Scheme and Syllabus

of

B. Tech.

Electronics and Communication Engineering

(2025-2026 onwards)

Offered by:

Department of Electronics & Communication Engineering

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

Delhi-110036

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India)

*As per the recommendation of Honourable Senate in it's 19TH Senate meeting held on 10.07.2025

Department of Electronics and Communications Engineering
National Institute of Technology Delhi

1.1 About the Department

Welcome to the Department of Electronic and Communication Engineering (ECE), National Institute of Technology Delhi. It was established in 2010, immediately with the beginning of the Institute under the aegis of the Ministry of Human Resource and Development (MHRD), Govt. of India. Currently, Department is offering one Undergraduate Program as B. Tech (ECE) and two Postgraduate programs as M. Tech. ECE and M. Tech. ECE (VLSI). The Department also offers Ph.D. and Post-Doctoral Fellowship (PDF) Programme in relevant areas. It has excellent laboratories and research facilities in electronic devices and circuits, electronic measurement and instrumentation, microprocessor and microcontroller, microwave and antenna design, optical fiber communication and optical device, multimedia, and advanced communication and design automation and simulation laboratory. The Department has received projects, grants, and fellowships from the Ministry of Electronics and Information Technology (MeitY), the Department of Science and Technology (DST)-SERB, and other funding agencies. The Department has active collaborations with academic Institutes & research institutes in India and abroad.

The Department of ECE has a blend of young as well as experienced dynamic faculty members and is committed to providing quality education and research in the field. Faculty members of the department have excellent academic & research credentials and published numerous peer-reviewed journal articles/papers, Books, Book Chapters, etc. in the diversified field and have adequate experience in advanced research. The department of ECE provides a creative learning environment to the students for excellence in technical education. Here the students learn to face the challenges related to emerging technologies in electronics and communication engineering. The department of ECE promotes a self- learning attitude, entrepreneurial skills, and professional ethics. The department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical backgrounds so that they can fit into the industry immediately upon graduation.

1.2 Vision

Create an educational environment to prepare the students to meet the challenges of the modern electronics and communication industry through state of art technical knowledge and innovative approaches beneficial to society

1.3 Mission

- To promote teaching and learning by engaging in innovative research and by offering state-of- the-art undergraduate, postgraduate, and doctoral programs.
- To cultivate an entrepreneurial environment and industry interaction, leading to the emergence of creators, innovators, and leaders.
- To promote co-curricular and extra-curricular activities for the overall personality development of the students.
- Building of responsible citizens through awareness and acceptance of ethical values.

B. Tech. in Electronics and Communication Engineering (ECE)

2.1 Preamble

B. Tech. (Electronics and Communication Engineering) program offered at NIT Delhi is designed to equip students with a unique blend of skill sets that include:

- Strong theoretical foundation
- Predominantly practice-oriented approach with access to well-equipped and specialized laboratories, and supervised internship via the Practice School
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with emphasis on innovation and entrepreneurship

2.2 Salient Features

- Minimum Credits requirements for completion of B. Tech. program are 160.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the Multi Exit/ Multi Entry in the B. Tech. program.
- There is provision of Major degree and Minor Degree for students.
- The curriculum is designed to meet the prevailing and on-going industrial requirements.
- The curriculum includes Project based Education with Projects every year.
- The curriculum is flexible and offers Choice Based Credit System (CBCS).
- The curriculum inherits the Value based Education and offers Interdisciplinary/ Multidisciplinary Courses.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups.
- The curriculum aims the Holistic Development of the students.

2.3 Cardinal Mentions

- Students exiting after completing 1st Year, 2nd Year and 3rd Year will be awarded Certificate, Diploma and Advanced Diploma in Electronics Engineering respectively. A minimum Credit requirement for Certificate is 40 Credits, Diploma is 80 Credits and Advanced Diploma is 120 Credits respectively.
- The students can opt for Minor Degree across any specialization offered in the Institute from 5th Semester e.g. a student pursuing B. Tech. (Electronics and Communication Engineering) may opt for Minor Degrees offered by the different Departments in the Institute depending upon his/her interest.
- The students opting for Minor Degree will have to earn additional credits for the Minor Degree as per Institute norms which may vary from time to time.

2.4 Program Educational Objectives (PEOs)

PEO-1	Engineering Graduates will excel in Electronics & Communication fields both in the industry and academics by analyzing and applying their knowledge in a professional manner.
PEO-2	Demonstrate multi-disciplinary knowledge and skills to analyze, interpret and create solutions to the real-life electronics engineering problems.
PEO-3	Embrace capability to expand horizons beyond engineering for creativity, innovation and entrepreneurship.
PEO-4	Imbibe competence and ethics for social and environmental sustainability with a focus on the welfare of humankind.

2.5 Program Outcomes (POs)

PO-1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO-4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern Tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO-11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

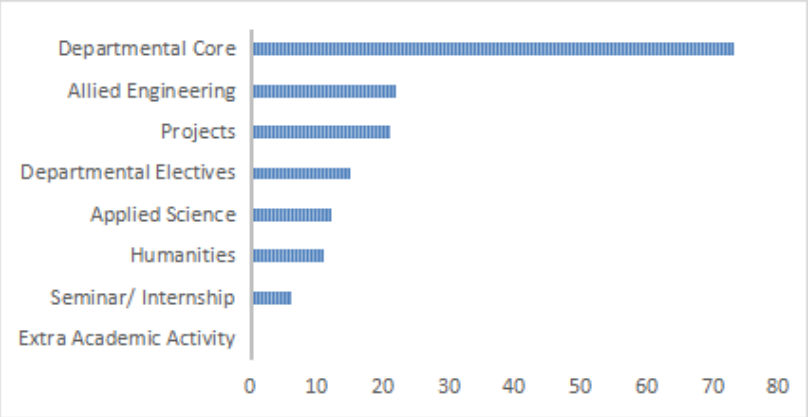
2.6 Program Specific Objectives (PSOs)

PSO -1	Capability to analyze the problems and develop solutions in the area of Electronics and Communication.
PSO -2	An ability to make use of acquired technical knowledge for a successful career, contribution to research and entrepreneurship.

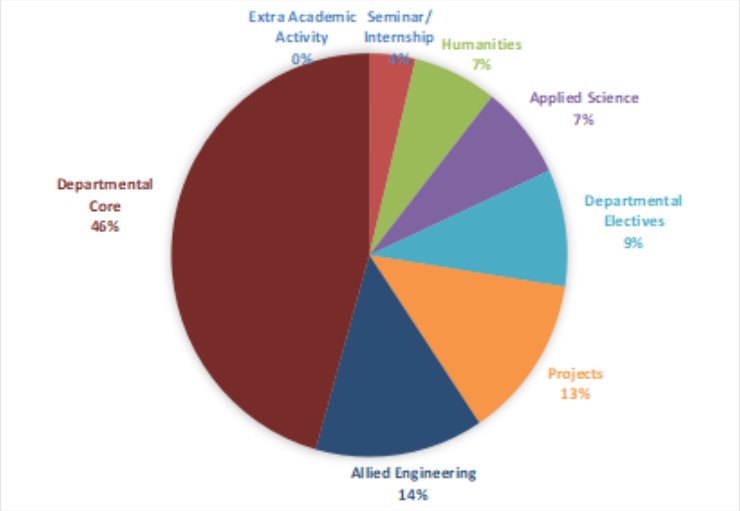
3.1 Semester wise Credit Structure

S. No.	Category of Courses	1st Year		2nd Year		3rd Year		4th Year		Total
		Sem I	Sem II	Sem III	Sem IV	Sem V	Semes VI	Sem VII	Sem VIII	
1.	Departmen t al Core	04	07	19	12	16	11	04	0	73
2.	Departmen t al Electives	--	--	--	--	03	03	09	--	15
3.	Allied Engineerin g	04	08	--	04	--	03	03	--	22
4.	Applied Sciences	08	04	--	--	--	--	--	--	12
5.	Seminar/ Summer Internships/ Independent Study and Seminar	--	--	--	--	01	---	01	04	06
6.	Project	--	01	--	01	--	03	--	16	21
7.	Extra Academic Activity	00	--	--	--	--	--	--	--	00
8.	Humanities	04	--	01	03	--	--	03	--	11
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

3.2 Credits Distribution



3.3 Credits Distribution (in %)



Course Coding Pattern	
Semester	**B. Tech in Electronics and Communication Engineering**
Autumn Semester	ECXB Y01 (onwards)
Spring Semester	ECXB Y51 (onwards)

Y =Year Number: 1= 1st Year; 2=2nd Year; 3 = 3rd Year and 4 = 4th Year) Y = 5 (stands for Departmental Electives)

X = Course Type (Lecture course = L; Laboratory/ Practical course = P; Lecture + Practical course = B (both))

Teaching Scheme for
B. Tech in Electronics and Communication Engineering (ECE)

Semester I						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
MALB 101	Advanced Calculus	Applied Sciences	3	1	0	4
PHBB 101	Engineering Physics	Applied Sciences	3	0	2	4
CYBB 100	Engineering Chemistry	Applied Sciences	2	0	2	3
ECBB 102	Basics of Electronics and Electrical Engineering	Departmental Core	2	0	2	3
MEPB 121	Product Design and Realization Laboratory	Allied Engineering	0	0	2	1
HMBB 101	Theory and Practices of Human Ethics	Humanities and Management	2	0	2	3
CELB 101	Environmental Sciences	Allied Engineering	2	0	0	2
Total Credits			**14**	**1**	**10**	**20**

Semester II						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
MALB 151	Linear Algebra and Complex Analysis	Applied Sciences	3	1	0	4
ECLB153	Basic Communication Systems	Departmental Core	2	0	0	2
CSBB 181	Problem Solving and Computer Programming	Allied Engineering	3	0	2	4
MEBB 162	Engineering Visualization	Allied Engineering	3	0	2	4
ECBB 152	Digital Electronics & Logic Design	Departmental Core	3	0	2	4
HMPB 152	Communication Skills	Humanities and Management	0	0	2	1
HSPB 150	Holistic Health and sports	Extra Academic Activity	0	0	2	1
Total Credits			**13**	**1**	**12**	**20**

Semester III						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECBB 201	Solid State Devices	Departmental Core	3	0	2	4
ECLB 202	Network Analysis and Synthesis	Departmental Core	3	1	0	4
ECLB 203	Electromagnetic Theory	Departmental Core	3	1	0	4
ECBB 204	Signals and Systems	Departmental Core	3	0	2	4
ECLB 205	Control Theory	Departmental Core	3	0	0	3
HMPB 103	Technical Report Writing	Humanities and Management	0	0	2	1
Total Credits			**15**	**2**	**6**	**20**

Semester IV						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECBB 251	Analog Electronics	Departmental Core	3	0	2	4
ECBB 252	Analog Communication	Departmental Core	3	0	2	4
ECBB 253	Electronic Measurement and Instrumentation	Departmental Core	3	0	2	4
CSBB 255	Data Structures	Allied Engineering	3	0	2	4
HMBB 251	Professional Communication	Humanities and Management	2	0	2	3
ECPB 251	Mini Project	Departmental Core	0	0	2	1
Total Credits			**12**	**0**	**14**	**20**

***Summer Internship (6-8 weeks) is mandatory during the summer vacation in between semester IV and V for each student to continue the programme and the corresponding valuation will take place in the next semester (semester V).**

Semester V						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECBB 301	Microprocessor and Microcontroller	Departmental Core	3	0	2	4
ECBB 302	Computer Networks	Departmental Core	3	0	2	4
ECBB 303	Digital Communication	Departmental Core	3	0	2	4
ECBB 304	IC Applications	Departmental Core	3	0	2	4
ECLB 3xx / ECBB 3xx	Elective – I	Departmental Elective	3/2	0/0	0/2	3
ECPB 301	Seminar/ Summer Internship I	Departmental Core	0	0	2	1
Total Credits			**15**	**0**	**10**	**20**

Semester VI						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECLB 351	Antenna and Wave Propagation	Departmental Core	3	0	0	3
ECBB 352	Basics of VLSI	Departmental Core	3	0	2	4
ECBB 353	Digital Signal Processing	Departmental Core	3	0	2	4
ECLB 3xx/ ECBB 3xx	Elective – II	Departmental Elective	3/2	0/0	0/2	3
	Open Elective – I	Allied Engineering	3	0	0	3
ECPB 351	Project	Departmental Core	0	0	6	3
Total Credits			**15**	**0**	**10**	**20**

***Summer Internship (6-8 weeks) is mandatory during the summer vacation in between semester VI and VII for each student to continue the programme and the corresponding valuation will take place in the next semester (semester VII).**

Semester VII						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECBB 401	RF and Microwave Engineering	Departmental Core	3	0	2	4
ECLB 4xx / ECBB 4xx	Elective – III	Departmental Elective	3/2	0/0	0/2	3
ECLB 4xx/ ECBB 4xx	Elective – IV	Departmental Elective	3/2	0/0	0/2	3
ECLB 4xx/ ECBB 4xx	Elective – V	Departmental Elective	3/2	0/0	0/2	3
	Open Elective – II		3	0	0	3
HMLB 401	Management Principles and Practices	Humanities and Management	3	0	0	3
ECPB 402	Seminar/ Summer Internship II	Departmental Core	0	0	2	1
Total Credits			**18**	**0**	**4**	**20**

Semester VIII						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECPB 451	Project	Departmental Core	0	0	0	16
ECPB 452	Independent Study and Seminar	Departmental Core	0	0	6	4
Total Credits			0	0	6	**20**

***Open electives are such subjects which will be offered by other departments. Like ECE department students have to opt open electives from CSE/ EEE etc. departments, as per will be offered.**

List of Electives: Bouquets with Specializations

Specialization: Photonics and Optical Communication

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 321	Semiconductor Laser Theory	3	0	0	3	Elective I
2.	ECLB 322	Optical Fiber Communication	2	0	2	3	
3.	ECLB 334	Optical, electronic & photonic Properties of Nanostructures	3	0	0	3	
4.	ECBB 335	Lasers and Opto-electronics	2	0	2	3	
5.	ECLB 371	Semiconductor Device Modelling	3	0	0	3	Elective II
6.	ECLB 372	Fibre Optic Sensors and Devices	2	0	2	3	
7.	ECLB 390	Nano Electronics & Nano Photonics	3	0	0	3	
8.	ECLB 421	Integrated Optics	3	0	0	3	Elective III + Elective IV + Elective V
9.	ECLB 422	Optical Networks	3	0	0	3	
10.	ECLB 423	Non- Linear Fibre Optics	3	0	0	3	
11.	ECLB 424	Advanced Optical Communication Systems	3	0	0	3	
12.	ECLB 447	Photonics Materials & Devices for Communications	3	0	0	3	

Specialization: Circuit Design and Networks

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 323	Analytical and Computational Techniques in Electromagnetics	3	0	0	3	Elective I
2.	ECLB 324	Detection and Estimation Theory	3	0	0	3	
3.	ECLB 373	Information Theory and Coding	3	0	0	3	Elective II
4.	ECLB 374	Communication Networks	3	0	0	3	
5.	ECLB 425	RF Components and Circuit Design	3	0	0	3	Elective III + Elective IV + Elective V
6.	ECLB 426	Analog and Mixed Signal IC Design	3	0	0	3	
7.	ECLB 427	Architectural Design of ICs	3	0	0	3	

