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4771	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Digital Image Processing (EC4771)		
Course Objectives	● To study the image fundamentals and mathematical transforms necessary for image processing. ● To study the image enhancement techniques ● To study image restoration procedures. ● To study the image compression procedures		

Course Outcomes		Cognitive Levels
CO1	Introduction to image mathematical model	Knowledge/Comprehension (Level I/Level-II)
CO2	Various method for analysis of image	Application (Level-III)
CO3	Analyze the different types of transformation	Analysis (Level-IV)
CO4	Relation of image related to neural network	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VII	Summer

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	Signals and System (EC 2302)

Text Books		
1.	Title	1. Digital Image Processing,
	Author	Rafael C. Gonzalez, Richard E. Woods,
	Publisher	Pearson Education/PHI, 2000.
	Edition	Second Edition,
2.	Title	Digital Image Processing ,
	Author	W.K.Pratt

	Publisher	John Wiley & sons, Inc. 2006.	
	Edition	3rd Edition	
Reference Books			
1.	Title	Digital Image Processing,	
	Author	K. R. Castleman	
	Publisher	Pearson, 2006.	
	Edition	4th Edition	
Course Contents	UNIT I: Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.		9
	UNIT II: Image Enhancement - Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement. Image restoration - Degradation model, Unconstrained restoration - Lagrange multiplier and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering,		9
	UNIT III: Geometric transformations-spatial transformations. Image segmentation - Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm-Segmentation by K-Means Algorithm.		9
	UNIT IV : Digit Recognition using Convolutional Neural network. Compression - Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Image. Morphology - Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms.		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4772	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	INTERNET OF THINGS (EC 4772)		

Course Objectives	● To introduce Internet of Things (IOT) and its applications in modern world ● To learn in detail the various methods for implementation of IOT based systems ● To learn various communication techniques employed in IOT based systems ● To implement IOT based systems, with proper security measure for users				
Course Outcomes					Cognitive Levels
CO1	To understand the fundamentals of IOT, its applications and importance				Knowledge/Comprehension (Level/Level-II)
CO2	To understand various methods for implementation of IOT systems				Application (Level-III)
CO3	To design IOT based sub-systems and systems for various applications				Analysis (Level-IV)
CO4	To implement IOT based systems, with proper security measure for users				Synthesis/Evaluation (Level-VI/Level-V)
Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Digital Communication (EC2403), Analog Communication (EC2302), Introduction to Microprocessors (EC3501)				
Text Books					
1.	Title	Internet of Things (For Engineering Students)			
	Author	Dr. Jaikaran Singh Dr. Kalpana Rai Dr. Rajesh Kumar Rai			
	Publisher	Nitya Publications			
	Edition	1st Edition, 2020			
Reference Books					
1.	Title	Fundamentals of Internet of Things: For Students and Professionals			
	Author	F. John Dian			
	Publisher	Wiley			
	Edition	1st Edition,2023			
2.	Title	Internet of Things A to Z: Technologies and Applications			
	Author	Qusay F. Hassan			
	Publisher	Wiley			
	Edition	1st Edition, 2018			

Course Contents	UNIT I: Introduction Concepts and Definitions of The Internet of Things (IOT), structure of IOT, IOT enabling technologies, architecture, major component of IOT (Hardware & Software), communication and networking protocols, wired and wireless communication. IOT services and applications.	6
	UNIT II: IOT Platforms Micro-controllers, Real-time systems and embedded software OS and Drivers (End Device Program), Hardware & Software Requirements. Basics of Networking, Communication protocols, Sensor Networks	8
	UNIT III: Implementation of IOT Interoperability in IoT, Introduction to Arduino Programming: Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT	11
	UNIT IV: IOT Security Attack, Defense, and Network Robustness of Internet of Things, Malware Propagation and Control in Internet of Things, Privacy Preservation Data Dissemination, Trust, and Trust Models for the IoT, Authentication in IoT Computational Security for the IoT, Security Protocols for IoT Access Networks, Security Testing	11
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4773	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Digital Integrated Circuit Design (EC4773)		
Course Objectives	● To introduce the transistor level design of all digital building blocks common to all CMOS microprocessors, network processors, digital backend of all wireless systems etc., ● To introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures. ● To learn all important issues related to size, speed and power consumption.		
Course Outcomes			Cognitive Levels
CO1	To understand the power dissipated in the circuit.		Knowledge/Comprehension (Level I/Level-II)

CO2	To design a circuit to performed a certain functionality with specified speed.	Application (Level-III)
CO3	To identify the critical path of a combinational Circuit	Analysis (Level-IV)
CO4	To convert a combinational block to pipelined circuit and calculate the maximum frequency of the designed circuit.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Digital Electronics (EC 2401)				

Text Books			
1.	Title	Digital Integrated Circuit: A design perspective	
	Author	J. M. Rabaey, A. Chandrakasan, B. Nikolic	
	Publisher	Pearson Education, Delhi-2005	
	Edition	2nd Edition	
2.	Title	CMOS VLSI Design	
	Author	Weste, Neil HE, and David Money Harris	
	Publisher	Pearson/Addison Wesley, 2010. Geiger	
	Edition	1st Edition	
Reference Books			
1.	Title	Low power design methodologies	
	Author	J. M. Rabaey., and MassoudPedram, eds	
	Publisher	Springer Science & Business Media, 2012	
	Edition	1st Edition	
Course Contents	UNIT I: MOS Transistor Principles and CMOS Inverter Introduction, MOS Capacitor Threshold Voltage, MOS (FET) Transistor, Short Channel Transistor, CMOS Inverter Construction, Voltage Transfer Characteristics, Load line Analysis, Noise Margin Analysis, Pass Transistor, Inverter: Transient Response, Dynamic Power, Short Circuit Power, Leakage Power and Transistor Stacks		9
	UNIT II: Combinational Logic Circuits Implementing any Boolean Logic Function, Gate Sizing, Logic Gate Capacitance, Gate Delay, Parasitic Delay, Gate Delay with Load Capacitance, Path Delay Calculation and Optimization, Psuedo NMOS Logic, Domino Logic and Weak Keeper, Transmission Gate Logic, Gate Sizing for Large Circuits.		9

	UNIT III: Arithmetic Building Blocks Ripple Adder Introduction, Full Adder Circuit Implementation, Full Adder Optimization, Carry Select Adder, Two's Complement Arithmetic, Array Multiplier: Timing Analysis, Carry Save Multiplier: Signed Multiplication.	9
	UNIT IV: Sequential Logic Circuits Introduction to Pipelining, Time Borrowing, Master Slave Flip Flop, Flip-Flop Timing Parameters, Alternate Circuit Implementation, Clock Overlap, C2MOS Flip Flop, Flip Flop Characterization, Max and Min Delay of Flip Flop Based Systems, Flip Flop Min Delay Constraints, Latch – Max and Min Delay Constraints, Latch-Timing Analysis with Skew.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4774	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Embedded System (EC 4774)		
Course Objectives	● To write, test, and debug embedded software, using appropriate programming languages and tools ● To implement and configure a real-time operating system for task management, synchronization, and communication in embedded systems, understanding the trade-offs between different scheduling algorithms and RTOS features. ● To undertake and complete projects that require them to design, implement, and integrate both the software and hardware components of an embedded system, meeting specified requirements and constraints.		

Course Outcomes		Cognitive Levels
CO1	To impart foundational knowledge of embedded systems	Knowledge/Comprehension (Level I/Level-II)
CO2	To develop programming proficiency	Knowledge (Level-I)
CO3	To provide hands-on hardware experience	Analysis (Level-IV)
CO4	To foster system design and integration skills	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VII	Summer			
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	Introduction to Microprocessors (EC3501)		
Text Books			
1.	Title	An Embedded Software Primer	
	Author	David Simon	
	Publisher	Pearson India	
	Edition	1st Edition	
2.	Title	The Art of Designing Embedded Systems	
	Author	Jack Ganssle	
	Publisher	Newnes	
	Edition	2nd Edition	
Reference Books			
1.	Title	Introduction to Embedded Systems	
	Author	Shibu K V	
	Publisher	McGraw Hill Education India	
	Edition	2nd Edition	
Course Contents	UNIT I: Embedded systems overview: CPU vs DSP vs PLC vs GPU vs ARM, Cortex A8 and A9, SoC memory subsystems, ADC and DAC interfacing, Multi-standardI/Os, GPIOs, high-speed transceivers; CMOS, LVDS, LVPECL signaling Serial interfacing: SPI, RS232, RS485, I2C, UART, CAN, USB, HDMI, ARM architecture (cortex A8)		18
	UNIT II: Embedded software: process, scheduling; fork and exec, process – child and parent, process id, spawning new process, inter process communication, boot sequence,		5
	UNIT III: Operating system: BIOS, ROM, shell, DOS, UEFI boot, file system, Inode based file systems, POSIX standard Inodes, Flash memory-based file systems, device drivers, Watchdog timers		4
	UNIT IV: Introduction to Zynq 7000 series SoC:Processing system (PS), Programmable logic (PL) – FPGA, DSP, RAM; general purpose AXI ports, high-performance AXI ports, timers, memory interfaces, clocking between PS and PL		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4775	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y