Specialization: Microprocessor and VLSI

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 325	Analog VLSI Circuits	3	0	0	3	Elective I
2.	ECLB 326	Digital VLSI Circuits	3	0	0	3	
3.	ECLB 375	DSP Processors and Architecture	3	0	0	3	Elective II
4.	ECLB 376	Real Time Embedded Systems	3	0	0	3	
5.	ECLB 428	Advanced Microcontrollers	3	0	0	3	Elective III + Elective IV + Elective V
6.	ECLB 429	Analog and Mixed Signal IC Design	3	0	0	3	
7.	ECLB 430	VLSI Interconnects	3	0	0	3	

Specialization: RF and Microwave Engineering

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 327	Telecommunication Switching and Networks	3	0	0	3	Elective I
2.	ECLB 328	Antenna for Wireless Communication	3	0	0	3	
3.	ECLB 377	Radio and Microwave Wireless Systems	3	0	0	3	Elective II
4.	ECLB 431	RF Integrated Circuits	3	0	0	3	Elective III + Elective IV + Elective V
5.	ECLB 432	Microwave Devices and Circuits	3	0	0	3	
6.	ECLB 433	RF and Microwave Networks	3	0	0	3	

Specialization: Embedded System Design

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 329	Low Power Devices and Systems	3	0	0	3	Elective I
2.	ECLB 378	FPGA based Physical Design	3	0	0	3	Elective II
3.	ECLB 434	Micro Fabrication Technology	3	0	0	3	Elective III + Elective IV + Elective V
4.	ECLB 435	Embedded System Design	3	0	0	3	
5.	ECLB 436	CPLD and FPGA Architectures and Applications	3	0	0	3	

Specialization: Communication and Signal Processing

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 330	Digital Image Processing	3	0	0	3	Elective I
2.	ECLB 331	Next Generation Networks	3	0	0	3	
3.	ECLB 379	Statistical Signal Processing	3	0	0	3	Elective II
4.	ECLB 380	Multimedia Communication and Systems	3	0	0	3	
5.	ECLB 381	Satellite Communication	3	0	0	3	
5.	ECLB 438	Wireless and Adhoc Networks	3	0	0	3	Elective III + Elective IV + Elective V
6.	ECLB 439	Optical Signal Processing	3	0	0	3	
7.	ECLB 440	Error Control Coding	3	0	0	3	
8.	ECLB 441	DigitalCommunication Techniques	3	0	0	3	
9.	ECLB 453	Bio-Medical Electronics	3	0	0	3	

Specialization: Antenna Theory

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 332	RF Integrated Circuits	3	0	0	3	Elective I
2.	ECLB 381	Radar Signal Processing	3	0	0	3	Elective II
3.	ECLB 382	Millimeter Wave Technology	3	0	0	3	
4.	ECLB 442	Antenna Theory and Design	3	0	0	3	Elective III + Elective IV + Elective V
5.	ECLB 443	Modern Radar and Avionics Systems	3	0	0	3	
6.	ECLB 444	Radar Engineering	3	0	0	3	

Specialization: Machine Learning and Internet-on-Things

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 333	Wavelet Transforms	3	0	0	3	Elective I
2.	ECLB 383	Pattern Recognition and Machine Learning	3	0	0	3	Elective II
3.	ECLB 384	Signature Analysis and Radar Imaging	3	0	0	3	
4.	ECLB 445	Embedded Real Time Operating Systems	3	0	0	3	Elective III + Elective IV + Elective V
5.	ECLB 446	Neural Networks	3	0	0	3	

List of Open Electives to be offered to Other Departments

S. No.	Course Code	Course Title	L	T	P	Credits	Applicability
1.	ECLB 385	Introduction to Nano science and Nano technology	3	0	0	3	Open Elective - I
2.	ECLB 386	Growth, Fabrication and Manufacturing of Electronic Devices	3	0	0	3	
3.	ECLB 387	Neural Networks and Fuzzy Logic	3	0	0	3	
4.	ECLB 388	Electronic Materials and their Applications	3	0	0	3	
5.	ECLB 389	Optimization Techniques	3	0	0	3	
6.	ECLB 390	Standardization and Quality Ecosystem	3	0	0	3	
7.	ECLB 448	Green Technologies	3	0	0	3	Open Elective - II
8.	ECLB 449	Machine Learning and Pattern recognition	3	0	0	3	
9.	ECLB 450	Wireless Communication and Sensor Networks	3	0	0	3	
10.	ECLB 451	Data Communication and Networking	3	0	0	3	
11.	ECLB 452	Micro-electronics and VLSI Technology	3	0	0	3	

Semester I

Course Title:	**ADVANCED CALCULUS**
Course Code:	**MALB 101**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the theory and methods of Differential, Integral and Vector Calculus	Understanding (Level-II)
CO-2	Apply different methods for solving problems in Differential, Integral and Vector Calculus	Applying (Level-III)
CO-3	Analyze sequence and series for its convergence. Analyse function for continuity and differentiability. Analyse curves and surfaces for concavity, inflection points, maxima and minima.	Analyzing (Level-IV)
CO-4	Evaluate extreme points for function of several variables. Evaluate limits. Evaluate limit of sequences and sum of some convergent series. Evaluate multiple integrals in rectangular, polar, cylindrical, and spherical coordinates.	Evaluating (Level-V)
CO-5	Create power series. Formulate problems on maxima and minima. Combine vector differential calculus and vector integral calculus. Construct counter- examples for theorems and arguments. Formulate problems on integral and vector calculus.	Creating (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	-	-	-	-	-	-	-	-	1	2	1
CO-2	2	2	2	-	1	-	-	-	-	-	-	1	2	1
CO-3	2	3	1	-	1	-	-	-	-	-	-	1	2	1
CO-4	3	2	2	-	1	-	-	-	-	-	-	1	3	1
CO-5	3	2	1	-	1	-	-	-	-	-	-	1	3	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Differential Calculus [Functions of Single Variable]: Limit and Continuity of functions; differentiability; Jacobian, Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Convergence of sequences and series of real numbers; Power series.	**9**
Module-II	Differential Calculus [Functions of Several Variables]: Functions of several variables, limit and continuity, Partial Derivatives and Differentiability, Maxima & Minima of two variables, Lagrange method of multiplier.	**9**
Module-III	Integral Calculus: Fundamentals theorem of integral calculus, Riemann Integration, Improper Integrals, Double and Triple integrals-computation of surface area and volumes-change of variables in double and triple integrals.	**9**
Module-IV	Vector Calculus: Scalar and vector field; Vector differentiation; Level surfaces, Directional Derivatives, Gradient of Scalar field; Divergence and Curl of a vector field; Laplacian, Line and Surface integrals; Green's theorem in plane Gauss Divergence's theorem and Stoke's theorem.	**9**

Learning Resources:

Text Books:	1. Title: Thomas' Calculus Author: G. Thomas, M. Weir, J. Hass Publisher: Pearson Pub. 2. Title: Introduction to Real Analysis Author : R.G. Bartle, D.R. Sherbert Publisher: John Wiley and Sons
Reference Books:	Title Advanced Engineering Mathematics Author E. Kreyszig Publisher John Wiley and Sons
Other Suggested Readings:	

Course Title:	**ENGINEERING PHYSICS**
Course Code:	**PHBB 101**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Recall the basic principles of physics related to optics, relativity, quantum mechanics, atomic physics and thermodynamics.	Remembering (Level - I)
CO-2	Illustrate the various physical phenomena with interpretation based on the mathematical expressions involved.	Understanding (Level - II)
CO-3	Apply the concepts/principles to solve the problems related to wave nature of light, relativity, quantum mechanics and atomic physics.	Applying (Level - III)
CO-4	Analyze and examine the solution of the problems using physical and mathematical concepts involved.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	-	1	1	-	-	2	-	-	-	-	-	2	2	1
CO-2	1	2	2	2	-	-	-	-	-	-	-	-	2	1
CO-3	2	3	3	2	2	-	-	-	-	-	-	1	2	2
CO-4	3	2	3	2	-	1	-	-	-	1	-	1	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Coordinate Systems:** Orthogonal coordinate systems and frames of reference, conservative and non-conservative forces, work-energy theorem, potential energy and concept of equilibrium; Rotation about fixed axis, translational-rotational motion, vector nature of angular velocity, rigid body rotation and its applications, Euler's equations; Gyroscopic motion and its application; Accelerated frame of reference, centrifugal and Coriolis forces.	**12**
Module-II	**Classical Mechanics**: Review of Newtoninan Mechanics in rectilinear coordinate system, motion in plane polar coordinates. Conservation Principles. Collision problems and centre of mass frame. Rotation about fixed axis. Non-inertial frames and pseudo forces, rigid bossy systems.	**12**
Module-III	**Quantum Mechanics/ Physics:** Two−slit experiment. Dual nature of light; Compton Effect; De-Broglie hypothesis; Davisson-Germer Experiment; Phase and group velocities; Uncertainty principle; Wave-function; Schrodinger wave equation; Particle in a finite and infinite potential well; Tunnel effect. Superposition Principle, Continuity Equation for probability density; Normalization. Expectation values. Eigen values and eigen	**12**

	functions Stationary states, Bound states, Applications in one dimension: Particle in a box, 1-D Finite Potential well, Harmonic oscillator. Free-particle solution, 1-D infinite potential well, Expectation values and uncertainty relations; Quantum mechanical tunneling and alpha-decay, Kronig-Penny model and emergence of bands.	
Module-IV	**Electrodynamics:** Ohm's law, Motional EMF, Faraday's law, Lenz's law, Self and Mutual inductance, Energy stored in magnetic field, Maxwell's equations in differential and integral forms and their interpretation, EM wave equation, transverse nature and speed of EM waves, EM energy density, Poynting vector Interference, Diffraction, and Polarization**:** Interference of EM waves**;** Division of amplitude: Uniform and wedge-shaped films; interferometers; Fresnel and Fraunhofer diffractions of EM waves. **Magnetostatics:** Lorentz force, Bio-Savart and Ampere's Laws and their applications, Divergence and Curl of Magneto-static fields, Magnetic vector Potential, Force and torque on a magnetic dipole, Magnetic materials, Magnetization, Bound currents, Boundary conditions.	**12**

Learning Resources:

Text Books:	1. Title: Introduction to Electrodynamics Author: D. J. Griffiths Publisher: Addison Wesley Edition: 3rd ed. (1999) 2. Title: An Introduction to Mechanics Author: D. Kleppnerand R. J.Kolenkow Publisher: Tata McGraw−Hill 3. Title: Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles Author: R.Eisberg and R. Resnick Publisher: John−Wiley
Reference Books:	1. Title: Quantum Physics Author: S. Gasiorowicz Publisher: John Wiley 2. Title: Concepts of Modern Physics Author: A. Beiser Publisher: Tata McGraw-Hill Education
Other Suggested Readings:	-

List of Experiments:	
1.	Characteristics of PN junction, Zener, and Light emitting diodes
2.	Determination of semiconductor bandgap through thermal variation
3.	Determination of Planck's constant through LED
4.	Newton's rings apparatus experiment
5.	Malus' law verification for polarization
6.	Diffraction grating experiment

Course Title:	**ENGINEERING CHEMISTRY**
Course Code:	**CYBB 100**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand periodic properties such as ionization potential, electronegativity and oxidation state	Understanding (Level - II) Applying (Level - III)
CO-2	To understand the importance and application of photochemistry	Understanding (Level - II) Applying (Level - III)
CO-3	To develop an understanding of electrochemistry and its applications in fuel cells/batteries and controlling corrosion.	Understanding (Level - II) Applying (Level - III)
CO-4	To understand solid-state chemistry regarding its structure, defects, and electrical/magnetic properties.	Understanding (Level - II) Applying (Level - III) Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	-	1	1	-	-	2	-	-	-	-	-	2	2	1
CO-2	1	2	2	2	-	-	-	-	-	-	-	-	2	1
CO-3	2	3	3	2	2	-	-	-	-	-	-	1	2	2
CO-4	3	2	3	2	-	1	-	-	-	1	-	1	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases.	**06**
Module-II	Photochemistry and Applications: Photochemical and thermal reactions - laws of photochemistry - quantum yield - excited states - spin allowed and spin forbidden processes - Kasha's rule - Jablonski diagram - fluorescence - phosphorescence - chemiluminescence - photosensitization - applications of photochemistry-light emitting diodes (LED) - photovoltaic cells and solar cells.	**06**
Module-III	Electrochemistry: Electrochemical cells, origin of electrode potential, standard potential, Nernst equation, EMF series, types of batteries - primary battery - dry cell - secondary battery - lead acid battery, Fuel cell-hydrogen-oxygen fuel cell, Li-ion batteries, functioning and their applications. Corrosion: Introduction, theory and mechanism of corrosion, galvanic and differential aeration corrosion, and various preventive measures to control corrosion.	**06**

Module-IV	Solid State Chemistry: Introduction of crystal structure, properties, and bond type. Crystal Defects: Schottky and Frenkel defects, solid electrolytes, non-stoichiometric compounds, F-centers, and other defects in non- stoichiometric compounds. Electrical Properties of Solid: band structures of metals, semiconductors, insulators, and Controlled vacancy semiconductors -extrinsic and intrinsic, p-type and n-type semiconductor, supercapacitors. Magnetic Properties of Solids: diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism and ferrimagnetism.	**06**

Learning Resources:

Text Books:	1. P.C. Jain, M. Jain, Engineering Chemistry, 17th Edition, Dhanpat RaiPublishing Company, New Delhi, 2017. 2. J. Singh, J. Singh, Photochemistry and Pericyclic Reactions, 3rd Edition, New Age Science, 2009. 3. Concise Inorganic Chemistry by J. D. Lee. 4. Advanced inorganic Chemistry. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochann 5. Solid State Chemistry and Its Application by Anthony R. West.
Reference Books:	1. A Text book of Engineering Chemistry by Shashi Chawla, Dhanpat Rai and Sons. 2. J. Singh, J. Singh, Photochemistry and Pericyclic Reactions, 3rd Edition, New Age Science, 2009. 3. An introduction to Electrochemistry by Samuel Glasstone, Affiliated east west press private Ltd. 4. Inorganic Chemistry: Principles of Structure and Reactivity J. E. Huheey 5. Concept and Models of Inorganic Chemistry, B. E. Douglas, D. H. McDenial, and J. J. Alexander
Other Suggested Readings:	-

List of Experiments:	
1.	To find the strength in grams per litre of the given solution of sodium hydroxide with the help of stander oxalic acid solution.
2.	Synthesis of CdS nanomaterial
3.	Estimation of water hardness by EDTA method to determine the total hardness of given water sample by Complexometric Titrations
4.	Preparation of Phenol-formaldehyde resin.
5.	Verification of Freundlich Adsorption Isotherm of acetic acid on charcoal
6.	To determination the strength of ferrous ammonium sulphate with the help of K2Cr2O7 solution
7.	To synthesize copper ammonium complex
8.	Estimation of dissolved oxygen by Winkler's method
9.	To synthesize [Cu(H2O)6](ClO4)2 complex
10.	Estimation of chloride in water
11.	Order of a reaction (redox).
12.	Blue printing
13.	Determination of the viscosity of a lubricating oil by using Redwood viscometer
14.	Acid-base titration using pH meter