<table>
<tr><td colspan="2">Type of Course</td><td colspan="6">Theory Course</td></tr>
<tr><td colspan="2">Course Title & Code</td><td colspan="6">Low power VLSI (EC4775)</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">● Preliminaries on Power dissipation
● Fundamentals of low-power circuits.
● Basic synthesis, design and testing for low-power circuits.
● Basics of SRAM memory</td></tr>
<tr><td colspan="6">Course Outcomes</td><td colspan="2">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="5">Able to understand the basics of Power Dissipation.</td><td colspan="2">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="5">Able to understand the basics of Power Dissipation and low-power circuit design.</td><td colspan="2">Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="5">Able to acquire knowledge on SRAM.</td><td colspan="2">Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="5">Able to learn circuit-level optimization and design low-power circuits at the submicron level.</td><td colspan="2">Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="3">VII</td><td colspan="3">Summer</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td colspan="2">Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td colspan="2">36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="6">VLSI (EC3601)</td></tr>
<tr><td colspan="8">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="6">Low Power CMOS VLSI Circuit Design</td></tr>
<tr><td>Author</td><td colspan="6">K. Roy and S. C. Prasad,</td></tr>
<tr><td>Publisher</td><td colspan="6">John Wiley and Sons</td></tr>
<tr><td>Edition</td><td colspan="6">3rd Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="6">Low Power Design Essentials</td></tr>
<tr><td>Author</td><td colspan="6">Jan Rabaey</td></tr>
<tr><td>Publisher</td><td colspan="6">Springer Publications</td></tr>
<tr><td>Edition</td><td colspan="6">1st Edition</td></tr>
<tr><td colspan="8">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="6">Low-Power CMOS Design</td></tr>
<tr><td>Author</td><td colspan="6">Chandrakasan and R. Brodersen</td></tr>
<tr><td>Publisher</td><td colspan="6">IEEE Press</td></tr>
<tr><td>Edition</td><td colspan="6">1st Edition</td></tr>
<tr><td>Course Contents</td><td colspan="6">UNIT I: POWER DISSIPATION IN CMOS
Sources of Power Dissipation – Physics of Power Dissipation in MOSFET Devices: The MIS Structure, Long Channel MOSFET,Submicron MOSFET,</td><td>9</td></tr>
</table>

	Gate Induced Drain Leakage– Power Dissipation in CMOS: Short Circuit Dissipation, Dynamic Dissipation, Load Capacitance– Low Power VLSI Design: Limits – Principles of Low Power Design.	
	UNIT II: DESIGN AND SYNTHESIS OF LOW POWER CIRCUITS: Transistor and Gate Sizing: Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizingfor Leakage Power Reduction - Network Restructuring and Reorganization: Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops: Self-gating Flip-flop, Varieties of Boolean Functions, AdjustableDevice Threshold Voltage. Synthesis: Behavioral Level Transforms, Logic Level Optimization for Low power, Circuit Level Optimization.	9
	UNIT III: LOW POWER STATIC RAM ARCHITECTURES Organization of a Static RAM, MOS Static RAM Memory cell, Banked Organization of SRAMs, Reducing Voltage Swings on Bit Lines, Reducing Power in Write Driver Circuits, ReducingPower in Sense Amplifier Circuits, The Method for Achieving Low Core Voltagesfrom a Single Supply.	9
	UNIT IV: DESIGN AND TEST OF LOW-VOLTAGE CMOS CIRCUITS Circuit Design style, Leakage Current in Deep Sub Micro-Meter Transistors, Deep Sub Micro-meter Device Design Issues, Low Voltage Circuit Design Techniques, Designing Deep Sub Micro-Meter ICs with Elevated Intrinsic Leakage, Multiple Supply Voltages.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4871	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	FPGA Based Physical Design (EC 4871)		
Course Objectives	● To describe the internal architecture of FPGAs, including logic blocks, interconnects, and I/O blocks. ● To gain proficiency in using hardware description languages (HDLs) like VHDL or Verilog for FPGA design. ● To have capacity of creating complex digital designs and simulating them to verify functionality and performance. ● To understand the principles of floorplanning, partitioning, and the physical implementation of designs on FPGA platforms.		
Course Outcomes			Cognitive Levels

CO1	To understand FPGA architecture and its components.	Knowledge/Comprehension (Level I/Level-II)
CO2	To apply FPGA design methodologies for efficient hardware implementation.	Analysis (Level-IV)
CO3	To optimize FPGA designs for speed, area, and power consumption	Analysis (Level-IV)
CO4	To implement and troubleshoot complex digital systems on FPGAs.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VIII		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Digital Electronics (EC2401) VHDL and Verilog (EC3675)				

Text Books			
1.	Title	FPGA Prototyping by VHDL Examples: Xilinx MicroBlaze MCS SoC	
	Author	Pong P. Chu	
	Publisher	Wiley	
	Edition	2nd Edition	
2.	Title	Advanced FPGA Design: Architecture, Implementation, and Optimization	
	Author	Steve Kilts	
	Publisher	Wiley-IEEE Press	
	Edition	1st Edition	
Reference Books			
1.	Title	Designing with Xilinx FPGAs: Using Vivado	
	Author	Sanjay Churiwala	
	Publisher	Springer International Publishing	
	Edition	1st Edition	
Course Contents	UNIT I: Introduction to FPGAs: Overview of FPGA technology and applications, FPGA architecture: Logic blocks, interconnects, I/O blocks, Comparison with ASICs and CPLDs		6
	UNIT III: FPGA Design Flow & HDL for FPGA Design: Design entry: Schematic-based vs. HDL-based, Simulation and verification, Synthesis, place and route, Timing analysis and constraint management, Review of VHDL/Verilog, Advanced HDL techniques for FPGA, Behavioral vs. structural modelling, Testbenches and simulation		12

	UNIT III: Logic Optimization and Implementation: Logic optimization techniques, Mapping designs to FPGA architecture, Resource sharing and pipelining, Clock domain crossing techniques	6
	UNIT IV: Physical Design and Layout & Advanced FPGA Features, Real-World Applications and Case Studies: Floorplanning and partitioning, Power analysis and optimization, Thermal analysis and heat dissipation, Signal integrity issues and solutions, Embedded processors in FPGAs, High-speed serial interfaces, Memory interfaces and DSP blocks, IoT devices, Automotive applications, Aerospace and defence systems, Image processing and machine learning on FPGAs	12
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4872	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Low power devices and systems (EC4872)		
Course Objectives	● To introduce basic of low power technique in MOS and CMOS circuits. ● To introduce the power minimization in different strategies such as scaling, voltage technique, physical levels. ● To learn various architecture for low power design.		

Course Outcomes		Cognitive Levels
CO1	To understand the fundamentals low power for MOS and CMOS circuits in details.	Knowledge/Comprehension (Level I/Level-II)
CO2	To design the various level and approaches for low power consumption and its technique.	Application (Level-III)
CO3	To analysis the process/management for its lower power consumption.	Analysis (Level-IV)
CO4	To evaluate the architecture for low power systems.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VIII		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	VLSI Design (EC 3601)		
Text Books			
1.	Title	Power system stability and control	
	Author	P.Kundur	
	Publisher	McGraw-Hill	
	Edition	1993	
2.	Title	Electric Power Systems	
	Author	B.M. Weddy and B.J Cory and John Wiely and Sarma	
	Publisher	John Wiely and Sons	
	Edition	Fourth Edition, 2002	
Reference Books			
1.	Title	Digital Integrated Ciecuit	
	Author	Jan M. Rabaey	
	Publisher	Pearson Education	
	Edition	2nd Edition,2003	
Course Contents	UNIT I: Basics of MOS circuit Basic of MOS circuit, sources of power dissipation, supply voltage scaling approaches, switch activity and switched capacitance minimization approaches leakage power minimization approaches		9
	UNIT II: Low power in CMOS circuit through various angles Power dissipation in CMOS circuit, physical bounds on low power ,power estimation on different abstraction levels, methods and tools for power estimation ,strategies for power optimization, influence of supply voltage scaling and threshold voltage power consumption, multiple threshold voltage technique		9
	UNIT III: Technique low power Devices Delay balancing to minimize glitches, synthesis of state machines, energy recovery in CMOS circuit, power management gating the clock, power down and synchronism algorithm for low power and algorithm transformations on different abstractions level and data dependency		9
	UNIT IV: Various design architecture for low power Architectures for low power, arithmetic for low power, system partitioning programming for low lower consumption. Software design for low power.		9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4873	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Semiconductor IC Technology (EC4873)		
Course Objectives	• To introduce the concept of Semiconductor fundamentals fabrication steps by steps. • To design and fabricate semiconductor-based device • To understand fabrication principles and their synthesis.		

Course Outcomes		Cognitive Levels
CO1	To understand the fundamentals of semiconductor fabrication procedure in detail.	Knowledge (Level I)
CO2	To fabricate a semiconductor-based device for different efficient application.	Comprehension (Level-II)
CO3	To analysis the fabricated based device in terms of current, voltage, power dissipation etc.	Application/Analysis (Level-III/Level-IV)
CO4	To evaluate the IC technology for electrical testing, packaging and its future trends.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VIII		Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Introduction to Semiconductor Devices (EC 2404)				

Text Books		
1.	Title	Fundamental of Semiconductor fabrication
	Author	G.S May and S.M Sze.
	Publisher	Wiley education
	Edition	2004
Reference Books		
1.	Title	VLSI Technology
	Author	S.M Sze
	Publisher	2nt Edition
	Edition	TMH, 2004
2.	Title	Fundamentals of Microfabrication
	Author	M.J Madou
	Publisher	CRC Press

	Edition	2nd Edition, 2011	
Course Contents	UNIT I: Historical perspective and overview of semiconductor devices Historical perspective, processing overview, semiconductor substrate-crystal structure, crystal growth, czochralski growth, float zone growth, crystal defects, characterization and evaluation of crystals, basic properties of silicon wafers		9
	UNIT II: Basic wafer fabrication steps Epitaxy, thermal oxidation of silicon, Clean Rooms, Wafer Cleaning, wafer fabrication and its steps- Lithography, Wet and Dry Etching, Thin film deposition, Diffusion, Ion Implantation, Metallization.		12
	UNIT III: Process integration of different passive components Process Integration: Passive components, MOS Process Integration, Bipolar Process Integration: Basic MOS Device Considerations, MOS Transistor Layout and Design Rules, Complementary MOS (CMOS) Technology, The Junction-Isolated Structure, Current Gain, Transit Time, Base width, Breakdown Voltages, Low Voltage/Low-Power CMOS/Bi CMOS Processes., MOSFET Technology, MESFET Technology, MEMS Technology		9
	UNIT IV: Testing and its future trends IC Manufacturing: Electrical Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip.		6
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4875	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Radar Engineering (EC 4875)		
Course Objectives	● To introduce the scenario of radar system and its implementation advantages. ● To understand the different types of clutters in radar communication. ● To learn transmission, reception, display process and precaution need to take for radar communications.		
Course Outcomes			Cognitive Levels

CO1	Student should able to identify different type of radar technology.	Knowledge/Comprehension (Level I/Level-II)
CO2	To understand the different IEEE standard microwave frequency bands for radar applications.	Application (Level-III)
CO3	To identify the installation, transmission and reception of radar signals.	Analysis (Level-IV)
CO4	Student should able to understand how the radar is used in communication system.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Antenna and Wave Propagation (EC3604)				

Text Books		
1.	Title	Introduction Radar Systems
	Author	M.I. Skolnik
	Publisher	Tata McGraw Hill
	Edition	4th Edition
2.	Title	Radar Engineering and Fundamentals and Navigational Aids
	Author	G.S.N. Raju
	Publisher	I.K. International
	Edition	1st Edition
Reference Books		
1.	Title	Understanding Radar Systems
	Author	S. Kingsley and S. Quegan
	Publisher	SciTech
	Edition	1st Edition
2.	Title	Introduction to Radar Systems
	Author	Merrill I. Skolnik
	Publisher	TMH Special
	Edition	2nd Edition

Course Contents	UNIT I: Fundamental concept of Various Radar Introduction, Radar block Diagram and Operation, Radar and Radar Equation, Doppler Effect, CW Radar, FM - CW radar, altimeter, Multiple Frequency Radar, Pulse Radar, MTI and Pulse Doppler Radar, Tracking Radar, RADAR System Design, Prediction of Range Performance.	12

	UNIT II: Radar Clutter Introduction to Radar Clutter, Surface-Clutter Radar Equations, Sea Clutter, Detection of Targets in Sea Clutter, Land Clutter Detection of Targets in Land Clutter, Effects of Weather on Radar Detection of Targets in Precipitation	8
	UNIT III: Detection of Radar Signals in Noise Introduction, Matched Filter, Response, detection Characteristics and Derivation, Correlation detection, detection criterion, Matched Filter, Low Noise Front-Ends, Detector Characteristics, Advantages and Limitations Navigational Aids.	8
	UNIT IV: Receivers, Displays, and Duplexer Noise Figure and Noise Temperature, Mixture, Displays – types, Duplexers-Branch and Balanced Types, Introduction to Phased Arrays Antennas: Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, phase shifter, Applications, Advantages and Limitations.	8
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4875	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Optimization Techniques (EC4875)		
Course Objectives	● To understand the working principle of optimization techniques ● To understand optimization problem formulations, including objective functions and constraints ● To analyze the mathematical properties of optimization problems, such as convexity, linearity, and constraint qualifications ● To explore optimization applications in scientific research, such as parameter estimation, experimental design, and data fitting		

Course Outcomes		Cognitive Levels
CO1	To understand various optimization algorithms, including linear and nonlinear optimization, convex optimization, and metaheuristic algorithms.	Knowledge/Comprehension (Level I/Level-II)
CO2	Implement optimization algorithms using appropriate programming languages and software tools.	Application (Level-III)
CO3	Analyze optimization problems to determine their mathematical properties, such as convexity and linearity.	Analysis (Level-IV)

CO4	To evaluate the performance of the neural networks in signal and image processing applications using various optimization techniques.				Synthesis/Evaluation (Level-VI/Level-V)
Semester	VII		Summer		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Engineering Mathematics-I (MA1101), Engineering Mathematics-II (MA1201)				
Text Books					
1.	Title	An introduction to optimization			
	Author	Chong E.K., and Zak S.H.			
	Publisher	Wiley-Inter science Publication, 2001.			
	Edition	2nd Edition			
2.	Title	Introduction to Operations Research			
	Author	Frederick S. Hillier, and Gerald J. Lieberman			
	Publisher	Mc Graw Hill Higher Education			
	Edition	9th Edition			
Reference Books					
1.	Title	Linear and Nonlinear Programming			
	Author	Luenberger D.G., and Ye Y.			
	Publisher	Springer			
	Edition	3rd Edition			
2.	Title	Numerical Optimization			
	Author	Nocedel J., and Wright S.			
	Publisher	Springer (2006)			
	Edition				
Course Contents	UNIT I: Introduction to Optimization: Definition of optimization; Types of optimization problems-linear, nonlinear, discrete, continuous; Applications of optimization in various fields - engineering, economics, operations research; optimization terminology and concepts-objective function, decision variables, constraints, feasible solutions, optimal solutions				9
	UNIT II: Unconstrained Optimization: One-dimensional optimization techniques-brute force search, golden section search, bisection method; Multidimensional optimization techniques-gradient-based methods, Newton's method, quasi-Newton methods;				9

	Convergence analysis; Line Search Methods; Conjugate Gradient Methods; Trust Region Methods	
	UNIT III: Constrained Optimization: Types of Constraints-Equality and Inequality Constraints; Karush-Kuhn-Tucker (KKT) condition; Lagrange Multipliers; Penalty function Methods; Barrier function methods; Sequential Quadratic programming (SQP); Interior-point methods	9
	UNIT IV: Nonlinear programming methods: Gradient descent methods-Gradient descent (GD), stochastic gradient descent (SGD), Adam; Metaheuristic techniques- Genetic algorithms (GA), Particle swam optimization (PSO), Ant Colony optimization (ACO), Differential evolution (DE)	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2351	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Introduction to Nano Science and Nano Technology (EC 2351)		
Course Objectives	● To understand the fundamental principles and concepts of nanoscience and nanotechnology. ● To familiarize students with the synthesis, characterization, and manipulation of nanomaterials. ● To explore the various applications of nanotechnology in different fields. ● To develop critical thinking and problem-solving skills in the context of nanoscience and nanotechnology.		

Course Outcomes		Cognitive Levels
CO1	To identify types of nanomaterials and to understand the basic principles of nanotechnology and nanoscience.	Knowledge/Comprehension (Level I/Level-II)
CO2	To analyze properties of nanomaterials.	Analysis (Level IV)
CO3	To design experiments and communicate findings	Synthesis (Level VI)
CO4	To characterize nanomaterials and solve problems using nanotechnology principles.	Application (Level III)

CO5	To evaluate applications and critique scientific literature.				Evaluation (Level V)	
Semester	III/IV		Summer/Winter			
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours	
	3	0	0	3	36	
Prerequisite course codes with course names	Basic Electronics Circuit (EC 1201), Physics (PH1101), Chemistry (CH 1101)					
Text Books						
1.	Title	Introduction to Nanotechnology				
	Author	Charles P. Poole Jr. and Frank J. Owens				
	Publisher	Wiley, 2012				
	Edition	3rdEdition				
2.	Title	Nanotechnology: Understanding Small Systems				
	Author	Ben Rogers, Jesse Adams, and Sumita Pennathur				
	Publisher	CRC Press, 2012				
	Edition	3rd Edition				
Reference Books						
1.	Title	Nanomaterials: Synthesis, Properties, and Applications				
	Author	A.S. Edelstein and R.C. Cammarata				
	Publisher	CRC Press, 2017				
	Edition	2ndEdition				
Course Contents	UNIT I: Introduction to Nanoscience and Nanotechnology Definition and scope of nanoscience and nanotechnology, Historical development and milestones, Importance and potential impact of nanotechnology, Quantum mechanics and its relevance to nanoscale phenomena, Size-dependent properties, Surface effects and quantum confinement.					9
	UNIT II: Synthesis of Nanomaterials Top-down vs. bottom-up approaches, Chemical vapor deposition (CVD), Sol-gel synthesis, Self-assembly techniques, Characterization Techniques, Scanning electron microscopy (SEM),Transmission electron microscopy (TEM), Atomic force microscopy (AFM), X-ray diffraction (XRD), Spectroscopic techniques (UV-Vis, FTIR, Raman).					9
	UNIT III: Nanomaterials and Nanodevices Carbon-based nanomaterials (graphene, carbon nanotubes, fullerenes), Metal nanoparticles, Semiconductor nanoparticles (quantum dots), Polymer					9

	nanocomposites, Nanoelectronics, Nanophotonics, Nanomechanical devices, Nanosensors and biosensors.	
	UNIT IV: Applications in Electronics, Medicine and Energy Nanoscale transistors and integrated circuits, Nanomaterials for flexible electronics, Nanoelectromechanical systems (NEMS), Drug delivery systems, Nanomedicine and cancer therapy, Diagnostic techniques using nanoparticles, Nanomaterials for energy storage (batteries, supercapacitors), Photovoltaic devices, Catalysis and fuel cells.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2352	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Microelectronics and VLSI Technology (EC 2352)		
Course Objectives	● To understand the principles of microelectronics and semiconductor devices. ● To learn about the fabrication processes used in VLSI technology. ● To gain hands-on experience in designing and simulating integrated circuits. ● To explore advanced topics in VLSI technology and its applications.		