15.	Acid-base titration by conductometry
16.	Determination of the Flash & Fire point of a lubricating oil by using Pensky Martin's apparatus
17.	Determination of the Cloud& pour point of a lubricating oil
Note:	The concerned Course Coordinator will prepare the actual list of experiments at the start of semester based on above generic list

Course Title:	**BASICS OF ELECTRONICS AND ELECTRICAL ENGINEERING**
Course Code:	**ECBB 102**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Describe the fundamental physical processes and ballistics of electronics and the basic laws/ definitions.	Remembering (Level- I)
CO-2	To understand the physics behind electronic devices based on the above processes and laws/ definitions.	Understanding (Level - II)
CO-3	Explain and apply the basic principles of semiconductor based electronic devices such as PN Junction devices and related basic devices.	Applying (Level - III)
CO-4	To apply the concept of above semiconductor devices into various real- life applications like Half wave, center tapped and bridge full-wave, Zener diode regulator and voltage multiplier, clipping and clamping circuits.	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1								2	2	1
CO-2	3	3	2	1								2	2	1
CO-3	3	3	2	1								2	2	2
CO-4	3	3	2	1								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Semiconductor Devices: Conductivity of insulators, metals, and semiconductors in terms of energy bands, the chemical bond in Si and Ge, conductivity of intrinsic semiconductors, extrinsic semiconductors: n-type and p-type semiconductors, Hall Effect in semiconductors, Mechanism in current flow: drift and diffusion, Einstein relation, semiconductor materials: Element semiconductor, II-VI compound, III-V compounds, ternary and quaternary compounds. V-I characteristics of PN-junction diode. Diode equivalent circuit, diode as a switch, diode testing.	**9**
Module-II	Diode Applications: Rectifiers: Half wave, centre tapped and bridge full-wave, Zener diode regulator and voltage multiplier, clipping and clamping circuits.	**9**
Module-III	Electrical Circuit Analysis: Voltage and current sources, dependent and independent sources, source conversion, DC circuit's analysis using mesh & nodal method, Thevenin's& superposition theorem, star-delta transformation. 1- phase AC circuits under sinusoidal steady-state, active, reactive, and apparent power, physical meaning	**9**

	of reactive power, power factor, 3-phase balanced and unbalanced supply, star and delta connections.	
Module-IV	Electrical Machines (Static & Dynamic): Transformers: Magnetic Circuits: Review of laws of electromagnetism, Flux, MMF and their relation, analysis of the magnetic and electric circuit. Single-phase transformer: Basic concepts, constructional features, EMF equation, voltage, current, and impedance transformation, Equivalent circuits. Electrical Machines: DC Machines: Constructional features, working principle, emf equation, types of dc machines, and their characteristics. Induction Machines: Constructional features, working principle, emf equation, the concept of slip and torque–slip characteristics. Synchronous Machines: Constructional features, working principle and emf equation.	**9**

Learning Resources:

Text Books:	1. "Electronic Devices and Circuits" by Christos C. Halkias, Jacob Millman, Satyabrata Jit, Tata McGraw Hill Education Pvt Ltd, 2010. 3rd Edition. 2. "Solid State Electronic Devices" by Ben G Streetman and S. K. Banerjee, Pearson India Pvt. Ltd., 2014. 7th Edition. 3. "Integrated Electronics - Analog and Digital Circuit and Systems" Millman, Halkias& Parikh, McGraw-Hill Education, 2012. 2nd Edition
Reference Books:	1. "Fundamentals of Electrical and Electronics Engineering" by S. Ghosh, PHI Learning Pvt. Ltd., 2007. 2nd Edition. 2. "Electrical Engineering Fundamentals" by Vincent Del Toro. PHI Learning, 2015, 2nd Edition. 3. "Basic Electrical Engineering" by I.J. Nagrath& D P Kothari, Tata Mcgraw Hill, 2009, 3rd Edition
Other Suggested Readings:	

List of Experiments:	
1.	Introduction to Breadboard and Electronics components/ Equipment Task.
2.	Multimeter Operation, Colour Coding of Resistance and capacitor coding
3.	Study of Cathode Ray Oscilloscope (CRO)
4.	Study of Digital Storage Oscilloscope (DSO)
5.	Light a bulb/LED and its brightness control
6.	Series/ Parallel Connection of resistors and Water Level detector
7.	Slow light up of LED - Series/ Parallel Connection of Capacitors and build your own battery
8.	One-way current using diode and One-way Light Bulbs LED's
9.	The Electronic Switch- using Transistor
10.	THE LIGHTHOUSE- LED blinking
11.	a) Breadboard to PCB – PCB Introduction b) To learn how to solder and de- solder
12.	Study of Resonance in Series RLC Circuit and to find its resonance frequency**.**
13.	Study of Resonance in Parallel RLC Circuit and to find its resonance frequency**.**
14.	Study of characteristics of PN Junction Diode a) Forward bias b) Reverse bias

Course Title:	**PRODUCT DESIGN & REALIZATION LABORATORY**
Course Code:	**MEPB 121**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Define the basic of design (2D and 3D models) and associated tools.	Remembering (Level I)
CO-2	Demonstrate the knowledge and necessary skills to create various prototypes in the Sheet metal operation, Fitting Work and Welding operations and to perform sand testing, preparation of moulds.	Understanding (Level II)
CO-3	Demonstrate the working principle of lathe machine and able to fabricate the prototypes of desired shape and accuracies.	Understanding (Level II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1	1	2	2	-	-	-	-	-	-	2	2	3	2
CO-2	2	2	2	3	1	-	-	-	-	-	-	3	2	2	2
CO-3	3	3	2	3	3	-	-	-	-	-	-	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Product Design: Basics of Product design, Design process. Solid Works: Basics and the User Interface, Design Intent, File References, Opening Files, Solid Works User Interface. 2D Sketching, Stages in the Process, Saving Files, what are We Going to Sketch, Sketching, Sketch Entities, Basic Sketching, Rules That Govern Sketches, Design Intent, Sketch Relations, Dimensions, Extrude, Sketching Guidelines.	04
Module-II	Fitting Shop: Preparation of Square Fit Work piece, Preparation of T-shape, Preparation of U-shape, Preparation of V-Fit Work piece that contains: Filing, Sawing, Measuring, Punching and Finishing, Practice marking operations.	04
Module-III	Machine Shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools). Demonstration of different operations on Lathe machine. Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting. Study of Quick return mechanism of Shaper.	04
Module-IV	Foundry Shop: Introduction to foundry, Patterns, pattern allowances, ingredients of moulding sand and melting furnaces. Foundry tools and their purposes. Demo of mould preparation. Preparation of mould by using split pattern.	04
Module-V	Welding Shop: Introduction to welding, Study of Welding tools and equipment, Selection of welding electrode and current, Bead practice, Practice of Butt Joint, Lap Joint, T joint.	04

Module-VI	Sheet Metal Shop: Introduction to sheet metal operation, Tools, Metals used in Sheet Metal. Preparation of square tray, preparation of Funnel, Cylinder using a G.I. Sheet.	04

Learning Resources:

Text Books:	1. Singh, Rajender. Introduction to basic manufacturing process and workshop technology. New Age International, 2006.
Reference Books:	1. Khurmi, R.S. and Gupta, J.K., 2008. A Textbook of Workshop Technology. S. Chand Publishing.

List of Experiments:	
	A. INTRODUCTION TO PRODUCT DESIGN
1.	To study different tools used in SolidWorks.
2.	2D and 3D part design in SolidWorks.
	B. FITTING SHOP
1.	To study about different hand tools used in fitting shop.
2.	To make a V-Fit from the given mild steel pieces with specified dimensions.
3.	To make a square fit from the given mild steel pieces with specified dimensions
	C. MACHINE SHOP
1.	To study of different parts of Lathe machine**.**
2.	To perform turning and grooving operations on the given work piece in lathe machine.
3.	To perform facing, knurling, thread cutting operations on the given work piece in lathemachine.
	D. FOUNDRY SHOP
1.	To study the different tools used in Foundry shop.
2.	To prepare a pattern and moulding box for bench moulding process and sand mouldcasting in Foundry Shop.
3.	To determine the green shear strength of the given specimen for different percentages of clay and moisture.
	E. WELDING SHOP
1.	To make a lap joint of the given mild steel pieces by arc welding.
2.	To make a butt joint of the given mild steel pieces by arc welding.
3.	To make a T joint of the given mild steel pieces by arc welding.
	F. SHEET METAL SHOP
1.	To study different types of Hand tools used in Sheet metal shop.
2.	To prepare a square tray of given dimensions using a Galvanized iron (G.I) sheet.
3.	To prepare a Funnel of given dimensions using a G.I. sheet.

Course Title:	**THEORY AND PRACTICES OF HUMAN ETHICS**
Course Code:	**HMBB 101**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Gain a comprehensive understanding of the concept of organization and organizational behaviour.	Understand (Level II)
CO-2	Develop ways to solve real-life problems related to human behaviour based on his understanding of morals, values and ethics.	Apply (Level III)
CO-3	Understanding, developing and leveraging emotional, spiritual and social intelligence in the workplace.	Apply (Level III)
CO-4	Learn about the ethical and moral responsibilities of the engineers.	Understand (Level II)
CO-5	Explain the conceptual framework of HRP and evaluate practical solutions of problems related to manpower planning in the organization.	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1						**2**		**3**	**1**			**2**		**1**
CO-2						**2**		**3**	**1**			**2**		**1**
CO-3						**2**		**3**	**1**			**2**		**1**
CO-4						**2**		**3**	**1**			**2**		**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Organization and Organizational Behaviour- Concept and significance, Organizational Structures, Individual & Group Behaviour; Morals, Values and Ethics; Engineering Ethics- Need, Scope, and Approach; Personality- meaning and definition, Types of Personality; Personality Attributes; Determinants of Personality- Biographical and Personal factors, Environmental Factors, Psychological Factors; Big Five Personality traits.	**8**
Module-II	Feelings, Classification of Feelings; Dimensions of Emotions, Emotions and External Constraints; Emotional Intelligence; Spiritual Intelligence; Authority, Responsibility and Accountability: Meaning of Authority, Responsibility and Accountability, Balance between Authority, Responsibility and Accountability.	**8**
Module-III	Moral Development; Variety of Moral Issues; Moral Dilemma; Moral Autonomy; Theories of Moral Development- Cognitive Moral Development; Concept of moral Relativism and Moral Imperialism; Encouragement and Approaches to Ethical Behaviour.	**8**

Module-IV	Human Resource Policies& Procedures- Introduction, Importance of Policies, Policy Formation, Human Resources Planning. Decision-making & Ethics.	**6**

Learning Resources:

Text Books:	A.K. Chitale, R.P. Mohanty, and N.R. Dubey, Organizational Behaviour: Text and Cases, PHI Learning Private Limited, 2019. Ashwathappa, K., Text & Cases in Human Resources Management, Tata McGraw Hill. Bhattacharyya, D.K., Human Resource Planning, Excel Books India. M. Govindarajan, S. Nataraja, and V.S. Senthil Kumar, Engineering Ethics Includes Human Values, PHI Learning Pvt. Ltd., 2011. M.W. Martin and R. Schinzinger, Ethics in Engineering, McGraw-Hill Education, 2005.
Reference Books:	Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw-Hill. R.S. Naagarazan, A Textbook on Professional Ethics and Human Values, New Age International Publishers. R.W. Griffin and G. Moorhead, Organizational Behavior: Managing People and Organizations, Cengage Learning, 2013.

List of Activities	
1.	Management Activities and Games
2.	Case Studies
3.	Group Discussion
4.	Debate
5.	Presentation
6.	Skit

Course Title:	**ENVIRONMENTAL SCIENCES**
Course Code:	**CELB 101**
L-T-P:	**2-0-0**
Credits:	**2**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To gain knowledge about environment and ecosystem.	Understanding (Level-II)
CO-2	To gain knowledge about the conservation of biodiversity and its importance.	Applying (Level-III)
CO-3	To aware students about problems of environmental pollution, its impact on human, ecosystem and control measures and understand the issues related to Solid waste.	Analyzing (Level-IV)
CO-4	To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.	Evaluating (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	3	2					2	1	1	1
CO-2	2	2	2	2	1	3	3					2	1	1	1
CO-3	3	2	2	2	2	3	3					2	3	2	2
CO-4	3	2	1	1		2	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.	**04**
Module-II	Ecosystem: Ecosystems - Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Biogeochemical cycles.	**08**
Module-III	Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation, Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	**08**

Module-IV	Environmental Pollution: Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Noise pollution Solid waste, Green House Effect, Global Warming, Climate Change, Ozone Layer Depletion and Photochemical Smog	**12**

Learning Resources: To expose the students to the basics of environmental sciences through the multidisciplinary nature of environmental studies, ecosystem, biodiversity and its conservation, environmental pollution, social Issues and the environment.

Text Books:	1. Anubha Kaushik and C. P. Kaushik‘s —Perspectives in Environmental Studies, 6th Edition, New Age International Publishers, 2018. 2. Benny Joseph, Environmental Science and Engineering ‘, McGraw Hill Education, 2017. 3. Gilbert M. Masters, Introduction to Environmental Engineering and Science ‘, 2nd edition, Pearson Education, 2004. 4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall, 2011. 5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
Reference Books:	1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006. 2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
Other Suggested Readings:	

Semester II

Course Title:	**LINEAR ALGEBRA AND COMPLEX ANALYSIS**
Course Code:	**MALB 151**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**Advanced Calculus (MALB 101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the theory and methods of linear algebra and complex analysis.	Understanding (Level-II)
CO-2	Apply different methods for solving problems in linear algebra and complex analysis.	Applying (Level-III)
CO-3	Analyze the rank of a matrix, linear independence, orthogonal projections, transformations, and differentiability.	Analyzing (Level-IV)
CO-4	Evaluate inverse, eigenvalues and eigenvector, line integrals and integrals using residue theorem.	Evaluating (Level-V)
CO-5	Construct normal form of matrix, orthogonal and orthonormal bases, and Taylor and Laurent series.	Creating (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-2	**2**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-3	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-4	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**
CO-5	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Modul-I	**Linear Algebra: [Vectors, Spaces and Linear Transformation]:** Elementary of row and column operations on a matrix, Rank of a matrix, Normal form, Inverse of matrix, Systems of linear equation and their solutions, Vector space and its subspaces, Spanning sets and linear independence, Determinant properties, Linear transformation, Range space and Rank, Null space and nullity. Coordinate system and change of Basis.	**12**

Module-II	**Linear Algebra: [Eigenvalues and Eigenvectors, Orthogonality and Least Squares]:** Eigenvalues and eigenvector, Diagonalization of matrices, Similarity of matrices, Inner product, Orthogonal Projections, Gram Schmidt process, Least square approximations.	**12**
Module-III	**Complex Analysis [Functions of Complex Variable]:** Complex number and elementary properties, Complex Functions-Limit, continuity and differentiability, Polar form of Complex number, Cauchy Riemann Equations, Analytic and Harmonic functions.	**12**
Module-IV	**Complex Analysis [Integrals, Series and Residues]:** Cauchy's Theorem, Cauchy's Integral formula, Taylor and Laurent's series expansion, Zeros and singularities, Residues, Residue theorem and its applications.	**12**

Learning Resources:

Text Books:	1. Title: Linear Algebra and its Applications Author: David C. Lay Publisher: Pearson Pub. 2. Title: Complex variables and its applications Author : R. V. Churchill Publisher: McGraw Hill
Reference Books:	Title Advanced Engineering Mathematics Author E. Kreyszig Publisher John Wiley and Sons
Other Suggested Readings:	

Course Title:	**BASIC COMMUNICATION SYSTEMS**
Course Code:	**ECLB 153**
L-T-P:	**2-0-0**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the basics of communication system, transmitter/receiver block diagram, definition of basic terms related to communication.	Remember (Level I)
CO-2	To explain and discuss the need of modulation, understand the concept of analog communication including amplitude and angle modulation and to calculate the value of modulation index.	Understand (Level II)
CO-3	To understand the fundamentals of digital communication, Introduction to digital modulation techniques, distinguish between analog and digital communication.	Apply (Level III)
CO-4	To understand the basic concepts of optical communication systems, defining various terms, evaluating losses and other parameters of fibre	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**
CO-2	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**
CO-3	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**
CO-4	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction:** Introduction of communication system, Block diagram, type of communication, modes of communication, signal bandwidth, channel bandwidth, frequency spectrum, Signal classification (continuous time signal, discrete time), Energy and power signal.	**09**
Module-II	**Analog Communication**: Overview of Communication System; Need of Modulation and its Benefits, definition of amplitude modulation, demodulation, modulation index, efficiency, bandwidth requirement, advantage of angle modulation over amplitude modulation, Bandwidth comparison between amplitude and angle modulation.	**09**
Module-III	**Digital Communication:** Introduction of digital communication, advantage of digital communication over analog, Modulation Techniques: Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), Frequency Shift Keying.	**09**

Module-IV	**Advancement of communication system:** Introduction to optical communication systems, Advantage of optical communication, Signal propagation in optical fibre, TIR, refractive index, numerical aperture, relative refractive index, skew rays, classification of fibres, Propagation of EM signals in wireless channel –Reflection, diffraction and Scattering, Signal fading, Scattering, Friss transmission equation.	**09**

Learning Resources: This course provides the graduate-level introduction to understand and analyse various types of communication systems such as Analog communication; Digital communication, optical & wireless communication.

Text Books:		
1	Title	Wireless Communications principle and practice
	Author	Rappaport
	Publisher	Pearson
	Edition	2rd ed. (2010)
2	Title	Optical Fibre Communications
	Author	G. Keiser
	Publisher	3rd Edition Tata McGraw Hill, 2000
3	Title	Modern Digital and Analog Communication Systems
	Author	B. P. Lathi and Z. Ding
	Publisher	4th edition, OXFORD
	Reference Books:	
1	Title	Analog and digital communication
	Author	Simon Haykin, 2nd edition,
	Publisher	JOHN WILEY & SONS, INC
	Other Suggested Readings:	

Course Title:	**PROBLEM SOLVING AND COMPUTER PROGRAMMING**
Course Code:	**CSBB 181**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the basics of computer and various Problem solving approaches.	Remembering (Level – I) Understanding (Level – II)
CO-2	Understand the fundamentals of C programming.	Remembering (Level – I) Understanding (Level – II)
CO-3	Apply functions, arrays, and structures for solving problem.	Understanding (Level – II) Applying (Level – III)
CO-4	Understand the use of pointers and file management in C.	Understanding (Level – II) Applying (Level – III)

Course Articulation Matrix:

COs	**POs & PSOs**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												1	
CO2	2	1	1										2	2
CO3	3	2	2	2	2	1							2	2
CO4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Computers: Hardware and Software. Basic Model of Computation Notion of Algorithms, Flowcharts, Top down design, Bottom-up approaches of problem solving, Number system.	**8**
Module-II	Introduction to programming language, Basics of C, Basic Data types - int, float double, char, Bool, Void. Arithmetic and logical operators: precedence and association. Flow of Control Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for.	**8**
Module-III	Function - User defined functions, library functions, Parameter passing call by value, call by reference, recursion. Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.	**8**
Module-IV	Arrays- Advantages and drawbacks, One dimensional, Multi-Dimensional Arrays and strings: Declaration, initialization,	**8**

	Accessing, Passing arrays and strings as parameters to functions. Pointers, Dynamic memory allocation, Dynamic arrays- One dimensional, Multidimensional dynamic array.	
Module-V	Structure: Declaration, Initialization, passing structure to function, Use of pointers in structures. Preprocessors, Macros, File management in C 1/0 - Opening closing and| editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.	**4**

Learning Resources:

1. To understand the computational model of Computer.
2. To understand the concepts of C programming.
3. To apply functions of C programming for solving problems.
4. To understand the concept of file management in C.

Text Books:		
1	**Title**	Programming in ANSI C
	Author	E. Balagurusamy
	Publisher	TATA McGraw Hil1
	Edition	6 editions, 2012
Reference Book:		
1	**Title**	Let Us C
	Author	Yashwant Kanetkar
	Publisher	Infinity Science Press
	Edition	13th edition, 2012
2	**Title**	Schaum's Outline of Programming with C
	Author	Byron S Gottfried
	Publisher	TATA McGraw Hill

Exp. No.	List of Experiments
1	Familiarization of Linux environment - How to do Programming in C with Linux.
2	Familiarization of console VO and operators in C. a. Display "Hello World" b. Read two numbers, add them and display their sum c. Read the radius of a circle, calculate its area and display it d. Evaluate the arithmetic expression ((a -b/c *d+ e) * (f +g)) and display solution. Read the values of the variables from the user through console.
3	Write a program to a. Calculate simple and compound interest. b. Find the roots of quadratic equation.
4	Write a program to swap values of two variables with and without using third variable.
5	Write a program to find the largest of three numbers with and without ternary Operators.
6	Write a program to input name, marks of 5 subjects of a student and display the name of the student, the total marks scored, percentage scored and the class of result.
7	Read a Natural Number and check whether the number is a. prime or not b. Armstrong or not C. even or odd.
8	Write a program to compute grade of students using if else adder. The grades are assigned as followed: Marks Grade marks<50 F 50 marks< 60 C 60 marks<70 B 70 marks<80 B+ 80 marks<90 A 90 marks<100 A+
9	Write a program to check whether the entered year is leap year or not (a year is leap if it is divisible by 4 and divisible by 100 or 400).
10	Write a program to find whether a character is consonant or vowel using switch statement.
11	Find the factorial of a given Natural Number n using recursive and non-recursive functions.
12	Compute sum of the elements stored in an array using pointers and user defined function.

Course Title:	**ENGINEERING VISUALIZATION**
Course Code:	**MEBB 162**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Recall the use of different instruments used in Engineering Drawing and Importance of BIS and ISO codes.	Remembering (Level – I)
CO-2	Illustrate various types of mathematical curves and scale.	Understanding (Level – II)
CO-3	Classify different types of projection and Construct Orthographic projection of Point, Line, Plane and Solid.	Applying (Level – III)
CO-4	Construct Isometric Projection and Conversion of Orthographic view to Isometric view and vice-versa.	Applying (Level – III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	-	-	-	-	-	-	2	2	2	2
CO-2	2	2	1	2	3	-	-	-	-	-	-	3	2	3	3
CO-3	3	3	3	2	2	-	-	-	-	-	-	3	3	1	2
CO-4	3	1	3	3	1	-	-	-	-	-	-	3	3	2	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Lines Lettering and Dimensioning**: Types of lines, Lettering, Dimensioning, Geometrical Constructions, and Polygons. Scales: Plain scales, Diagonal scales, Scale of chords. **Engineering Curves:** Curves used in Engineering Practice: Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involutes, Cycloid, Epi-cycloid, Hypo-cycloid, Spiral, Helix on cone and cylinder.	**15**
Module-II	**Orthographic projection of points**: Principles of Orthographic projection, Projections of points. Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces **Projections of Planes**: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.	**15**
Module-III	**Projections of Solids**: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes. **Section of Solids**: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.	**15**
Module-IV	**Isometric views**: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects. Assembly drawings of the machine parts.	**15**

	Laboratory- Interpretation of drawings: Introduction of CAD package to construct a simple solid model, using a CAD package to construct solid models and generating orthographic, isometric, sectional views with dimensioning, Assembly of components and generation of corresponding drawings. Animation of single of machines in CAD.	

Learning Resources:

Text Books:	1. Bhatt, N.D., Panchal, V.M. and Ingle, P.R., 2010. Engineering Drawing. Charotar Publishing House Pvt. Limited.
Reference Books:	1. Finkelstein, E., 2011. AutoCAD 2008 and AutoCAD LT 2008 Bible (Vol. 415). John Wiley & Sons.

List of Experiments:	
1.	Lettering, Dimensioning.
2.	Plan Scale, Diagonal Scale, Scale of Chords.
3.	Geometrical construction of Engineering Curves.
4.	Introduction of Projection of Points and Lines.
5.	Traces of lines.
6.	Projection of Planes.
7.	Projections of Regular Solids.
8.	Sectional Views of Solids.
9.	Isometric views.
10.	Orthographic to isometric.

Course Title:	**DIGITAL ELECTRONICS AND LOGIC DESIGN**
Course Code:	**ECBB 152**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand and examine the structure of various number systems and their application in digital design.	Understanding (Level –II)
CO-2	Understand the basic logic gates and various reduction techniques of the digital logic circuit in detail and the fundamental concepts and techniques used in digital electronics. Minimize the digital circuits by simplification of the expression using Boolean algebra.	Analyzing (Level- IV)
CO-3	The ability to understand, apply and design various combinational and sequential circuits.	Applying (Level- III)
CO-4	Identify and prevent various hazards and timing problems in a digital design and develop skills to build and troubleshoot digital circuits.	Remembering (Level- I)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-3	**3**	**3**	**2**	**2**								**2**	**3**	**2**
CO-4	**2**	**3**	**3**	**3**	**1**							**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Number System: Various number systems-decimal, Binary, Hex and Octal with mutual conversion, binary arithmetic in computers, addition, subtraction, multiplication and division. Binary Codes: Weighted, non-weighted codes, error detecting and correcting codes, alphanumeric codes, ASCII codes. Boolean Algebra: AND, OR, NOT, NAND, NOR, XOR, operations and gates, laws of Boolean algebra, reduction of Boolean expression, logic diagram, universal building blocks, negative logic.	**12**
Module-II	Digital Logic Families: Parameters of Logic Families. Introduction to logic Families: DTL, RTL, ECL, TTL, CMOS. **Combinational circuits and system** Combinational logic: Minterms and maxterms, Truth table and Karnaugh mapping, reduction of Boolean expression with SOP, POS and mixed terms, incompletely specified functions multiple output minimization, variable mapping, minimization by labular/ Quine Mc cluskey method.	**12**

	Encoders, Decoders, Multiplexers, Demultiplexers, code convertors, Binary address Digital comparator, parity checker/generator, programming logic Array (PLA).	
Module-III	**Sequential circuits system:** State tables and diagrams, flip flop and its various types- JK, RS, T, D, pulse and edge triggered flip flops transition and excitation tables, timing diagrams. Shift registers: Series and parallel data transfer, ripple counters, synchronous counters, Modulo N counter design, Up down counters, Ring counter.	**12**
Module-IV	**Memory & A/D Conversion system** Semiconductor ROM, Bipolar and MOS RAM, organization of RAM memory subsystem. Timing circuit, clock circuit and IC Timer. Analog/Digital conversion: Digital to analog conversion, dual slope integration successive approximation, parallel and parallel/ series conversion, converter specifications.	**12**

Learning Resources:

Text Books:	J. F. Wakerly, Digital Design, Principles and Practices T.C. Bratee, Digital Computer Fundamentals
Reference Books:	M Morris Mano, Digital Logic & Computer Design
Other Suggested Readings:	

List of Experiments:	
1.	Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates
2.	Construction of half and full adder using XOR and NAND gates and verification of its operation.
3.	To Study and Verify Half and Full Subtractor
4.	Realization of logic functions with the help of Universal Gates (NAND, NOR)
5.	Construction of a NOR gate latch and verification of its operation
6.	Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates
7.	Design and verify the 4-Bit Serial In - Parallel Out Shift Registers
8.	Implementation and verification of decoder and encoder using logic gates
9.	Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates
10.	Design and verify the 4- Bit Synchronous or Asynchronous Counter using JK Flip Flop
11.	Verify Binary to Gray and Gray to Binary conversion using NAND gates only
12.	Verify the truth table of one bit and two-bit comparator using logic Gates.

Course Code:	**HMPB 152**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NIL**

Course Outcomes:

CO-1	To prepare engineering students to perform well in technical writing and presentation skills.	II Apply
CO-2	To prepare engineering students for core engineering skills through soft skills	II Apply
CO-3	To equip engineering students with writing skills.	III Apply
CO-4	To equip engineering students with presentation skills.	III Apply
CO-5	To equip engineering students with discussion and interview skills.	III Apply

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1									**1**	**3**		**1**		**1**
CO-2									**1**	**3**		**1**		**1**
CO-3									**1**	**3**		**1**		**1**
CO-4									**2**	**3**		**1**		**1**
CO-5									**2**	**3**		**1**		**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Activities:	
1.	**WRITTEN COMMUNICATION (3 Sessions /6 hours)** Writing Resume, Curriculum Vitae, and Bio-data (Design, Style); Writing Cover letter, Job Applications, Statement of Purpose (SoPs), Life Essay etc. Writing Technical Correspondences: Report Writing, Process Writing, Technical Description: Instructions, manuals etc. Proposals writing, Journal Articles and Conference Papers, Review and Research Articles. (Focus would be given to Grammar, Foreign Words &Phrases, Appropriate use of Prepositions and other aspects).
2.	**ORGANISATIONAL COMMUNICATION (3 Sessions/6 hours)** Samples of technical letters (Letter of Inquiry, Replies to Inquiry Letters, Letters Placing Orders, Instruction Letters, Letters Urging Action, Complaint Letters, and Adjustment Letters), E-mail Correspondences: Format, Standard Practices and Strategies
3.	**PRESENTATION SKILLS (3 session/6 hours)** Oral presentation Skills: How to make presentation (Focus on Paralinguistic features of speech: Pause, Voice, Stress, and Intonation etc. and Non-verbal cues: Body-language

	etc.). Preparing the Presentation: Develop the central idea, main ideas and supporting materials, visual aids. Rehearsing the presentation: Improving Delivery and handling stage Fright.
4.	**Group Discussion Skills (3 Sessions/6 hours)** Techniques for Group Discussion Subject Knowledge, Communication Skills, Leadership Skills, Group Behaviour, Group Contribution: Contributing Systematically; Creating Cooperative Environment, Optimal Participation, Handling Conflict, Effective Closure Individual Contribution: Topic analysis; Discussing Opinion, Problems, Case Studies, Exchanging Opinions, Suggestions and Proposals.
5.	**Job Interviews (2 Sessions/4 hours)** Pre-interview Presentation Techniques Self-Analysis, Research the Organisation Job Analysis, Revise your Subject Knowledge, Develop your Interview file. Interview questions: types, Answering Strategies.