Course Outcomes		Cognitive Levels
CO1	To understand the overview of semiconductor materials and devices.	Knowledge/Comprehension (Level I/Level-II)
CO2	To design and implement basic VLSI Circuits and simulate applying testing techniques.	Application (Level-III)
CO3	To optimize VLSI designs.	Evaluation (Level-V)
CO4	To analyse the VLSI device characteristics and research trends.	Analysis (Level- IV)
CO5	To develop layouts for VLSI circuits.	Synthesis (Level VI)

Semester	III (or) IV		Summer/Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	Digital Electronics (EC 2401) VLSI Design (EC 3601)		
Text Books			
1.	Title	Microelectronics: Circuit Analysis and Design	
	Author	Donald A. Neamen	
	Publisher	McGraw Hill Education, 2018	
	Edition	5th Edition	
2.	Title	CMOS VLSI Design: A Circuits and Systems Perspective	
	Author	Neil H. E. Weste and David Money Harris	
	Publisher	Pearson Education, 2010	
	Edition	4th Edition	
Reference Books			
1.	Title	VLSI Technology	
	Author	S.M. Sze and Kwok K. Ng	
	Publisher	McGraw Hill Education, 2003	
	Edition	2nd Edition	
Course Contents	UNIT I: Introduction to Microelectronics and VLSI Overview of semiconductor materials and device technologies, Evolution of integrated circuits and VLSI technology, Scaling trends and challenges in semiconductor manufacturing.		9
	UNIT II: Semiconductor Fabrication Processes Semiconductor basics: crystal structure, energy bands, carrier transport, PN junctions and diodes, MOSFET operation and characteristics, Bipolar junction transistors (BJTs), Semiconductor wafer fabrication: crystal growth, wafer preparation, Photolithography and patterning, Deposition techniques: thermal oxidation, chemical vapor deposition (CVD), physical vapor deposition (PVD), Etching and doping processes.		9
	UNIT III: CMOS Technology, Circuit Simulation and Modeling Complementary Metal-Oxide-Semiconductor (CMOS) technology,CMOS process flow and fabrication steps, Layout design rules and design for manufacturability (DFM), Introduction to SPICE (Simulation Program with Integrated Circuit Emphasis), Device modeling and parameter extraction, Circuit simulation techniques: DC, transient, and AC analysis.		9
	UNIT IV: VLSI Design Methodologies Overview of VLSI design flow, RTL (Register-Transfer Level) design and synthesis, Logic optimization and technology mapping, Floorplanning and placement techniques, Static timing analysis (STA), Timing closure and		9

	timing-driven design, Design rule checking (DRC) and layout versus schematic (LVS) verification.	
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2353	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	Y	N	N		
Type of Course	Theory Course				
Course Title & Code	Modern Communication Technologies (EC 2353)				
Course Objectives	● Familiarization with EM waves and their propagation through transmission lines. ● Understanding of modulation and demodulation schemes for analog and pulse modulation. ● Evaluation of the cellular communication in enhancing the capacy of the system.				
Course Outcomes					Cognitive Levels
CO1	Comprehension of EM waves and their propagation mechanism.				Knowledge/ Comprehension (Level I/Level-II)
CO2	Understand the transmission lines and their properties.				Application (Level-III)
CO3	Understand different modulation and demodulation schemes for analog communications (AM, FM and PM) and pulse Modulation.				Analysis (Level-IV)
CO4	Importance of cellular communication and its role in improving capacity.				Synthesis/ Evaluation (Level-VI/Level-V)
Semester	III/IV		Summer/Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Engineering Mathematics – II (MA 1201), Physics (PH1101)				
Text Books					
1.	Title	Electronic Communication Systems			
	Author	G.Kennedy and Bernard Davis			
	Publisher	Tata McGraw Hill			
	Edition	Latest edition			

2.	Title	Electronics Communication Systems	
	Author	Dennis Roody and John Coolen	
	Publisher	PHI	
	Edition	Latest Edition	
Reference Books			
1.	Title	Communication Systems	
	Author	A. B. Carlson	
	Publisher	McGraw Hill	
	Edition	Latest Edition	
Course Contents	UNIT I: EM Waves Introduction to EM waves and their spectrum. Principles of Radiation. Types of EM wave propagation –Ground wave, Sky wave, Space wave propagation. Structure of Ionosphere, Skip distance, Radio horizon, skip zone.		8
	UNIT II: Transmission Lines Introduction to Transmission lines –Twisted pair wires, coaxial cables and Wave guides		8
	UNIT III: Modulations Principles of Amplitude, Frequency and phase Modulation Techniques		10
	UNIT IV: Cellular Communication Limitations of conventional mobile system. Cellular communication: introduction, frequency reuse, cluster size, cellular system architecture, mobile station, base station, MSC, channel assignment strategies, call handover strategies, interference and system capacity, improving capacity in cellular systems.		10
Course Assessment	Theory (100 Marks)	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2451	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Introduction to Photonics (EC2451)		
Course Objectives	• Learn the fundamental principles of photonics and light-matter interactions, • Develop the ability to formulate problems related to photonic structures/processes and analyze them, and • Understand processes that help to manipulate the fundamental properties of light.		

Course Outcomes		Cognitive Levels
CO1	Defining and explaining the physics governing laser behavior and light matter interaction.Applying wave optics and diffraction theory to a range of problems	Knowledge/Comprehension (Level I/Level-II)
CO2	Applying the principles of atomic physics to materials used in optics and photonics.Exploring the production and nature of light	Application (Level-III)
CO3	Learning the laws of reflection and refraction, theory of image formation,principles of wave optics (including interference, diffraction and polarization)	Analysis (Level-IV)
CO4	Learning fundamentals of fiber optic theory, principles of lasers and laser safety,Learning the basics of holography	Synthesis/Evaluation (Level-VI/Level-V)

Semester	III/IV			Summer/Winter	
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Electromagnetic theory (EC 3502)				

Text Books		
1.	Title	Optics Edn
	Author	E.Hecht
	Publisher	Pearson2004
	Edition	(4th Ed)
2.	Title	Introduction to Optics, 2012
	Author	Frank L. Pedrotti, S.J., Leno M. Pedrotti, Leno S.Pedrotti,
	Publisher	Pearson2012
	Edition	(3rdEdition
Reference Books		
1.	Title	Optics
	Author	Ajoy Ghatak,
	Publisher	Tata McGraw Hill, 2005
	Edition	3rd edition

Course Contents	UNIT I: Introduction; Different quantities associated with light; Properties of Light; Reflection; Refraction; Interference & Diffraction; Absorption & Scattering	6
	UNIT II Properties of materials with respect to reflection, refraction, absorption and transmission of light; thermal, mechanical and chemical properties; Optical coatings and methods;	9
	UNIT III Properties of materials with respect to reflection, refraction, absorption and transmission of light; thermal, mechanical and chemical properties; Optical coatings and methods;	9
	UNIT IV Properties of materials with respect to reflection, refraction, absorption and transmission of light; thermal, mechanical and chemical properties; Optical coatings and methods; Interaction of light waves; Interference; Young's double slit experiment; Thin film interference; Diffraction Polarization; Formation & types of holograms Polarization; Formation & types of holograms	12
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2452	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Nanofabrication Techniques (EC 2452)		
Course Objectives	● To introduce chip manufacturing process, FEOL and BEOL concepts. ● To introduce the basic of photolithography, Deposition, Oxidation, Testing and yield during chip manufacturing. ● To learn various process/steps of chip manufacturing process.		

Course Outcomes		Cognitive Levels
CO1	To understand the basic fundamentals of chip manufacturing process in detail.	Knowledge/Comprehension (Level I/Level-II)
CO2	To implement the basic of photolithography, Deposition, Oxidation, Testing and yield during chip manufacturing.	Application (Level-III)
CO3	To analysis the mechanism of manufacturing process for chip.	Analysis (Level-IV)
CO4	To evaluate the process/steps done during nanofabrication technique.	Synthesis/Evaluation (Level-VI/Level-V)

<table>
<tr><td colspan="2">Semester</td><td colspan="3">III/IV</td><td>Summer</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="5">Introduction to Semiconductor Devices (EC 2404)</td></tr>
<tr><td colspan="7">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">The Science and Engineering of Microelectronics Fabrication</td></tr>
<tr><td>Author</td><td colspan="5">S.A Campbell</td></tr>
<tr><td>Publisher</td><td colspan="5">Oxford University Press</td></tr>
<tr><td>Edition</td><td colspan="5">2nd Edition ,2001</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="5">VLSI Technology</td></tr>
<tr><td>Author</td><td colspan="5">C.Y. Chang and S.M Sze</td></tr>
<tr><td>Publisher</td><td colspan="5">McGraw-Hill</td></tr>
<tr><td>Edition</td><td colspan="5">1996</td></tr>
<tr><td colspan="7">Reference Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">Introduction to Microelectronics Fabrication</td></tr>
<tr><td>Author</td><td colspan="5">Richard C. Jaeger</td></tr>
<tr><td>Publisher</td><td colspan="5">Prentice Hill</td></tr>
<tr><td>Edition</td><td colspan="5">2nd Edition,2001</td></tr>
<tr><td rowspan="3">Course Contents</td><td colspan="5">UNIT I: Introduction
Review of Chip Manufacturing Process, FEOL and BEOL concepts</td><td>9</td></tr>
<tr><td colspan="5">UNIT II: Photolithography, Deposition, Material Removal:
Lithography basics, Wavelength, Layout and Optical Proximity Correction (OPC), Mask making, Phase shift mask, Lithography details, Production issues including depth of focus, misalignment: Physical and Chemical Vapour Deposition (PVD & CVD) basics, Electrochemical deposition; Plasma and wet etching, Chemical Mechanical Polishing (CMP) basics, Dishing, Erosion, Issues in Shallow Trench Isolation, Oxide Polish and Copper Polish, Post CMP issues</td><td>9</td></tr>
<tr><td colspan="5">UNIT III: FEOL, Diffusion and Ion implantation, Oxidation
Semiconductor electron band structure, band gap MOS capacitor, MOS transistor structure for enhancement mode devices, Transistor fabrication, MOS transistor operation: Implantation basics, Constant source and limited source diffusion, Diffusion vs. ion implantation, Mechanism and Models, Equipment, relevant issues; Process Types, Details of thermal oxidation, Models, relevant issues;</td><td>9</td></tr>
</table>

	UNIT IV: Process Integration, Testing and Yield BEOL Issues, Cu vs. Al metallization, oxide vs. low-k integration, MEMS; Scribe line Test (for process evaluation), Functional Test (for product evaluation), Yield Models, process and design modifications for yield optimization.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 2453	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)
	Y	N	N

Type of Course	Theory Course
Course Title & Code	Wireless Communication and Sensor Network (EC 2453)
Course Objectives	• To familiarize with wireless sensors. • To understand the communication among the sensor nodes. • To learn the applications and simulations of sensor networks.

Course Outcomes		Cognitive Levels
CO1	Understand challenges and technologies for wireless networks	Knowledge/Comprehension (Level I/ Level-II)
CO2	Understand architecture and sensors	Application (Level-III)
CO3	Describe the communication, energy efficiency, computing, storage and transmission	Analysis (Level-IV)
CO4	Explain the concept of programming the in WSN environment	Synthesis/Evaluation (Level-VI/Level-V)

Semester	III/IV	Summer/Winter

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36

Prerequisite course codes with course names	RF and Microwave Engineering (EC 4701)

Text Books

1.	Title	Protocols And Architectures for Wireless Sensor Networks
	Author	Holger Karl & Andreas Willig
	Publisher	John Wiley

	Edition	Latest	
2.	Title	Wireless Sensor Networks- An Information Processing Approach	
	Author	Feng Zhao & Leonidas J.Guibas	
	Publisher	Elsevier	
	Edition	Latest	
Reference Books			
1.	Title	Fundamentals of Wireless Sensor Networks - Theory and Practice	
	Author	Waltenegus Dargie , Christian Poellabauer	
	Publisher	John Wiley & Sons	
	Edition	Latest	
2.	Title	Wireless Sensor Networks Technology, Protocols, and Applications	
	Author	Kazem Sohraby, Daniel Minoli, & Taieb Znati	
	Publisher	John Wiley	
	Edition	Latest	
Course Contents	UNIT – I: OVERVIEW OF WIRELESS SENSOR NETWORKS: Single - Node Architecture - Hardware Components - Network Characteristics- unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks - Types of wireless sensor networks.		9
	UNIT – II: ARCHITECTURES: Network Architecture - Sensor Networks - Scenarios - Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Operating Systems and Execution Environments - introduction to Tiny OS and nesC - Internet to WSN Communication.		9
	UNIT – III: NETWORKING SENSORS: MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts – SMAC, - B-MAC Protocol, IEEE 802.15.4 standard and ZigBee, the Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols Energy - Efficient Routing, Geographic Routing.		9

	UNIT – IV: INFRASTRUCTURE ESTABLISHMENT: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Sensor Node Hardware – Berkeley Motes, Programming Challenges.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC3651	Open Elective Course: (Y/N)	Departmental Core Course: (Y/N)	Departmental Elective Course: (Y/N)		
	Y	N	N		
Type of Course	Theory Course				
Course Title & Code	RF Integrated Circuits (EC 3651)				
Course Objectives	• To introduce the high frequency circuits and its implementation. • To understand the different types of circuits for RF communication. • To learn the design process of transmitted, low noise amplifier, receiver and mixer RF applications.				
Course Outcomes					Cognitive Levels
CO1	Student should able to identify different type of high frequency RF modules.				Knowledge/Comprehension (Level I/Level-II)
CO2	To understand the different types of RF integrated circuit boards for wireless system.				Application (Level-III)
CO3	To identify the active and passive devices of the RF system.				Analysis (Level-IV)
CO4	Student should able to understand how the all active and passive devices are work together in RF system.				Synthesis/Evaluation (Level-VI/Level-V)
Semester	V/VI		Summer/Winter		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	RF and Microwave Engineering (EC 4701)				

Text Books			
1.	Title	RF Microelectronics	
	Author	B. Razavi	
	Publisher	Pearson	
	Edition	2nd Edition	
2.	Title	Microwave Engineering	
	Author	David. M. Pozar,	
	Publisher	John Wiley	
	Edition	4th Edition	
Reference Books			
1.	Title	Fundamental of Microwave Engineering	
	Author	R.E. Collins	
	Publisher	Wiley	
	Edition	2nd Edition	
2.	Title	Antenna Theory - Analysis and Design	
	Author	C.A. Balanis	
	Publisher	John Wiley	
	Edition	3rd Edition	
Course Contents	**UNIT I: Fundamentals of RF circuits and systems:** Review of Transmission line Theory, terminated transmission lines, smith chart, impedance matching, Microstrip and Coplanar waveguide implementations, microwave network analysis, ABCD parameters, S parameters, X parameters.		**9**
	UNIT II: Transmitter and Receiver architectures: Passive RLC network, Behavior of passive components and networks, resonant structures using distributed transmission lines, power dividers, couplers and filters; CRLH transmission line based components.		**8**

	UNIT III: Low Noise Amplifiers and CMOS: Basics of high frequency amplifier design, biasing techniques, simultaneous tuning of 2 port circuits, noise and distortion, linearity, noise and large signal performance, *CMOS RFIC:* Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors	**10**
	UNIT IV: Power Amplifiers, Mixers, Oscillators: Basics and Class A, B, C, D, E, F and other configurations, Power combining, Linearity improvement techniques, , Specifications, NL system as a mixer, Active mixers, Passive mixers, Power amplifier design,	**8**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3652	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Green Technologies (EC 3652)		
Course Objectives	● To familiarize with the concept of Green Computing and Green IT infrastructure for making computing and information system environment sustainable. ● To encourage optimized software and hardware designs for development of Green IT Storage, Communication and Services. ● To highlight useful approaches to embrace green IT initiatives.		

Course Outcomes		**Cognitive Levels**
CO1	To learn the basic of green IT by hardware, software, network communication and data centre operations.	Knowledge/Comprehension (Level I/Level-II)
CO2	To design the development of Green IT storage infrastructure.	Application (Level-III)
CO3	To understand the strategies, frameworks, processes and management of green IT.	Analysis (Level-IV)
CO4	To evaluate the different approaches against Green Technologies.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**V/VI**	**Summer/Winter**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36
Prerequisite course codes with course names	Introduction to Computing (CS 1201)				

Text Books			
1.	Title	Green Communications: Principles, Concepts and Practice	
	Author	Samdanis J	
	Publisher	Wiley	
	Edition		
2.	Title	Green IT for Sustainable Business Practice: An ISEB Foundation Guide	
	Author	Mark G. O'Neill	
	Publisher	The Chartered Institute for IT	
	Edition	2010	
Reference Books			
1.	Title	Green IT	
	Author	Deepak Shikarpur	
	Publisher	Vishwkarma Publications	
	Edition	2014	
Course Contents	**UNIT I: Green IT Overview, Green Devices and Hardware, Green Software** Introduction, Environmental Concerns and Sustainable Development, Environmental Impacts of IT, Green I, Holistic Approach to Greening IT, Greening IT, Applying IT for Enhancing Environmental Sustainability, Green IT Standards and Eco-Labelling of IT, Enterprise Green IT Strategy, Green Washing, Green IT: Burden or Opportunity? Introduction of Green Devices and Hardware, Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose. Green Software: Introduction, Processor Power States, Energy-Saving Software Techniques.		9
	UNIT II: Green Data Centers, Green Data Storage Green Networks and Communications Data Centers and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, and Green Data Centre Metrics. Introduction of Green Data Storage, Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management. Introduction of Green Networks and Communications,		9

	Objectives of Green Network Protocols, Green Network Protocols and Standards.	
	UNIT III: Sustainable Information Systems and Green Metrics, Enterprise Green IT Readiness Introduction, Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, functional Level Information, Organizational Level Information, Measuring the Maturity of Sustainable ICT, Introduction of Enterprise Green IT readiness, Readiness and Capability, Development of the G-Readiness Framework, Measuring an Organization's G-Readiness.	9
	UNIT IV: Sustainable IT Services: Creating a Framework for Service Innovation, Green Enterprises and the Role of IT Introduction, Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework, Introduction of Green Enterprises and the Role of IT: Organizational and Enterprise, Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware, Inter-organizational Enterprise Activities and Green Issues.	9
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3653	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Data Communication and Networking (EC3653)		
Course Objectives	● To gain comprehensive knowledge about the layered communication architectures (OSI and TCP/IP) and its functionalities. ● Understand the switching concept and different types of switching techniques.		

Course Outcomes		**Cognitive Levels**
CO1	Obtain insight about basic network theory and layered communication architectures	Knowledge/Comprehension (Level I/Level-II)
CO2	Analyze the shortest path over which data can be transmitted, and design a routing mechanism for secure transmission of data from sender to the receiver.	Analysis (Level-IV)

CO3	Provide solutions to various problems in network theory.	Application (Level-III)
CO4	Design a network topology with the available networking elements and can implement a routing protocol ensuring the error free transmission of data.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**V/VI**		**Summer/Winter**		
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	0	0	3	36
Prerequisite course codes with course names	Physics (PH1101)				

Text Books		
1.	**Title**	Data and Computer Communication
	Author	W. Stallings
	Publisher	Pearson Education, 2007
	Edition	8th Edition
2.	**Title**	Computer Networks
	Author	Andrew S. Tanenbaum and David J. Wetherall
	Publisher	Prentice Hall, 2010
	Edition	5st Edition
Reference Books		
1.	**Title**	Data Communication and Networking
	Author	Behrouz A. Forouzan
	Publisher	McGraw Hill Education,2017
	Edition	4st Edition

Course Contents	**UNIT I: Introduction to Data Communication** Goals and Applications of Networks, Wireless Network, Interfaces and services. Reference Models: The OSI reference model, TCP/IP reference model. Network Hardware and software. Digital signaling and encoding techniques, Data Rate Limit, Transmission Impairments, Line Coding, Block Coding, Sampling, Transmission Mode, Modulation of Digital Data, Telephone Modems, Modulation of Analog Signal, FDM, WDM, TDM, Guided Media, Unguided Media, Switching.	**9**
	UNIT II: Data Link Layer Data Link Layer Design Issues, Services Provided to Network Layers, Framing, Error Control, Flow Control, Error Detection and Correction, Elementary Data Link Protocols, An Unrestricted Simplex Protocol, A Simplex Stop-and-Wait Protocol, Simplex Protocol for a Noisy Channel,	**8**