Learning Resources:

Text Books:	Rizvi, M. A. (2005). *Effective Technical Communication*. New Delhi: Tata McGraw-Hill Education. Jones, L., & Alexander, R. (1996). *New International Business English: Communication Skills in English for Business Purposes*. Cambridge: Cambridge University Press. Bansal, R. K., & Harrison, J. B. (2013). *Spoken English: A Manual of Speech and Phonetics*. Hyderabad: Orient Blackswan. Hewings, M. (2007). *English Pronunciation in Use: Advanced*. Cambridge: Cambridge University Press.
Reference Books:	Marks, J. (2007). *English Pronunciation in Use: Elementary*. Cambridge: Cambridge University Press. Nambiar, K. C. (2011). *Speaking Accurately: A Course in International Communication*. New Delhi: Foundation Books. Soundararaj, F. (2012). *Basics of Communication in English: Soft Skills for Listening, Speaking, Reading and Writing*. New Delhi: Macmillan Publishers India Ltd.

Course Title:	**HOLISTIC HEALTH AND SPORTS**
Course Code:	**HSPB 151**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

1. Course Objectives

The course is designed to:

1. Promote awareness of holistic health, physical fitness, and mental well-being.
2. Introduce students to fundamental principles of Yoga, Athletics, and Sports.
3. Foster development of team spirit, leadership, discipline, and ethical conduct.
4. Enhance self-confidence, stress management skills, and concentration.
5. Encourage a healthy, active lifestyle through lifelong engagement in physical activity.

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2. Course Outcomes (COs)

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

CO Code	Course Outcome Description
CO1	Demonstrate improved physical fitness, coordination, and flexibility through yoga and sports activities.
CO2	Apply yogic practices (asana, pranayama, and meditation) for enhancing mental well-being, concentration, and emotional balance.
CO3	Exhibit proper techniques and understanding in basic athletic and sports skills.
CO4	Participate effectively in team and individual sports with leadership, cooperation, and ethical conduct.
CO5	Integrate regular physical activity into a healthy lifestyle and appreciate its lifelong benefits.

3. Program Outcomes (POs)

Students who complete the **Holistic Health and Sports (HSPB 150)** course will demonstrate the ability to:

1. **PO1 – Awareness of Health & Wellness:** Understand and apply fundamental principles of physical fitness, yoga, and mental well-being in personal and professional life.
2. **PO2 – Holistic Problem Solving:** Use physical and mental strategies (like yoga, breath work, sports tactics) to manage stress, improve focus, and support emotional balance.
3. **PO3 – Performance Design:** Demonstrate the ability to plan and implement fitness routines and sports strategies that enhance personal health and group performance.
4. **PO4 – Analytical Skills in Movement:** Evaluate and improve athletic techniques, body mechanics, and yoga practices through observation and self-assessment.
5. **PO5 – Adaptation of Tools:** Use sports equipment, fitness trackers, or yoga props to optimize training and performance safely and effectively.
6. **PO6 – Societal Contribution:** Recognize the role of physical education and sports in building healthy communities, social inclusion, and national identity.
7. **PO7 – Sustainability in Lifestyle:** Adopt and promote sustainable habits related to health, environment (e.g., eco-friendly sports), and wellness.
8. **PO8 – Ethics & Fair Play:** Demonstrate ethical behavior, integrity, and fair play in all physical activities and competitions.

9. **PO9 – Teamwork and Leadership:** Exhibit collaboration, team coordination, and leadership in group sports and fitness activities.
10. **PO10 – Effective Communication:** Communicate clearly during team play, instruction, and in expressing ideas related to health and sports.
11. **PO11 – Organizational Skills:** Participate in planning sports events or group activities, applying time management and event coordination skills.
12. **PO12 – Lifelong Fitness Learning:** Commit to continuous physical self-improvement and understand the importance of lifelong health and active living.

4. Program Educational Objectives (PEOs)

1. **PEO1 – Practice Holistic Well-being:** Integrate physical activity, mindfulness, and healthy habits into their daily lifestyle for enhanced productivity and personal growth.
2. **PEO2 – Be Health Ambassadors:** Contribute positively to society by promoting awareness about fitness, yoga, and wellness among peers and in the community.
3. **PEO3 – Lead Through Sport:** Demonstrate leadership, resilience, and ethical behavior learned through sports and physical education in professional and academic settings.
4. **PEO4 – Pursue Continuous Self-Improvement:** Remain engaged in lifelong physical and mental self-improvement, exploring various fitness modalities and wellness techniques.
5. **PEO5 – Adapt to a Balanced Life:** Maintain an effective balance between work, study, and recreation through knowledge and habits gained in this course.

5. CO-PO Mapping

COs \ POs	PO1 Health & Wellness	PO2 Problem Solving	PO3 Performance Design	PO4 Movement Analysis	PO5 Tool Usage	PO6 Society	PO7 Sustainability	PO8 Ethics	PO9 Teamwork	PO10 Communication	PO11 Org. Skills	PO12 Lifelong Learning
CO1	✔		✔	✔	✔		✔					
CO2	✔	✔		✔			✔	✔				
CO3	✔		✔	✔	✔				✔			
CO4		✔				✔		✔	✔	✔		
CO5	✔					✔	✔	✔				

Semester III

Course Title:	**SOLID STATE DEVICES**
Course Code:	**ECBB 201**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101, Engineering Physics (PHBB 101)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Describe the fundamental physical processes related to electronic and photonic transitions in semiconductors and the basic laws/ definitions.	Remember (Level I)
CO-2	To understand the advanced physics behind electronic and photonic devices based on the above processes and laws/ definitions.	Understand (Level II)
CO-3	Application of above concepts to understand the physical processes and principle of operation of various electronic and opto-electronic solid devices.	Apply (Level III)
CO-4	To develop the circuit level concepts of above electronic and opto-electronic solid devices.	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	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.	**09**
Module-II	PN junction and hetero-structures: Basic structure and principle of operation, pn junction under bias, junction capacitance, steady state conditions, transient and ac conditions, reverse bias breakdown, metal-semiconductor junctions, PIN diode, Tunnel diode, voltage regulator, power devices, MSM junction diode/ Schottky contact diode.	**09**
Module-III	Bipolar Junction Transistors: Fundamental operation, amplification with BJTs, generalized biasing and equivalent circuit models, non-ideal effects, Classification (CC, CB & CE), configurations, transistor as an amplifier, testing of transistor, load line analysis, biasing of the transistor, bias compensation, and transistor as a switch. Field – Effect Transistors:	**09**

	Transistor operations. JFET, Metal-Semiconductor FET, MISFET, MOSFET and their operations, device characteristics, non-ideal effects, CV characteristics, equivalent circuits, HEMTS. Introduction to advanced processes and semiconductor Devices	
Module-IV	Photonics Devices: Electro-optic conversions processes, photoconductive devices, Light emitting diodes, semiconductor lasers, photo detectors, solar cells, etc.	**09**

Learning Resources: This course provides the graduate-level introduction to understand, analyze, characterize and design the operation of semiconductor devices such as transistors, diodes, solar cells, light-emitting devices, and more.

Text Books:	1. Solid State Electronic Devices, Ben G Streetman and S. K. Banerjee, PHI Learning Pvt Ltd, 2009, Global Edition. 2. Electronic Devices and Circuits, Christos C. Halkias, Jacob Millman, Satyabrata Jit, Tata McGraw Hill Education Pvt Ltd., 2010, 3rd Edition. 3. Semiconductor Physics and Devices, Basic Principles, Donald A. Neamen, McGraw Hill Higher Education, 3rd Edition.
Reference Books:	1.Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition. 2. Semiconductor Device Physics and Design, Umesh K Mishra, Jasprit Singh, Springer, 2008.
Other Suggested Readings:	

List of Experiments:	
1.	P-N JUNCTION DIODE CHARACTERISTICS
2.	ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR
3.	HALF -WAVE RECTIFIER WITH AND WITHOUT FILTER
4.	FULL - WAVE RECTIFIER WITH AND WITHOUT FILTER
5.	INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR CB CONFIGURATION
6.	INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR CE CONFIGURATION
7.	FET CHARACTERISTICS
8.	h-PARAMETERS OF CB CONFIGURATION
9.	h-PARAMETERS OF CE CONFIGURATION
10.	FREQUENCY RESPONSE OF CE AMPLIFIER
11.	FREQUENCY RESPONSE OF CC AMPLIFIER
12.	FREQUENCY RESPONSE OF COMMON SOURCE FET AMPLIFIER
13.	CHARACTERISTICS OF LDR, PHOTO DIODE, PHOTO TRANSISTOR
14.	V-I CHARACTERISTICS OF LED

Course Title:	**NETWORK ANALYSIS AND SYNTHESIS**
Course Code:	**ECLB 202**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Apply network topology concepts in the formulation and solution of electric network problems.	Remember (Level I)
CO2	Apply two-port network analysis in the design and analysis of filter and attenuator networks.	Apply (Level III)
CO3	Identify the properties and characteristics of network functions and verify the mathematical constraints for their physical realisation.	Analyze (Level IV)
CO4	Synthesize passive one-port networks using standard Foster and Cauer-forms	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**2**	**3**							**2**		**2**	**3**
CO-2	**2**	**3**	**3**	**2**							**1**		**2**	**2**
CO-3	**3**	**2**	**3**	**3**							**1**		**2**	**2**
CO-4	**2**	**2**	**3**	**3**							**1**		**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: KCL, KVL, Network theorems and its application in the analysis of networks.	**10**
Module-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, Two port parameters, relationships among different network parameters, inter connections of networks.	**15**
Module-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-to-Star transformation, Voltage, current and power in a star and delta connected system, three phase balanced and unbalanced circuits.	**11**
Module-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**

Learning Resources:

Text Books:

Title	Network Analysis
Author	M.E. Van Valkenburg
Publisher	Prentice Hall
Edition	3rd Ed.
Title	Network Analysis and Synthesis
Author	Franklin F. Kuo
Publisher	Wiley
Edition	2nd Ed.
Title	Engineering Circuit Analysis
Author	W. H. Hayt and J E Kemmerly
Publisher	TMH
Edition	8th Ed.

Course Title:	**ELECTROMAGNETIC THEORY**
Course Code:	**ECLB 203**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**Engineering Physics (PHBB 101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain the concepts of vector calculus to solve complex problem and relate among different coordinate systems for electromagnetic fields.	Understand (Level II)
CO-2	To apply the basic principles of electrostatics and magnetostatics and relate the electric and magnetic fields.	Apply (Level III)
CO-3	To analyze the static electric and magnetic fields, their behavior in different media, associated laws, boundary conditions and electromagnetic potentials.	Analyze Level IV)
CO-4	To use integral and point form of Maxwell`s equations for solving the problems of electromagnetic field theory.	Apply (Level III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**
CO-2	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-3	**3**	**3**	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-4	**3**	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Vector Calculus: Spherical and cylindrical coordinate's gradient, divergence and curl, Laplacian operator. Volume and line integrals, surface integrals, Divergence and Stoke's theorem. Dirac delta function.	**12**
Module-II	Magnetostatics and Electrostatics: Coulomb's Law and Electric Field Intensity: The Experimental Law of Coulomb Electric Field Intensity Field Arising from a Continuous Volume Charge Distribution Field of a Line Charge Field of a Sheet of Charge Streamlines and Sketches of Fields, Electric Flux Density, Gauss's Law, and Divergence: Electric Flux Density, Gauss's Law, Application of Gauss's Law: Some Symmetrical Charge Distributions, Application of Gauss's Law: Differential Volume Element Divergence and Maxwell's First Equation, The Vector Operator ∇ and the Divergence Theorem.	**16**
Module-III	Energy and Potential: Energy Expended in Moving a Point Charge in an Electric Field, The Line Integral, Definition of Potential Difference and Potential, The Potential Field of a System of	**10**

	Charges, Property Potential Gradient, The Electric Dipole Energy Density in the Electrostatic Field Conductors and Dielectrics	
Module-IV	The Steady Magnetic Field: Biot-Savart Law, Ampere's Circuital Law, Curl, Stokes' Theorem, Magnetic Flux and Magnetic Flux Density, The Scalar and Vector Magnetic Potentials, Derivation of the Steady-Magnetic-Field Laws.	**10**

Learning Resources:

Text Books:	Engineering Electromagnetics
	William H. Hayt and John A. Buck
	McGraw Hill Education
	8th Edition, 2012
Reference Books:	Theory and Computation of Electromagnetic Fields
	Jian-Ming Jin
	John Wiley & Sons
	Second revised edition, 2015.
Other Suggested Readings:	NPTEL Lectures, Research papers

Course Title:	**SIGNALS AND SYSTEMS**
Course Code:	**ECBB 204**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basic Communication System (ECLB 151)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand mathematical description and representation of continuous and discrete-time signals and systems.	Remember (Level I)
CO2	Develop input-output relationships for linear shift-invariant systems and understand the convolution operator for continuous and discrete-time systems.	Analyze (Level IV)
CO3	Understand and resolve the signals in the frequency domain using Fourier series and Fourier transforms. Understand the limitations of the Fourier transform and the need for the Laplace transform and develop the ability to analyze the system in s- domain.	Evaluate (Level V)
CO4	Understand the basic concept of probability, random variables & amp; random signals and develop the ability to find a correlation, CDF, PDF and probability of a given event.	Evaluate (Level V)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	0	2	0	0	0	0	0	0	2	2	1
CO-2	3	2	2	2	2	0	0	0	0	0	0	2	3	2
CO-3	3	3	2	2	2	0	0	0	0	0	0	2	3	2
CO-4	3	3	2	2	1	0	0	0	0	0	0	2	2	2

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Signals and their representation: Signal and System Theory, The black- box approach. Formal definition of 'signal' and 'system'. The domain and range variables, continuous and discrete signals and cont. and discrete systems. Signal operations: folding, Shifting, scaling for Continuous and Discrete Time Signal. Sampling of discrete-time signals.	**12**
Module-II	Fourier Series and Transforms: Fourier analysis of continuous time signals and systems: Fourier series for periodic signals, Fourier transform. Properties of continuous time fourier series and transform. Energy spectral density, parsevals theorem, power spectral density.	**12**
Module-III	Laplace and Z Transform: Relation between Laplace Transform and Fourier Transform. Properties of laplace transform. Application of laplace transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, solution to	**11**

	differential equations and system behavior. z-Transform, definition, ROC, inverse z-Transform, properties.	
Module-IV	LTI Systems and Sampling: Impulse response, response of a linear system, linear time invariant system, linear time variant system, transfer function of LTI system. The Sampling Theorem and its implications. Spectra of sampled signals. Aliasing and its effects.	**12**

Learning Resources:

Text Books:		
1.	Title	Signals and Systems
	Author	Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab
	Publisher	PHI Publications
Reference Books:		
1.	Title	Principles of Linear Systems and Signals
	Author	B.P. Lathi
	Publisher	Oxford University Press Publications
	Edition	
2.	Title	Signals and Systems
	Author	Simon Haykin
	Publisher	John Wiley and Sons Publications
	Edition	

Course Title:	**CONTROL THEORY**
Course Code:	**ECLB 205**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Network Analysis and Synthesis (ECLB 202)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand the basic concept of control system and identify a set of algebraic equation to represent and model complicated system into more simplified form.	Remember (Level I)
CO2	Interpret different physical and mechanical system in terms of electrical system to construct equivalent electrical models for analysis.	Understand (Level II)
CO3	To formulate time domain and frequency domain analysis of control systems required for stability analysis.	Evaluate (Level V)
CO4	To formulate time domain and frequency domain analysis of control systems required for stability analysis.	Understand (Level II)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	3									2	2
CO-2	2	3	3	2									3	2
CO-3	2	3	3	3									2	2
CO-4	2	3	3	2									2	3