	Sliding Window Protocols, A protocol using go-back-N, A Protocol using Selective Repeat, Example Data Link Protocol-HDLC, PPP.	
	UNIT III: Medium Access Control Random access, ALOHA, Slotted ALOHA, CSMA, CSMA CD, Scheduling approaches to medium access control, reservation systems, polling, token-passing rings, comparisons, Delay performance of MAC: Performance of channelization with bursty traffic, performance of polling and token ring, random access and CSMACD. Local area networks: LAN protocols, Ethernet, token ring, wireless LAN and IEEE 802.11 standard.	**8**
	UNIT IV: Packet Switching Networks and TCP/IP Packet network topology, datagrams and virtual circuit, routing in packet networks, Shortest-path routing, ATM networks, traffic management at packet level, traffic management at flow level, traffic management at the flow-aggregate level. Architecture and protocol, IP packet, addressing, subnet, IP routing, CIDR, address resolution, reverse address resolution, fragmentation and reassembly, ICMP, IPv6, UDP, Transmission control protocol, internet routing protocols, multicast routing, DHCP, NAT and mobile IP.	**11**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 3654	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	**Electronics Materials and their Applications (EC 3654)**		
Course Objectives	• To impart knowledge of different electronics materials and various components used in electronics industries. • To describes suitability and characteristics of various electronics components for different applications.		

Course Outcomes		**Cognitive Levels**
CO1	To learn about the conducting materials, magnetic materials, insulating materials, semiconductor and electronics components.	Knowledge/Comprehension (Level I/Level-II)
CO2	To design the development of electronics-based device in an efficient application.	Application (Level-III)
CO3	To understand the strategies, frameworks, processes and management of electronics materials.	Analysis (Level-IV)
CO4	To evaluate the different approaches against electronics materials.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**VII/VIII**			**Summer/Winter**	
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36
Prerequisite course codes with course names	**Introduction to Semiconductor Devices (EC 2404), Physics (PH1101)**				

Text Books		
1.	Title	Electronics Engg. Materials
	Author	Rains & bhatacharya
	Publisher	Khanna
	Edition	
2.	Title	Electronics Engg. Materials
	Author	M.L Gupta
	Publisher	Khanna
	Edition	2020
Reference Books		
1.	Title	Applied Electronics
	Author	R.S Sedha and S. Chand
	Publisher	
	Edition	2014

Course Contents	**UNIT I: CONDUCTING MATERIALS:** Electronic properties of solids, band theory, resistivity - factors affecting resistivity, temperature co-eff. of resistance, thermal conductivity, properties and applications of -copper, aluminum, nickel, silver, tungsten, manganese, tantalum, brass & bronze and resistive alloys. Superconductivity.	**9**
	UNIT II: MAGNETIC MATERIALS: Introduction of magnetic materials, classification of magnetic materials, magnetization curve and magnetic properties, Hysterisys loss and eddy current loss- methods to reduce eddy current losses, soft and hard magnetic materials, properties and uses of magnetic steel and steel alloys, Ferrites & powdered core- their construction, characteristics and uses, Choice of material for transformer core, armature of motors, loud speakers, submarine communication, long distance telephone lines, current, transformers, audio-frequency transformers, moving iron instruments, TV tubes.	**9**
	UNIT III: INSULATING MATERIALS: Classification of insulating materials on the basis of operating temperatures, Electrical and chemical properties of insulating materials (Insulation resistance, di-electric strength, di-electric constant, dielectric loss and chemical resistance), Common insulating material: Ceramic, glass, paper,	**9**

	mica, rubber, plastics-thermosetting and thermoplastic materials, PTFE, FRP (Fiber Reinforced Plastic), their important properties and applications.	
	UNIT IV: SEMICONDUCTORS AND ELECTRONICS COMPONENTS Qualitative discussion of semiconductors, electrical properties of silicon and germanium, intrinsic semiconductors, trivalent and pentavalent impurities, extrinsic semiconductors, formation of P and N type semiconductors, P-N junction, construction and use of common electronic components, resistors - carbon composition, carbon film, cracked carbon, metal oxide film, wire-wound, variable resistors, capacitors - paper , silvered paper, mica, silvered mica, ceramic plastic foil, electrolytic, variable resistor, inductors - fixed and variable inductors, Relays - electromagnetic and reed relay, Chokes - A.F and R.F chokes, Printed circuit board and its fabrication, Piezo electric crystal - Principle, cat. & applications.	**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC4851	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N

Type of Course	Theory Course
Course Title & Code	Advanced Semiconductor Devices (EC 4851)
Course Objectives	• To understand the importance of device miniaturization and problems related to the scaling down of device dimensions. • To analyze the short channels effects of the devices. • To investigate the advantages of architectural modifications of devices such as SOI device technology, multi-gate device etc.

Course Outcomes		**Cognitive Levels**
CO1	To understand the fundamental rules of scaling and power crisis problem.	Knowledge/Comprehension (Level I/Level-II)
CO2	To analyze the impact of gate oxide scaling on the device characteristics.	Application (Level-III)
CO3	To demonstrate the SOI device Technology considering fully depleted and partially depleted case.	Analysis (Level-IV)
CO4	To illustrate the multigate device physics and to evaluate the benchmarking of analog and digital models and layouting	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**VII/VIII**			**Summer/Winter**	
Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours

	3	0	0	3	36

Prerequisite course codes with course names	Engineering Physics-I (PH101), Introduction to semiconductor devices (EC2404)

Text Books		
1.	**Title**	Nano-CMOS Circuit and Physical Design
	Author	B. Wong, A. Mittal, Y. Cao, G. Starr
	Publisher	Wiley Interscience.
	Edition	2004
2.	**Title**	Solid State Electronic Devices
	Author	Ben G. Streetman
	Publisher	Pearson
	Edition	7^{th}Edition

Reference Books		
1.	**Title**	FinFETs and Other Multi-Gate Transistors
	Author	J.P. Colinge
	Publisher	Springer
	Edition	2010
2.	**Title**	Nano-CMOS Gate Dielectric Engineering
	Author	Hei Wong
	Publisher	CRC
	Edition	2011

Course Contents	**UNIT I: Fundamentals of Semiconductor Device Physics** History of Si technology, Review of CMOS scaling. Problems with traditional geometric scaling. Power crisis. Review of basic quantum mechanics. Mobility enhancement techniques. Review of stress and strain, how it affects band structure of silicon. Types and realization of stress elements. Problems with stress elements.	**9**

	UNIT II: High-K Gate Dielectric and process Gate oxide scaling trend. Urgency to switch gate dielectric material. High K material selection. Fermi level pinning Process integration of high K gate dielectrics and metal gates multi-gate transistors. Ways of realization. Fabrication issues and integration challenges.	**9**
	UNIT III: Silicon-on-Insulator (SOI) Devices Basic principle of MOSFETs, Introduction to classical planer bulk MOSFETs, VMOS devices. Introduction to SOI Technology, radiation hardness capability. Partially depleted SOI MOSFET, Fully depleted SOI MOSFET. Single gate SOI MOSFET, Double Gate SOI MOSFET, kink effect, Floating Body effect, Applications of SOI MOSFET, Comparison with Classical planer bulk MOSFET.	**9**
	UNIT IV: Multi-gate CMOS devices and CMOS compatible memory devices Introduction to FinFETs, Ways of realization, Fabrication issues and integration challenges.Analog and digital benchmarking of models. Layout dependent effects. Test structures used for characterization, Variations and how it can affect scaling. Basics of sub wavelength lithography. Design for manufacturability.	**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4852	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Image and Video Processing (EC 4852)		

<table>
<tr><td>Course Objectives</td><td colspan="5">To understand the basic principles and concepts underlying digital image and video processing comprising pixel representation, colour spaces, and image/video formats
Acquire proficiency in a variety of image and video processing techniques, such as filtering, compression, segmentation, feature extraction, and object detection
To Learn to analyze and interpret processed images and videos, including understanding motion, detecting objects, tracking features, and extracting meaningful information from visual data
To Learn techniques for evaluating the performance of image and video processing algorithms, as well as optimizing them for efficiency, accuracy, and scalability</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="4">Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="3">To understand the fundamental concepts in digital image and video processing</td><td colspan="2">Knowledge/Comprehension (Level I/Level-II)</td></tr>
<tr><td>CO2</td><td colspan="3">To be proficient in applying various image and video processing techniques such as enhancement, segmentation, and transformation to manipulate and improve visual data</td><td colspan="2">Application (Level-III)</td></tr>
<tr><td>CO3</td><td colspan="3">To be able to implement algorithms for image and video processing using programming languages such as Python, MATLAB, or C/C++</td><td colspan="2">Analysis (Level-IV)</td></tr>
<tr><td>CO4</td><td colspan="3">To be capable of developing applications that involve image and video processing, such as video stabilization, object tracking, facial recognition, and augmented reality</td><td colspan="2">Synthesis/Evaluation (Level-VI/Level-V)</td></tr>
<tr><td>Semester</td><td colspan="2">VII/VIII</td><td colspan="3">Summer/Winter</td></tr>
<tr><td rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td>Prerequisite course codes with course names</td><td colspan="5">Engineering Mathematics-I (MA1101), Digital Signal Processing (EC3504), Digital Image Processing (EC4771)</td></tr>
<tr><td colspan="6">Text Books</td></tr>
<tr><td rowspan="3">1.</td><td>Title</td><td colspan="4">Digital Image Processing, http://www.imageprocessingplace.com/DIP-3E/dip3e_main_page.htm/</td></tr>
<tr><td>Author</td><td colspan="4">R. C. Gonzalez and R. E. Woods</td></tr>
<tr><td>Publisher</td><td colspan="4">Prentice Hall, 2008</td></tr>
</table>