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Control system modelling: Basic Elements of Control System – Open loop and Closed loop systems – Differential equation – Transfer function, Modelling of Electric systems, Translational and rotational mechanical systems – Block diagram reduction Techniques – Signal flow graph.	**9**
Module-II	Time and Frequency Response analysis– First Order Systems – Impulse and Step Response analysis of second order systems – Steady state errors – P, PI, PD and PID Compensation, Analysis using MATLAB, Bode Plot, Polar Plot, Nyquist Plot – Frequency Domain specifications from the plots – Constant M and N Circles – Nichol's Chart – Use of Nichol's Chart in Control System Analysis. Series, Parallel, series-parallel Compensators – Lead, Lag, and Lead Lag Compensators, Analysis using MATLAB.	**9**
Module-III	Stability analysis: stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram – Nyquist Stability Criterion – Relative Stability, Analysis using MATLAB.	**9**

Module-IV	State variable analysis and digital control systems: State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation – Solutions of the state equations – Concepts of Controllability and Observability – State space representation for Discrete time systems. Sampled Data control systems – Sampling Theorem – Sample & Hold – Open loop & Closed loop sampled data systems.	**9**

Learning Resources:

Text Books:		
1.	Title	Control System Engineering
	Author	J. Nagrath and M. Gopal
	Publisher	New Age International Publishers
	Edition	5th Edition, 2007
2.	Title	Control System – Principles and Design
	Author	M. Gopal
	Publisher	Tata McGraw Hill
	Edition	2nd Edition, 2002
3.	Title	Automatic control systems
	Author	Benjamin. C. Kuo
	Publisher	Prentice Hall of India
	Edition	7th Edition, 1995

Reference Books:		
1.	Title	Digital Control and State Variable Methods
	Author	M. Gopal
	Publisher	TMH
	Edition	2nd Edition, TMH, 2007
2.	Title	Feedback and Control Systems
	Author	Schaum's Outline Series
	Publisher	Tata McGraw- Hill
	Edition	2007

Course Title:	**TECHNICAL REPORT WRITING**
Course Code:	**HMPB 103**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Identify and apply the structure and components of standard technical reports.	Apply (Level III)
CO-2	Compose different types of technical reports, using appropriate tone, style, and formatting.	Apply (Level III)
CO-3	Edit and refine technical documents for grammar, coherence, and audience.	Analyse (Level IV)
CO-4	Collaborate in peer-review activities to improve report quality.	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1		**1**		**1**						**3**				**1**
CO-2		**1**		**1**						**3**				**1**
CO-3		**1**		**1**						**3**				**1**
CO-4		**1**		**1**						**3**				**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Session No.	**Lab Activity**
1	Introduction to technical writing: Basics, types of reports, audience analysis.
2	Planning a report: Purpose, scope, outline, and data collection strategies.
3	Writing effective Introductions and Background sections.
4	Writing Methodology/Procedure sections (for lab or field-based reports).
5	Writing Results and Discussion: Presenting data (text, table, figures).
6	Writing Conclusions and Recommendations.
7	Writing Executive Summaries and Abstracts.
8	Formatting a complete technical report (headings, TOC, numbering, visuals, citations).
9	Writing technical definitions, descriptions, and instructions.
10	Report revision techniques: Editing for clarity, coherence, conciseness.
11	Peer review activity: Exchange and critique each other's drafts.
12	Writing short reports: incident report, progress report, and feasibility report.
13	Writing a mini-project report (group work begins).
14	Final presentation and submission of mini-project technical report.

Learning Resources:

Text Books:	Rizvi, M. A. (2005). Effective Technical Communication. New Delhi: McGraw Hill Education. Jones, L., & Alexander, R. (2006). New International Business English. Cambridge: Cambridge University Press. Bansal, R. K., & Harrison, J. B. (2013). Spoken English: A Manual of Speech and Phonetics. Hyderabad: Orient Blackswan. Hewings, M. (2009). English Pronunciation in Use: Advanced. Cambridge: Cambridge University Press.
Reference Books:	Marks, J. (2009). *English Pronunciation in Use: Elementary*. Cambridge: Cambridge University Press. Nambiar, K. C. (2011). *Speaking Accurately: A Course in International Communication*. New Delhi: Foundation Books. Soundararaj, F. (2012). *Basics of Communication in English*. New Delhi: Macmillan.

Semester IV

Course Title:	**ANALOG ELECTRONICS**
Course Code:	**ECBB 251**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**ECBB 101 (Basics of Electronics and Electrical Engineering), PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Design and analysis of CE, CB, CC amplifiers using small signal h-model and pi-model and derivation of voltage gain, current gain, input impedance and output impedance.	Understand (Level II)
CO-2	Design and analysis of RC coupled single stage and multistage amplifiers and their frequency responses; and the effects of coupling and bypass capacitors in amplifiers.	Analyze (Level IV)
CO-3	Design and analysis of common source FET amplifier and its frequency response. Design and analysis of negative feedback amplifiers and oscillators.	Evaluate (Level V)
CO-4	Design and analysis of different types of power amplifiers and tuned amplifiers and Behaviour of noise in an amplifier.	Apply (Level III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	3	1	2	1		1	2				3	3
CO-2	3	2	3	1	2	1		1	2				3	3
CO-3	3	2	3	1	2	1		1	2				3	3
CO-4	3	2	3	1	2	1		1	2				3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Transistor biasing and basic characteristics: Operating point, Bias stability, Different biasing arrangements, stabilization, Thermal runway and thermal stability, small signal low frequency amplifiers, analysis of generalized amplifier models, Transistor hybrid models, Determination and measurement of h- parameters, analysis of transistor amplifier circuits using h- parameters.	**08**
Module-II	Low frequency response of amplifiers and Large Signal Amplifier: Cascading transistor amplifiers, calculations for different amplifier configurations, Emitter follower, Miller's theorem, Cascode transistor configurations, few configurations of high frequency response, Basic overview on difference and power amplifiers, a) Difference between voltage and power amplifiers b) Importance of impedance matching in amplifiers c) Class A, Class B, Class AB, and Class C amplifiers d) Single ended power amplifiers, push-pull amplifier, and complementary symmetry push-pull amplifier.	**10**
Module-III	Feedback and operational amplifiers and Sinusoidal Oscillators: Feedback concept, positive and negative feedback, different feedback configurations, Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier	**09**

	models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Nonlinear applications of operational amplifiers: Comparators, Linearization amplifiers; Logarithmic amplifiers, Barkhausen criterion for oscillations, Different oscillator circuits-tuned collector, Hartley Colpitts, phase shift, Wien's bridge, and crystal oscillator.	
Module-IV	Multistage Amplifiers and Power Supplies: Need for multistage amplifier, gain of multistage amplifier, Different types of multistage amplifier like RC coupled, transformer coupled, direct coupled, and their frequency response and bandwidth, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers. Wave Shaping Circuits General idea about different wave shapers, RC and RL integrating and differentiating circuits with their applications, Mult vibration Circuits, Concept of multi-vibrator: Block diagram of IC555 and its working, IC555 as monostable and astable multi-vibrator. Regulated DC Power Supplies: Concept of DC power supply. Line and load regulation, Concept of fixed voltage, IC regulators (like 7805, 7905), and variable voltage regulator like (IC 723), SMPS.	**09**

Learning Resources: The goal of this course is to introduce and verify basic principles, operation and applications of the various analog electronic circuits made up of devices like: BJT and MOSFET for various engineering/ social applications.

Text Books:	1. Malvino, Electronics Principles, 3rd Edition, Tata McGraw Hills, New Delhi. 2. Christos C. Halkias, Jacob Millman, SatyabrataJit, Electronic Devices and Circuits, 4th Edition, McGraw Hill Education Pvt Ltd, 2015. 3. Boylestead and Nashelski, Electronic Circuit Theory, 3rd Edition, Tata McGraw Hills
Reference Books:	1. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits, International Student Edition, Oxford University Press, 2006.
Other Suggested Readings:	

List of Experiments:	
1.	RC coupled amplifier
2.	Darlington Emitter Follower
3.	Voltage Series Feedback Amplifier
4.	RC Phase shift Oscillator
5.	Hartley & Colpitt's Oscillator
6.	Clipping circuits
7.	Clamping circuits
8.	Op-Amp applications
9.	ZCD & Schmitt trigger
10.	Full wave Precision Rectifier
11.	Voltage Regulator
12.	Digital-Analog Converter
13.	Analog-Digital Converter

Course Title:	**ANALOG COMMUNICATION**
Course Code:	**ECBB 252**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**ECLB 151 (Basic Communication System); ECBB 204 (Signals and Systems)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Gain the knowledge of components of analog communication system.	Remembering (Level I)
CO-2	To analyze various methods of baseband/band pass Analog transmission and detection.	Analyzing (Level IV)
CO-3	Analyze and allocate performance objectives to components of an analog communicationsystem and to design analog communication systems.	Analyzing (Level IV)
CO-4	To evaluate the performance of analogue communications in the presence of noise.	Evaluating (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**								**2**	**2**			**1**	**2**
CO-2	**3**	**3**							**2**	**2**			**3**	**3**
CO-3	**3**	**3**							**2**	**2**			**3**	**3**
CO-4	**3**	**2**							**2**	**2**			**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Introduction to communication systems, guided and unguided transmission media, concept of bandwidth, electromagnetic spectrum and its usage, Review of Signal representation using Fourier Series & Fourier Transform. Introduction to Noise: Atmospheric, Thermal, Shot and Partition noise, Noise figure and experimental determination of noise figure, Shot noise in temperature limited diode and space charge limited diodes, Pulse response and Digital noise	**9**
Module-II	Analog Modulation Techniques: Introduction and need of modulation, Theory of Amplitude Modulation; Amplitude modulation, DSB, SSB, (with and without carrier), VSB, Power Calculations, Generation of AM. Theory of Frequency Modulation (FM); FM and PM, Transmission FM spectra, Carson's rule, Bandwidth of FM, reactance FET modulator Armstrong method, Foster-Seely discriminator, PLL detector, Stereophonic FM, Narrow band and wide band FM. Comparison of FM and PM.	**9**
Module-III	Radio receivers: Tuned radio frequency receiver, Super heterodyne receiver, Sensitivity and selectivity, selection of IF. Block diagram and features of Communication Receiver and its spectral features.	**9**

Module-IV	Pulse Modulation Transmission and Reception: Sampling Theorem–low pass and band pass, Pulse Amplitude Modulation (PAM), Pulse Time Modulation (PTM); Pulse Width Modulation (PWM).	**9**

Learning Resources: This course provides the graduate-level introduction to understand, analyze, characterize and design the operation of Transmitters, receivers to transmit and receive analog signal successfully using analog modulation techniques such as AM, FM & PM along with the Pulse Modulation and impact of noise on signal.

Learning Resources:

Text Books:		
1	Title	Electronic Communication Systems
	Author	Kennedy, Davis
	Publisher	McGraw Hill
	Edition	4/e, 1999
2	Title	Communication Systems
	Author	S. Haykins
	Publisher	Wiley
	Edition	4/e, 2001
3	Title	Modern Digital and Analog Communication Systems
	Author	B.P. Lathi
	Publisher	Oxford University Press
	Edition	3/e, 1998
	Reference Books:	
1	Title	Introduction to Communication Systems
	Author	B. Carlson
	Publisher	McGraw-Hill
	Edition	4/e, 2009
2	Title	Modern Communication Circuits
	Author	J. Smith
	Publisher	McGraw Hill
	Edition	2/e, 1997
3	Title	Modern Electronic Communication
	Author	J. S. Beasley & G. M. Miler
	Publisher	Prentice Hall
	Edition	9/e, 2008
	Other Suggested Readings:	

List of Experiments:	
1.	Study of AM Modulation/Demodulation.
2.	Study of FM Modulation/Demodulation.
3.	Study of Diode detector and AGC.
4.	To Study Sampling theorem.
5.	Sensitivity of a Superheterodyne Receiver.
6.	Selectivity of a Superheterodyne Receiver.
7.	Fidelity of a Superheterodyne Receiver.
8.	Study of Pulse Amplitude Modulation/Demodulation.
9.	Study of Pulse Width Modulation/Demodulation.
10.	Study of Pulse Position Modulation/Demodulation

Course Title:	**ELECTRONIC MEASUREMENT AND INSTRUMENTATION**
Course Code:	**ECBB 253**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**ECBB 101 (Basics of Electronics and Electrical Engineering), PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understanding of instrument characteristics, errors and generalized Measurement system.	Understand (Level II)
CO-2	Analyze and use the circuit for the measurement of R, L, C, F, I, V etc.	Analyze (Level IV)
CO-3	Use of Ammeters, Voltmeter and Multimeters and CRO for measurement.	Evaluate (Level V)
CO-4	Analyze and interpret different signal generator circuits for the generation of various waveforms.	Analyze (Level IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**			**1**					**2**	**3**	**2**
CO-2	**2**	**3**	**1**	**2**			**1**					**2**	**3**	**2**
CO-3	**2**	**3**	**1**	**2**			**1**					**3**	**3**	**2**
CO-4	**2**	**3**	**1**	**2**			**1**					**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction, Theory of Performance: Performance characteristics of Instruments-Static, Performance characteristics of instruments-Dynamic, Types of Error- Problem, Types of Errors: Systematic & random errors Modeling of errors, Probable error & standard deviation, Gaussian error analysis, Combination of errors, Measuring Basic parameters: Electronic Multimeters, Electronic Voltmeter, Component Measuring Instruments, Q meter, Vector Impedance meter, RF Power & Voltage Measurements.	**12**
Module-II	Oscilloscopes: CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay, Multibeam, multi trace, storage & sampling Oscilloscopes. Curve tracers. Signal Generation: Sine wave generators, Frequency synthesized signal generators, Sweep	**12**

	frequency generators, Measurement Technique, Wave Analyzers, and Frequency - selective wave analyser, heterodyne wave analyzer, Harmonic distortion analyser, and Spectrum analyser.	
Module-III	Transducers: Classification, Selection Criteria, Characteristics, Construction, Working Principles, Application of following Transducers- RTD, Thermocouples, Thermistors. Characteristics, Construction, Working Principles of LVDT, RVDT, Strain Gauges, Bourdon Tubes, Bellows. Diaphragms, Seismic Accelerometers, Tacho generators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.	**12**
Module-IV	Medical Instrumentation: General introduction of medical instrumentation, its problems and specialty. Sensing devices for biomedical instruments: general requirements and special considerations. Diagnostic equipment: vector cardiograph, echocardiography, comparison of ECG, VCG and ECHO.	**12**

Learning Resources:

Text Books:

Title	Electronic Instrumentation
Author	H S Kalsi
Publisher	Tata McGraw Hill
Edition	3rd
Title	Modern Electronic Instrumentation and Measurement techniques
Author	W D Cooper
Publisher	Prentice Hall of India
Edition	2nd
Title	Principles of Measurement & Instrumentation
Author	Morris
Publisher	Prentice Hall of India
Edition	2nd

Reference Books:

Title	Transducers & Instrumentation
Author	D.U. S Murthy
Publisher	Prentice Hall of India
Edition	3rd

Other Suggested Readings:

List of Experiments:	Lab Experiments/ Lab Sessions
1.	Measurement of Resistance using Wheatstone Bridge.
2.	Study of Cathode Ray Oscilloscope (CRO).
3.	Measurement of Frequency and Phase measurement using Lissajous patterns.
4.	Study of Digital Storage Oscilloscope (DSO).
5.	Study LVDT as displacement transducer and observe displacement versus output voltage characteristics.
6.	Measurement of strain using a strain gauge.
7.	Measurement of unknown Inductance using Maxwell's Bridge.
8.	Measurement of unknown Capacitance using Schering Bridge.
9.	Measurement of Resistance using Kelvin double Bridge.
10.	Study LVDT as a pressure measuring transducer and observe pressure versus output voltage characteristics.
11.	Study displacement transducers using inductance observe displacement versus output voltage characteristics.
12.	Study the characteristics of temperature sensors (RTD).
13.	Study the characteristics of temperature sensors (Thermocouple).

Course Title:	**DATA STRUCTURES**
Course Code:	**CSBB 255**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Problem Solving and Computer Programming (CSBB 181)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Apply fundamental operations on data structures such as linked-lists, trees, binary search trees, AVL trees, heap trees, graphs, and hash-tables.	Apply (Level III)
CO2	Analyze and compare different sorting algorithms - Merge Sort, Quick sort, Shell sort and Bucket Sort.	Analyze (Level IV)
CO3	Identify suitable data structure and develop solution for the given problem.	Apply (Level III)
CO4	Formulate solutions for programming problems or improve existing code using algorithms such as, Backtracking, Branch and Bound, Greedy algorithm and Dynamic programming.	Apply (Level III)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	2	1	3	0	0	0	0	0	0	2	3	2
CO-2	3	3	2	2	2	0	0	0	0	0	0	2	3	2
CO-3	3	3	3	2	3	0	0	0	2	0	2	2	3	3
CO-4	3	3	3	3	2	0	0	0	2	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Dynamic aspects of operations on data, Characteristics of data structures, Creation and manipulation of data structures, Operations on data structures, Types of data structures – linear and nonlinear. Introduction to algorithm: Asymptotic notations, Analysis of algorithms: Time and Space complexity.	**12**
Module-II	Arrays and Stacks: Dynamic memory allocation, one-dimensional arrays, multidimensional arrays, operations on arrays, storage – Row major order, Column major order. Linked lists: types of linked lists – singly, doubly and circularly linked lists, operations on linked lists, Implementation of stacks– array and linked list, operations on stacks, Applications of Stacks, Notations – infix, prefix and postfix, Conversion and evaluation of arithmetic expressions using Stacks. Queues: Implementation of queues– array and linked list, operations on queues, Types of queues – queue, double ended queue and priority queue.	**12**
Module-III	Trees: Binary tree, Binary search tree, threaded binary tree, Height balanced trees, Tries, Heaps, Hash tables. Graph traversals: Breadth First Search, Depth First Search, Shortest path: Depth first search in directed and undirected graphs. Union-find data structure and	**12**

	applications. Directed acyclic graphs; topological sort.	
Module-IV	Searching: Linear search, Binary search and Hashing. Algorithms and data structures for sorting: Insertion Sort, Bubble sort, Selection Sort, Merge sort, Quick Sort, Heap sort, Radix sort, Bucket sort. Algorithm design techniques: Divide and conquer, Greedy approach, dynamic programming.	**12**

Learning Resources:

Text Books:		
1.	Title	Fundamentals of Data Structures
	Author	E. Horowitz, S. Sahni
	Publisher	Computer Science Press
	Edition	2nd Edition, 2008
2.	Title	Data Structures Using C
	Author	E. Balagurusamy
	Publisher	TATA McGraw Hill
	Edition	2013
3.	Title	Data Structure and Program Design
	Author	R.L. Kruse
	Publisher	Prentice Hall
	Edition	2nd Edition, 1996
4.	Title	Data Structures Using C
	Author	A. M. Tanenbaum, Y. Langsam, M. J. Augenstein
	Publisher	Pearson Education
	Edition	1990

List of Experiments:	**Lab Experiments/ Lab Sessions**
1.	a) write a program to find max and min elements in a 1-D array. b) write a program to create a 1-D integer array using dynamic memory allocation. Enter the values of array elements using the keyboard. Perform the following operation on it: - i) traverse the array from first to last ii) traverse the array from last to first iii) search a particular number in the array. c) write a program to create a 1-D integer array. Perform the following operations on it: - i) Insert an element at a given position ii) delete an element present at given position.
2.	a) write a program to create a 1-D array of unique integers and perform the following: - i)search a particular key value. ii) delete a particular key value. b) write a program to create a 1-D array of integers (containing repetition) and perform the following: - i) search a particular key value ii) delete a particular key value c) write a program to create a 1-D array of integers and perform bubble sort to arrange the elements in: - i) ascending order ii) descending order

3.	a) write a program for selection sort. b) write a program for insertion sort. c) write a program for merge sort. d) write a program for quick sort.
4.	a) write a program to create two matrices of size 4*4. Calculate and print the product matrix. b) write a program to create a matrix of size 5*5. Find whether it is orthogonal or not.
5.	a) write a program to create a linked list of integers entered by user and perform the following: - i) traverse the linked list and print all the elements from first to last. ii) insert a new node at the start of the linked list. Print the new linked list. iii) insert a new node at the end of the linked list. Print the new linked list. Iv) insert a new node after a node having a key value. Print the new linked list. b) write a program to create a linked list of integers entered by user and delete a node: - i) at a particular position entered by the user ii) after a node having a key value iii) before a node having a key value iv) having a key value after each deletion. Print the resultant linked list.
6.	a) write a program to print the given linked list in reverse order. b) write a program to sort the given linked list. c) write a program to create a circularly linked list of integers entered by user and insert a new node: - i) at the beginning ii) at the end after each deletion print the resultant linked list.
7.	a) write a program to create a doubly linked list of integers entered by user and traverse the list: - i) from first to last ii) from last to first b) write a program to create a doubly linked list of integers entered by user and insert a new node: - i) after a node having a key value ii) before a node having a key value c) write a program to delete a node having given value from a doubly linked list.
8.	a) write a program to implement stacks using arrays. b) write a program to implement recursion using stacks using one example each: - i) tail recursion ii) non-tail recursion iii)nested recursion iv)indirect recursion c)write a program to convert an infix expression to its equivalent postfix notation using stack. d)write a program to evaluate a postfix expression using stack. e) write a program to implement the tower of Hanoi problem using stack.
9.	- a) write a program to implement queue and its operations (insertion, deletion, and traverse) using array. b) write a program to implement the following types of dequeue using array implementation: -

	i) input restricted deque ii)output restricted deque iii)unrestricted deque c) write a program to implement the following types of dequeue using linked list implementation: - i) input restricted deque ii)output restricted deque iii)unrestricted deque
10.	write a menu driven program to create a binary search tree of elements entered by the user implement the following operations on this binary search tree: - i)insert a new node ii) search a node having a key value iii)delete a node having a key value iv)display elements in preorder v)display elements in in order vi)display elements in post order

Course Title:	**PROFESSIONAL COMMUNICATION**
Course Code:	**HMBB 251**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**Communication Skills (HMPB 102)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand and apply communication theory.	Apply (Level III)
CO-2	Critically think about communication processes and messages.	Evaluate (Level V)
CO-3	Write effectively for a variety of contexts and audiences.	Apply (Level III)
CO-4	Develop and deliver professional presentations.	Apply (Level III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1						**1**		**2**	**1**	**3**		**1**		**2**
CO-2						**1**		**2**	**1**	**3**		**1**		**2**
CO-3						**1**		**1**	**2**	**3**		**1**		**2**
CO-4						**1**		**1**	**2**	**3**		**1**		**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Theory of communication, Cycle of communication, Types of communication, Verbal and Non- verbal Communication, Oral communication, Written Communication, Body language, Paralanguage, Proxemics, Chronemics, Haptics, Flow of communication, 7Cs of communication, Barriers to communication.	**8**
Module-II	Reading Skills: Practice in reading a wide range of texts with a view to improving their reading comprehension, and also grammar and vocabulary. Reading Comprehension, reading a Novel, Note Making, Interpretation of Non-Verbal Data.	**8**
Module-III	Writing Skills: Practice in Written Communication with a view to enabling independent, original and creative writing. Construction of Sentences and Paragraphs to write the Research paper, Correspondence (letters, memos, emails, and fax), Professional Writing (Process Writing, Technical Description and Report Writing), Tips for making presentation, Curriculum Vitae etc.	**8**
Module-IV	Speaking and Listening Skills: Individual speech sounds, Stress and Intonation patterns, Personality Development Questionnaires.	**6**

Learning Resources:

Text Books:	Raman, M., & Sharma, S. (2004). Technical Communication: Principles and Practice. New Delhi: Oxford University Press. Huckin, T. N., & Olsen, L. A. (2004). Technical Writing and Professional Communication. New York: McGraw-Hill.
Reference Books	Kumar, K. Effective Communication Skills. Khanna Publishing House, Delhi. Pushplata, & Kumar, S. Communication Skills. Oxford University Press. Rizvi, M. A. Effective Technical Communication. New Delhi: McGraw Hills Education Jones, L &R. Alexander. New International Business English. UK: CUP

Lab Activities:

List of Activities:	
1.	**Communication Foundations:** Analyse the communication cycle and 7Cs through group activities. Identify common communication barriers.
2.	**Non-verbal Communication Practice:** Demonstrate and observe body language, tone, and space in interaction through video-based discussion and pair activities.
3.	**Listening Skills Workshop:** Practice active listening using short talks, conversations, and videos. Complete comprehension-based tasks.
4.	**Stress and Intonation Practice:** Practice pronunciation, word stress, sentence stress, and rising/falling intonation using audio drills.
5.	**Group Discussion Techniques:** Understand GD rules and expectations. Observe and discuss model GDs. Practice mini-rounds in subgroups.
6.	**Group Discussion – Practice:** full-length GD rounds in small groups. Peer and instructor feedback on participation and soft skills.
7.	**Role Play – Professional Contexts:** Act out real-world workplace scenarios such as client interaction, team meetings, and conflict resolution.
8.	**Extempore Speaking & Impromptu Talk:** Deliver short speeches on random topics. Focus on spontaneity, coherence, and confidence.
9.	**Mock Interviews – Round 1:** Half the class participates in mock interviews with HR-style feedback. Focus on self-introduction and Q&A.
10.	**Mock Interviews – Round 2:** Remaining students complete interview rounds. Feedback on body language, verbal clarity, and poise.
11.	**Presentation Planning & Design:** Learn structure, visual aids, and planning strategies. Draft presentations in small groups or pairs.
12.	**Presentations – Delivery 1:** First half of students deliver presentations. Peer and faculty feedback on clarity, structure, and delivery.
13.	**Presentations – Delivery 2:** Remaining students present. Feedback focuses on audience engagement and non-verbal techniques.
14.	**CV Pitch + Personality Workshop:** Present highlights of one's CV and take part in personality analysis and self-reflection tasks.

Course Title:	**MINI PROJECT**
Course Code:	**ECPB 251**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand, plan, and execute the project with team.	Apply (Level III)
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.	Evaluate (Level V)
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach	Apply (Level III)
CO-4	Communicate and report effectively project related activities and findings.	Apply (Level III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	**Description**	**Weightages**
I	Identification of Problem Domain	10
II	Study of Existing Systems and establishing clear objectives	20
III	Planning of project and work distribution within the team	30
IV	Proper Documentation and Technical Writing	25
V	Presentation and Response to questions	15

Evaluation Criteria-CO Mapping

CO / **Criteria**	**CO-1**	**CO-2**	**CO-3**	**CO-4**

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.

It is desirable that students should work on the project in group of 2 or 3 but not more than three.

After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.

At the end, students must submit the final report of the project and the format for the same will be given by the department.

The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.

The students will report to the respective guide/supervisor at every fortnight to discuss their progress.

The final evaluation of the project will be done based on the demonstration and presentation.

Semester V

Course Title:	**MICROPROCESOR AND MICROCONTROLLER**
Course Code:	**ECBB 301**
L-T-P:	**3–0–2**
Credits:	**4**
Pre-requisites:	**Digital Electronics and Logic Design (ECBB 152), Analog Electronics (ECBB 251)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Ability to analyze and develop the assembly language program for microprocessor 8085, 8086 and microcontroller 8051.	Understanding (Level - II)
CO-2	Ability to interface peripherals with Microprocessors and Microcontrollers	Applying (Level – III)
CO-3	Ability to design and create Microprocessor/Microcontroller-based system.	Analyzing (Level - IV)
CO-4	Ability to analyze architecture and develop assembly language program for ARM 32-bit processor.	Evaluating (Level –V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓		✓	✓			✓			✓	✓		✓	
CO-2			✓	✓			✓			✓		✓	✓	✓
CO-3			✓	✓		✓	✓		✓	✓			✓	
CO-4			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	8085 Architecture, Instruction set, Addressing modes, Interrupts Timing diagrams, Memory and I/O interfacing. 8086 Architecture, Instruction set and programming, Minimum and Maximum mode configurations.	**12**
Module-II	Programmable Peripheral Interface (8255), Keyboard display controller (8279), ADC0808 and DAC0808 Interface, Programmable Timer Controller (8254), Programmable interrupt controller (8259), Serial Communication Interface (8251).	**12**
Module-III	8051–Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes, Assembly language programming, I/O Ports, Timers / counters, Interrupts and serial communication. Interfacing to: matrix display, (16x2) LCD, high power devices, optical motor shaft encoder, Stepper Motor, DC Motor speed Control using PWM, RTC and EEPROM interface using I2C protocol.	**12**
Module-IV	RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, pipelining, ARM instruction Set and its Programming.	**12**

Learning Resources:

Text Books:	Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, Penram International Publishing reprint, 6th Edition, 2017
Reference Books:	1)Microprocessor and Interfacing, Programming and Hardware Douglas V. Hall, Tata McGraw Hill Revised 2nd Edition 2006, 11th reprint 2015 2)The 8051 Microcontroller and Embedded Systems Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D. McKinley Pearson Education 2nd Edition,12th impression 2018 3) Advanced Microprocessor and Peripherals A.K. Ray, K.M. Bhurchandi Tata McGraw-Hill 2nd Edition, 2010 4)Microprocessor and MicrocontrollerArchitecture, programming and system design using 8085, 8086, 8051 and 8096 Krishna Kant PHI 2007, 7th Reprint, 2015
Other Suggested Readings:	ARM System-on-Chip Architecture, Steve Furber, Pearson Education, Second

List of Experiments:	
	Assembly Language Programming of 8086: 1. Programs for 8 / 16 bit Arithmetic, Sorting, Searching and String operations. 2. Programs for Digital clock, Interfacing ADC and DAC. 3. Interfacing and programming 8279, 8259, and 8253. 4. Serial Communication between two microprocessors kits using 8251. 5. Interfacing Stepper Motor, Speed control of DC Motor 6. Parallel communication between two microprocessors kits using Mode 1 and Mode 2 of 8255. 7. Macro assembler Programming for 8086. 8051 based experiments using assembly language and C programming: 8. Programming using Arithmetic, Logical and Bit Manipulation instructions of the 8051 microcontrollers. 9. Programming and verifying Timer, Interrupts and UART operations in 8051 microcontrollers. 10. Interfacing – DAC and ADC and 8051 based temperature measurement 11. Interfacing – LED and LCD 12. Interfacing – Stepper motor and traffic light control system. 13. Communication between 8051 Microcontroller kit and PC. 14. Programming ARM processor using Embedded C.