	Edition	3rd Edition	
2.	**Title**	Video Processing and Communications, http://eeweb.poly.edu/~yao/videobook/	
	Author	Y. Wang, J. Ostermann, and Y.Q.Zhang	
	Publisher	Prentice Hall, 2002	
	Edition	1st Edition	
Reference Books			
1.	**Title**	Computer Vision: Algorithms and Applications, http://szeliski.org/Book/	
	Author	Richard Szeliski	
	Publisher		
	Edition	2nt Edition	
Course Contents	**UNIT I: Basic Requirements** Colour image capture, representation, and manipulation; Colour space; 2D transforms - DFT, DCT, KLT, and SVD, Overview of video processing concepts and applications, Basics terminology: frames, resolution, aspect ratio, frame rate, codecs, containers, introduction to video formats		**9**
	UNIT II: Enhancement and Restoration Contrast Enhancement, Image Enhancement - Histogram equalization and specification techniques, Sharpening and Edge Detection, segmentation, frequency domain interpretation of linear convolution, Degradation model, Types of Noises, Spatial domain filtering		**9**
	UNIT III: Compression Compression - Need for data compression, Huffman, Run Length Encoding, shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Principles of video compression, lossy and lossless compression, Common Video Codecs		**9**
	UNIT IV: Motion Analysis Object Detection and tracking, Motion representation and Estimation, Object tracking in video sequences		**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4853	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	MEMS (EC 4853)		
Course Objectives	● To impart knowledge about the need and applications of microsystem in engineering. ● To introduce the fundamental concepts relevant to fabrication and machining process of MEMS sensors and actuators. ● To enable the students to understand the various sensing and actuation mechanisms.		

Course Outcomes		**Cognitive Levels**
CO1	Identify structural and sacrificial materials for MEMS.	Knowledge/Comprehension (Level I/Level-II)
CO2	Describe the fabrication steps in designing of various MEMS parts.	Analysis (Level-IV)
CO3	Apply principles for the design of Sensor and actuators	Application (Level-III)
CO4	Characterize MEMS devices for different applications in various fields of engineering.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**VII/VIII**	**Summer/Winter**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36

Prerequisite course codes with course names	Microelectronics and VLSI Technology (EC 2352)

Text Books		
1.	**Title**	MEMS
	Author	N. P. Mahalik
	Publisher	Tata McGraw Hill, 2007
	Edition	1nd Edition
2.	**Title**	Introductory MEMS Fabrication and Applications
	Author	T. M. Adams and R. A. Layton
	Publisher	Springer Science & Business Media, 2010
	Edition	1st Edition
Reference Books		

1.	**Title**	Analysis and Design Principles of MEMS Devices	
	Author	Minhang Bao	
	Publisher	Elsevier Science Ltd, 2005	
	Edition	1st Edition	
Course Contents	**UNIT I: Introduction** Introduction to MEMS and Microsystems, MEMS Materials, Structural and Sacrificial Materials, Properties of Silicon, Polymers, Ceramics, and Composites, Basic Modeling of Elements in Electrical and Mechanical Systems. Introduction of layout, Simulation Tools, Packaging and Various Characterization Techniques for MEMS Devices		**8**
	UNIT II: MEMS Fabrication Silicon Growth, Additive Techniques: Oxidation, Physical Vapor Deposition, Chemical Vapor Deposition, Thin Film Deposition, Photolithography, Etching, Bulk and Surface, Micromachining, Etch Stop Technique and Microstructure, Microstereolithography LIGA, and Wafer Bonding.		**9**
	UNIT III: Microsensors and Microactuators Basic Modeling Elements in Mechanical, Electrical and Thermal Systems, Types of Beams: Fixed-Free (Cantilevers), Fixed-Fixed (Bridges), Fixed-Guided beams, Electrostatic sensing and Actuation: Parallel plate capacitor, Applications of parallel plate capacitors: Inertial sensor, Pressure sensor, Flow sensor, Parallel plate Actuators, Piezoresistive Sensors: Origin and Expressions of Piezoresistivity, Piezoresistive Sensor Materials, Applications of Piezoresistive Sensors, Piezoelectric Sensing and Actuation, Thermal Sensing and Actuation: Sensors and Actuators based on Thermal Expansion, Thermocouples, Thermoresistors, Shape Memory Alloy, Applications: Inertial sensors, Flow sensors, Infrared sensors		**12**
	UNIT IV: MEMS Applications MEMS in consumer electronics, Automotive MEMS, Biomedical MEMS, Aerospace and defense applications, Environmental and industrial monitoring		**7**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4854	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		

<table>
<tr><td colspan="2">Course Title & Code</td><td colspan="5">5G Communications and MIMO (EC 4854)</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="5">● To understand the principles and challenges of 5G wireless communication systems.
● To study the fundamentals of MIMO technology and its applications in 5G networks.
● To analyze advanced techniques such as massive MIMO, beam forming, and mmWave communication.
● To explore real-world implementations and standards of 5G networks.
● To gain hands-on experience through simulations and practical exercises</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="4"></td><td>Cognitive Levels</td></tr>
<tr><td>CO1</td><td colspan="3">To understand the principles of 5G Communication and MIMO Technology</td><td colspan="3">Knowledge (Level I)
Comprehension (Level II)</td></tr>
<tr><td>CO2</td><td colspan="3">To analyze the different access techniques.</td><td colspan="3">Application/Analysis (Level III/Level- IV)</td></tr>
<tr><td>CO3</td><td colspan="3">To evaluate advanced MIMO systems and MIMO channels.</td><td colspan="3">Evaluate (Level-V)</td></tr>
<tr><td>CO4</td><td colspan="3">To design and simulate 5G communication systems.</td><td colspan="3">Synthesis (Level- VI)</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">VII/VIII</td><td colspan="3">Summer/Winter</td></tr>
<tr><td colspan="2" rowspan="2">Contact Hours</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Credits</td><td>Total Teaching Hours</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>36</td></tr>
<tr><td colspan="2">Prerequisite course codes with course names</td><td colspan="5">Digital Communication (EC 2403)
Digital Signal Processing (EC 3504)
Electromagnetic Theory (EC 3502)</td></tr>
<tr><td colspan="7">Text Books</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td colspan="5">5G NR: The Next Generation Wireless Access Technology</td></tr>
<tr><td>Author</td><td colspan="5">Erik Dahlman, Stefan Parkvall, and Johan Skold</td></tr>
<tr><td>Publisher</td><td colspan="5">Academic Press, 2018</td></tr>
<tr><td>Edition</td><td colspan="5">1st Edition</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td colspan="5">Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency</td></tr>
<tr><td>Author</td><td colspan="5">Emil Bjornson, Jakob Hoydis, and Luca Sanguinetti</td></tr>
<tr><td>Publisher</td><td colspan="5">Cambridge University Press, 2017</td></tr>
<tr><td>Edition</td><td colspan="5">1st Edition</td></tr>
<tr><td colspan="7">Reference Books</td></tr>
</table>

1.	**Title**	Millimeter Wave Wireless Communications	
	Author	Theodore S. Rappaport, Robert W. Heath Jr, Robert Daniels and James Murdock	
	Publisher	Prentice Hall, 2014	
	Edition	1st Edition	
Course Contents	**UNIT I: Introduction to 5G Communications** Evolution of wireless communication systems (1G to 5G), Key features and requirements of 5G networks, use cases and applications of 5G technology Wireless Channel Modeling, Path loss models (free-space, log-distance, etc.), Fading channels (Rayleigh, Rician, Nakagami), Small-scale and large-scale fading effects.		**9**
	UNIT II: Multiple Access Techniques Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Code Division Multiple Access (CDMA).		**9**
	UNIT III: MIMO Systems and MIMO Channel Models Introduction to MIMO technology,Spatial multiplexing and diversity techniques, Channel capacity and spatial degrees of freedom, SISO, SIMO, MISO, and MIMO channel models, Correlation and capacity analysis, Channel state information (CSI) estimation.		**9**
	UNIT IV: Massive MIMO and Beamforming and Antenna Arrays Principles of massive MIMO technology, Benefits and challenges of massive MIMO systems, Precoding and beamforming techniques, Beamforming fundamentals, Analog and digital beamforming techniques, Beamforming in mmWave communication. Characteristics and challenges of mmWave communication, Beamforming and beam steering at mmWave frequencies, Channel modeling and propagation characteristics.		**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4855	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	VLSI Physical Design (EC4855)		
Course Objectives	● To introduce to the physical design automation, floor planning, placement and routing.		

	● To perform static timing analysis for low power VLSI design.				
Course Outcomes					**Cognitive Levels**
CO1	To partition a given logic circuits using CAD tools to meet the cost function and other constraints.				Knowledge/Comprehension (Level I/Level-II)
CO2	To solve the floor planning and placement issues in circuit layout using appropriate CAD tools.				Application (Level-III)
CO3	Toanalyse the physical design requirements and find the most appropriate routing path for the modules inside the chip.				Analysis (Level-IV)
CO4	To be able to carry out all the physical verification (such as DRC rules, LVS, ERC etc.) of the layout designed.				Synthesis/Evaluation (Level-VI/Level-V)
Semester	**VII/VIII**		**Summer/Winter**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36
Prerequisite course codes with course names	VLSI Design (EC 3601)				
Text/Reference Books					
1.	**Title**	An Introduction to Physical VLSI Design			
	Author	M. Sarrafzadeh & C.K Wong			
	Publisher	McGraw-Hill Series			
	Edition	1996			
2.	**Title**	Principles of CMOS VLSI Design.			
	Author	Neil Weste & K Eshraghian			
	Publisher	Pearson			
	Edition	2nd Edition			
Course Contents	**UNIT I: Introduction** Design representation, VLSI Design Styles, VLSI Design Automation, partitioning, floor planning, floor planning algorithms, Pin assignment, placement, grid routing, global routing, detailed routing.				**9**
	UNIT II: Timing Analysis Clock design, clock network synthesis, power and ground routing, time closure, time driven placement, time driven routing.				**9**
	UNIT III: Physical Synthesis Physical synthesis, performance driven design flow, interconnect modelling, design rule check, layout compaction, testing, fault model.				**9**
	UNIT IV: Test Pattern Generation				**9**

	Test pattern generation, design for testability, boundary scan standard, built-in self-test, low power design, techniques to reduce power, gate level design for low power.	
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4856	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N

Type of Course	Theory Course
Course Title & Code	Machine Learning and Pattern Recognition (EC 4856)
Course Objectives	● To understand the theoretical underpinnings of machine learning and pattern recognition. ● To familiarize with machine learning algorithms with their theoretical foundations and practical implementation. ● To explore the various topics in machine learning such as CNNs, RNNs and GANs. ● To develop critical thinking and problem-solving skills in the context of machine learning and pattern recognition.

Course Outcomes		**Cognitive Levels**
CO1	To understand the foundational concepts, algorithms, and techniques in machine learning and pattern recognition.	**Knowledge/Comprehension (Level I/Level-II)**
CO2	To be able to implement various machine learning algorithms.	**Application (Level-III)**
CO3	To critically analyze the performance of machine learning models, select appropriate evaluation metrics, and make informed decisions for model improvement and optimization.	**Analysis (Level-IV)**
CO4	To evaluate the merits and demerits of existing machine learning and pattern recognition methods in different contexts.	**Evaluation/Synthesis(Level-V/Level-VI)**

Semester	**VII/VIII**	**Summer/Winter**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36

Prerequisite course codes with course names	Digital Signal Processing (EC 3504)
Text Books	

1.	**Title**	Deep Learning

	Author	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	
	Publisher	Springer, 2006	
	Edition	1st Edition	
Reference Books			
1.	**Title**	Pattern Recognition and Machine Learning	
	Author	Christopher M. Bishop	
	Publisher	MIT Press, 2016	
	Edition	1st Edition	
Course Contents	**UNIT I: Introduction to Machine Learning** Overview of Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Basics of Python for Machine Learning, Introduction to NumPy and Pandas.		**9**
	UNIT II: Supervised Learning and Unsupervised Linear Regression, Logistic Regression, Decision Trees and Ensemble Learning (Random Forests, Gradient Boosting), Evaluation Metrics for Classification and Regression, K-Means Clustering, Hierarchical Clustering, Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE).		**9**
	UNIT III: Deep Learning Basics and Convolutional Neural Networks Introduction to Neural Networks, Activation Functions, Optimization Algorithms (Gradient Descent, Adam), Backpropagation Algorithm Architecture of CNNs, Convolutional Layers, Pooling Layers, CNN Applications: Image Classification, Object Detection.		**9**
	UNIT IV: Introduction to Pattern Recognition Introduction to Pattern recognition, feature extraction and selection, pattern classification techniques, applications of pattern recognition.		**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%		

Course Code: EC 4857	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	N	N	Y
Type of Course	Theory Course		
Course Title & Code	Biophotonics (EC 4857)		
Course Objectives	• To impart knowledge about the emerging field of Biophotonics. • To understand the application of Optical based Technologies in the field of biosensing, imaging, cell manipulation and so on.		

Course Outcomes		**Cognitive Levels**
CO1	Able to understand the basics of Biophotonics.	Knowledge/Comprehension (Level I/Level-II)
CO2	Able to understand the basics of Biosensors and Applications of Bioimaging.	Application (Level-III)
CO3	Able to acquire knowledge on Biosensing and Bioimaging.	Analysis (Level-IV)
CO4	Able to learn about Bioscience and Photonics.	Synthesis/Evaluation (Level-VI/Level-V)

Semester	**VII/VIII**	**Summer/Winter**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36
Prerequisite course codes with course names	Introduction to Photonics (EC 2451) Introduction to Semiconductor Devices (EC 2404)				

Text Books			
1.	**Title**	Introduction to Biophotonics	
	Author	Paras N. Prasad	
	Publisher	John Wiley and Sons	
	Edition	1st Edition	
2.	**Title**	Fundamentals of Photonics	
	Author	Bahaa Saleh	
	Publisher	John Wiley and Sons	
	Edition	3rd Edition	
Reference Books			
1.	**Title**	Biomedical Photonics Handbook	
	Author	T. Vo-Dinh ed.	
	Publisher	CRC Press Optics	
	Edition	1st Edition	
Course Contents	**UNIT I: LIGHT AND MATTER** Basics of Structure and Function of Living Materials, Process of Light Interaction with Matter, Light – Matter Interaction, Fundamental Nature of Light.		**9**
	UNIT II: INTERACTION OF LIGHT WITH CELLS AND TISSUES Interaction of Light with Cells and Tissues- Components that Interact with Light, Light Absorption in Cells, Light Induced Cellular Processes, Interaction of Light with Tissues- Absorption, Scattering, Tissue Optical Properties, Light Induced Processes in Tissue, Radiative Transport Theory.		**9**

	UNIT III: OPTICAL SPECTROSCOPY& PRINCIPLES OF LASER Optical Spectroscopy: Fluorescence Spectroscopy, Raman Spectroscopy, CARS, Fluorescence Detection and Quantification of Nucleic Acids, Proteins and Cells, Optical Activity and Circular Dichroism. Laser: Types of Light Sources, Basic Principles of Lasers, Lasers Relevant to Biophotonics.	**9**
	UNIT IV: BIOIMAGING AND OPTICAL BIOSENSORS: PRINCIPLES, TECHNIQUES AND APPLICATIONS Optical Imaging- Background and Need for Optical Imaging, Different Optical Imaging Techniques, Microscopy –Simple, Compound, Fluorescence Microscopy, Confocal Microscopy, Optical Tomography, Fluorescence Resonance Energy Transfer (FRET), Fluorescence Life Time Imaging (FLIM). Applications of Bioimaging- Endogenous and Exogenous Fluorophores, Tissue Imaging, In Vivo Imaging. Optical Diagnostic Technique, Light for Therapy and Treatment, Optical Tweezer, Laser Scissor. Optical Biosensing- Principle, Fiber Optic Biosensors, Surface Plasmon Resonance Biosensors.	**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	

Course Code: EC 4858	**Open Elective Course: (Y/N)**	**Departmental Core Course: (Y/N)**	**Departmental Elective Course: (Y/N)**
	Y	N	N
Type of Course	Theory Course		
Course Title & Code	Hardware Description Language (EC 4858)		
Course Objectives	● To understand the fundamental principles and concepts of nanoscience and nanotechnology. ● To familiarize students with the synthesis, characterization, and manipulation of nanomaterials. ● To explore the various applications of nanotechnology in different fields. ● To develop critical thinking and problem-solving skills in the context of nanoscience and nanotechnology.		

Course Outcomes		**Cognitive Levels**
CO1	To understand the basic requirements of Hardware Description Language.	Knowledge/Comprehension (Level I/Level-II)
CO2	To design combinational and sequential circuits and use of HDLs in practical applications like FPGA programming.	Application (Level-III)
CO3	To analyse the HDL codes and perform timing analysis.	Analysis (Level-IV)

CO4	To design and evaluate complex systems, develop testbenches and integrate modules to form complete digital systems,					Synthesis/Evaluation (Level-VI/Level-V)
Semester	**VII/VIII**			**Summer/Winter**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**	
	3	0	0	3	36	
Prerequisite course codes with course names	Digital Electronics (EC 2401) VLSI Design (EC 3601)					
Text Books						
1.	**Title**	Digital Design and Computer Architecture				
	Author	David Money Harris and Sarah L. Harris				
	Publisher	Morgan Kaufmann, 2012				
	Edition	2nd Edition				
2.	**Title**	Digital Design: With an Introduction to the Verilog HDL				
	Author	M. Morris Mano and Michael D. Ciletti				
	Publisher	Pearson Education, 2017				
	Edition	6th Edition				
Reference Books						
1.	**Title**	VHDL for Digital Design				
	Author	Frank Vahid and Roman Lysecky				
	Publisher	Wiley, 2007				
	Edition	1st Edition				
Course Contents	**UNIT I: Introduction to HDLs (Verilog and VHDL)** Overview of digital design and electronic systems, Role and importance of HDLs in digital design, Comparison of Verilog and VHDL, Verilog syntax and structure Data types and variables, Module instantiation and hierarchical design, VHDL syntax and structure, Entity-architecture modeling, Data types and signal declarations.					**9**
	UNIT II: Combinational and Sequential Logic Design Modeling combinatorial circuits in Verilog and VHDL, Operators and expressions Case and if-else statements, Introduction to sequential circuits, Modeling flip-flops and latches, Finite State Machine (FSM) design.					**9**
	UNIT III: Behavioral Modeling and Advanced Modeling Techniques Behavioral modeling techniques in Verilog and VHDL, Procedural blocks and assignments, Modeling delays and timing constraints, Parameterized modules and generics, Generate statements and loop constructs, User-defined data types and functions.					**9**

	UNIT IV: Testbenches, Simulation, Synthesis and Optimization Writing testbenches for HDL designs, Simulation tools and environments (e.g., ModelSim, Xilinx Vivado), Verification techniques and test coverage, Synthesis flow and process, Optimizing HDL code for area and timing constraints, Timing analysis and constraints. FPGA architecture and design flow, Synthesizing HDL designs forFPGAs, Hardware description for ASIC implementation, High Level Synthesis (HLS) and design abstraction, Emerging trends in HDl-based design.	**9**
Course Assessment	Continuous Evaluation 20% Mid Semester 30% End Semester 50%	