Course Title:	**COMPUTER NETWORKS**
Course Code:	**ECBB 302**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Network Analysis and Synthesis (ECLB 202), Signals and Systems (ECBB 204)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain basic concepts, OSI reference model, services and role of each layer of OSI model and TCP/IP, networks devices and transmission media, Analog and digital data transmission. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.	Remembering (Level-I)
CO-2	Apply channel allocation, framing, error and flow control techniques. Describe the functions of the Network Layer i.e. Logical addressing, subnetting & Routing Mechanism.	Analyzing (Level IV)
CO-3	Explain the different Transport Layer functions i.e. Port addressing, Connection Management, Error control and Flow control mechanism. Explain the functions offered by session and presentation layer and their Implementation.	Creating (Level VI)
CO-4	Analyze, specify and design the topological and routing strategies for an IP-based networking infrastructure. Explain the different protocols used at the application layer, i.e. HTTP, SNMP, SMTP, FTP, TELNET and VPN.	(Evaluating (Level V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	2	1	0	0	0	1	1	2	3	3
CO-2	3	3	2	2	2	0	0	0	0	1	0	2	3	2
CO-3	2	2	2	1	2	0	0	0	0	1	0	2	2	2
CO-4	3	3	3	2	2	1	0	0	0	2	1	2	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: history and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit switched, packet switched, message switched, extranet, intranet, Internet, wired, wireless)	**12**
Module-II	Physical layer: line encoding, block encoding, scrambling, Different types of transmission media. Data Link Layer services: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.	**12**
Module-III	Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Super-netting, Classless addressing, Network Address Translation	**12**
Module-IV	Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little's formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP.	**12**

Learning Resources:

Text Books:		
1.	**Title**	Computer Networks
	Author	AS Tanenbaum, DJ Wetherall
	Publisher	Prentice-Hall
	Edition	5th Edition, 2010
Reference Books:		
1.	Title	Computer Networks: A Systems Approach
	Author	LL Peterson, BS Davie,
	Publisher	Morgan-Kauffman
	Edition	5th Edition, 2011
2.	Title	Computer Networking: A Top-Down Approach
	Author	JF Kurose, KW Ross
	Publisher	Addison-Wesley
	Edition	5th Edition, 2009
3	Title	Data Communication and Network
	Author	Behrouz A. Forouzan
	Publisher	McGraw Hill
	Edition	5th Edition, 2012
4	Title	Data and Computer Communications
	Author	William Stallings
	Publisher	Pearson
	Edition	8th Edition, 2007

S. No	List of Experiments:
1.	Study of different types of Network cables and practically implement the cross-wired cable and straight through cable using clamping tool.
2.	Study of Network Devices in Detail.
3.	Study of network IP.
4.	Connect the computers in Local Area Network.
5.	Study of basic network commands and Network configuration commands.
6.	Performing an Initial Switch Configuration
7.	Performing an Initial Router Configuration
8.	Configuring and Troubleshooting a Switched Network
9.	Connecting a Switch
10.	Configuring WEP on a Wireless Router

Course Title:	**DIGITAL COMMUNICATION**
Course Code:	**ECBB 303**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**ECLB 151 (Basic Communication System); ECBB 204 (Signal and Systems) ECBB 252 (Analog Communication)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To describe the basic building blocks of a digital communication system and understand the concept of sampling and bandwidth. Revision of Fourier series and transform concepts.	Remembering (Level - I)/Understanding (Level – II)
CO-2	To compare and contrast various line coding techniques for efficient digital data transmission and to analyze all waveform coding schemes for digital communication systems.	Analyzing (Level - IV)
CO-3	To design the digital radio receiver structure and analyze the performance of receivers in terms of probability of error in presence of noise.	Creating (Level - VI)
CO-4	To explain and discuss all binary and multilevel digital modulation techniques and evaluate the performance of these techniques in terms of bit error rate and spectral efficiency.	Understanding (Level - II)/Evaluating (Level - V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**1**	**2**
CO-2	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**3**
CO-4	**3**	**2**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction:** Introduction to Digital Communication System, Basic block diagram of system, need of digital communication, Guided and unguided transmission media, concept of bandwidth, Electromagnetic spectrum and its usage, Review of Signal representation using Fourier Series &Transform, Review of Sampling Theorem. **Probability and Random Processes:** Basic introduction, Properties of probability, Random variables, CDF & PDF of random variables, Joint CDF & PDF, Marginal Densities,	**09**

	Statistical averages, Random processes, types of random processes.	
Module-II	**Line Coding:** Basic introduction, Need and properties of line coding techniques, NRZ, RZ, Manchester encoding, Differential Manchester Encoding, AMI coding, High density bipolar code, Binary with n-zero substitution codes **Waveform Coding:** Uniform and Non-uniform Quantization, Commanding, μ- Law and A-Law compressors, Concept & Analysis of PCM, DPSM, DM & ADM Modulators and demodulators, SNR for all techniques, Probability of error for PCM & other modulation techniques.	**09**
Module-III	**Digital Modulation Schemes:** Coherent Binary Schemes: ASK, FSK, PSK, QPSK, MSK. Coherent M-ary Schemes, Incoherent schemes DPSK, Calculation of Average Probability of Error for different Modulation Schemes, Power Spectra of Digitally modulated signals, Performance comparison of different digital modulation schemes.	**09**
Module-IV	**Designing of Receivers:** Analysis of Digital receivers, Error performance degradation in radio receivers, Demodulation and Detection, Maximum Likelihood Receiver structure, Design and Properties of Matched Filter, Coherent receiver Design, Inter Symbol Interference, Eye Pattern	**09**

Learning Resources: This course provides the graduate-level introduction to understand, analyze, characterize and design the transmission and reception of digital signals along with modulation processes such as ASK, FSK, PSK & more; including the design and analysis of Matched filter.

Text Books:		
1	Title	Digital Communication
	Author	John G. Proakis
	Publisher	Tata McGraw
	Edition	4^{th}
2	Title	Communication Systems
	Author	Simon Haykins
	Publisher	John Wiley & Sons
	Reference Books:	
1	Title	Modern Digital & Analog Communication
	Author	B.P.Lathi
	Publisher	Oxford University Press
	Edition	3^{rd}
2	Title	Principles of Communication Systems
	Author	Taub Schilling
	Publisher	Tata McGraw Hill
	Edition	2^{nd}
	Other Suggested Readings:	

List of Experiments:	
1.	Write a program to generate a periodic as well as a periodic signal.
2.	Write a program to generate following line-coding techniques. a. NRZ signal b. RZ signal c. Alternate Mark Inversion d. Polar Quaternary e. Manchester coding techniques f. Write a code to generate the signal 1101001100 for all coding techniques.
3.	Write a program to generate a sample signal along with its reconstruction that is from analog to sample and then reverse.
4.	Write a program to study and calculate SNR of PCM using MATLAB
5.	Write a program to study DPCM modulation and demodulation techniques using MATLAB.
6.	Write a program to study Delta Modulation Technique using MATLAB
7.	Write a program to study Adaptive Delta Modulation techniques using MATLAB
8.	Write a program to study Amplitude Shift Keying (ASK) technique using MATLAB.
9.	Write a program to study Frequency Shift Keying (FSK) technique using MATLAB
10.	Write a program to study Phase Shift Keying (PSK) technique using MATLAB
11.	Write a program to study Differential Phase Shift Keying (DPSK) technique using MATLAB
12.	Write a program to study Quadrature Phase Shift Keying (QPSK) technique using MATLAB
13.	Write a program to study Quadrature Amplitude Modulation (QAM) technique using MATLAB
14.	Write a program to generate a periodic as well as a periodic signal.

Course Title:	**IC APPLICATIONS**
Course Code:	**ECBB 304**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Solid State Devices (ECBB 201), Network Analysis and Synthesis (ECLB 202), Analog Electronics (ECBB 251)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Study of basics of operational amplifier ideal and practical.	Understanding (Level - II)
CO-2	Application of operational amplifier.	Analyzing (Level - IV)
CO-3	Study and analysis of op-amp filters.	Evaluating (Level - V)
CO-4	Comparator, convertor circuit analysis.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	1				2				2	3	1
CO-2	2	2	1	1				1				2	2	2
CO-3	3	2	3	3				3				2	3	2
CO-4	2	3	1	2				1				2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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). Input offset voltage, input bias current, input offset current. Total output offset voltage, thermal drift, error voltage, variation of OP-AMP parameter with temperature & supply voltage. Supply voltage rejection ration (SVRR), CMRR-Measurement of OP-AMP parameters. Frequency response compensator networks. Frequency response of internally compensated OPAMP & 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.	**9**
Module-II	**OPERATIONAL AMPLIFIER CONFIGURATIONS & LINEAR APPLICATION:** 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	**9**

	converters, integrators & differentiators, logarithmic & anti logarithmic amplifiers.	
Module-III	**ACTIVE FILTERS & OSCILLATORS:** Advantages of active filters, classification of filters, response characteristics of butter worth, chebyshev, causal filters, first order and second order butter worth filter- low pass and high pass types. Band pass & band reject filters. Oscillator principles, types of oscillators – phase shift, wein bridge & quadrature. Square wave, triangular wave and saw tooth wave generators, voltage-controlled oscillator.	**9**
Module-IV	**COMPARATORS & CONVERTERS**: Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, absolute value detectors, sample and hold circuit.	**9**

Learning Resources:

Text Books		
1.	Title	OP-AMP and linear integrated circuits
	Author	Ramakant A. Gayakwad
	Publisher	Pearson
	Edition	2rd ed.
2.	Title	Design with operation amplifiers and Analog Integrated circuits
	Author	Sergei Franco
	Publisher	John Wiley and Sons
	Title	OP-AMP and linear integrated circuits
Reference Books		
1.	Title	Integrated Electronics: Analog and Digital circuits &system
	Author	Millman & Halkias
	Publisher	TMH
	Title	Integrated Electronics: Analog and Digital circuits &system

List of Experiments:	
1.	Study of OP AMPs – IC 741, IC 555, IC 565, IC 566, IC 1496 – functioning, parameters and Specifications.
2.	OP AMP Applications – Adder, Subtractor, Comparator Circuits.
3.	Integrator and Differentiator Circuits using IC 741.
4.	Active Filter Applications – LPF, HPF (first order).
5.	Active Filter Applications – BPF, Band Reject (Wideband) and Notch Filters
6.	IC 741 Oscillator Circuits – Phase Shift and Wien Bridge Oscillators.
7.	IC 555 Timer – Monostable Operation Circuit
8.	IC 555 Timer – Astable Operation Circuit
9.	Schmitt Trigger Circuits – using IC 741 and IC 555.
10.	4 bit DAC using OP AMP.

Course Title:	**SEMINAR/ SUMMER INTERNSHIP I**
Course Code:	**ECPB 301**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes	Cognitive Levels
CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:
Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:
The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Identification of Problem Domain	10
II	Study of Existing Systems and establishing clear objectives	20
III	Planning of project and work distribution within the team	30
IV	Proper Documentation and Technical Writing	25
V	Presentation and Response to questions	15

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

SEMESTER VI

Course Title:	**ANTENNAS AND WAVE PROPAGATION**
Course Code:	**ECLB 351**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electromagnetic Theory (ECLB 203), Control Theory (ECLB 205), Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Recall the concepts of Electromagnetic field theory, classify different types of antennas, illustrate antenna parameters and demonstrate the effect on antenna parameters due to changes in the physical dimensions.	Understanding (Level-II)
CO2	Compare Broadband Antennas, Frequency Independent antennas and Aperture antennas. Explain Dipole antenna and their characteristic, loop antenna	Applying (Level-III)
CO3	Design Array Antennas and identify the E and H fields for the antennas. Design Reconfigurable antenna, Active antenna, Dielectric antennas and measure radiation pattern, polarization and VSWR.	Creating (Level-VI)
CO4	Define terminology relevant to mode of propagation and examine the propagation of radio waves in different atmospheres.	Analyzing (Level-III)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	3	2	2					3			3	2
CO-2	2	3	3	2	2					3			2	2
CO-3	2	3	2	2	2					2			3	2
CO-4	2	2	3	3	3					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction:** Radiation fundamentals. Potential theory. Helmholtz integrals. Radiation from a current element. Basic antenna parameters. Radiation field of an arbitrary current distribution. Small loop antennas. Receiving antenna. Reciprocity relations. Receiving cross section, and its relation to gain. Reception of completely polarized waves. Linear antennas. Current distribution. Radiation field of a thin dipole. Folded dipole. Feeding methods. Baluns.	**9**
Module-II	**Antenna Array:** Array factorization. Array parameters. Broad side and end fire arrays. Yagi-Uda arrays Log-periodic arrays.	**9**
Module-III	**Aperture Antenna:** Fields as sources of radiation. Horn antenna Babinet's principle. Parabolic reflector antenna. Microstrip antennas.	**9**
Module-IV	**Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, tropospheric propagation, Super refraction.	**9**

Learning Resources:

Text Books		
1.	**Title**	Antennas and Radio Wave Propagation
	Author	R.E.Collin
	Publisher	McGraw – Hill
	Edition	1985
2.	**Title**	Antenna Theory and Design
	Author	W. L. Stutzman & G.A.Thiele
	Publisher	Wiley
	Title	Antennas and Radio Wave Propagation
Reference Books		
1.	**Title**	Principles of Antenna Theory
	Author	K.F.Lee
	Publisher	Wiley
	Edition	1984
2.	**Title**	Electronic Radio Engineering (4/e)
	Author	F.E. Terman
	Publisher	McGraw Hill.
	Title	Modern Antenna Handbook
3.	**Author**	C.A.Balanis,
	Publisher	Wiley India Pvt. Limited
	Title	Principles of Antenna Theory
	Author	K.F.Lee

Course Title:	**BASICS OF VLSI**
Course Code:	**ECBB 352**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Digital Electronics & Logic Design (ECBB 152), Solid State Devices (ECBB 201), Analog Electronics (ECBB 251), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand MOS transistor theory, circuit models and short channel effects.	Understanding (Level - II)
CO-2	To study and design the static and dynamic characteristics of CMOS inverter.	Analyzing (Level - IV)
CO-3	To design a combinational and sequential CMOS circuit.	Creating (Level - VI)
CO-4	To study the operation of MOS based SRAM and DRAM Cells.	Understanding (Level - II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction MOSFET, threshold voltage, current, Channel length modulation, body bias effect and short channel effects: drain-induced barrier lowering, velocity saturation, hot carrier effect, MOS switch, MOSFET capacitances, MOSFET models for calculation- Transistors and Layout, CMOS layout elements, parasitics, design rules, Lambda based design rules, layout design, SPICE simulation of MOSFET I-V characteristics. Body effect, Latch up in CMOS circuits, Scaling and its types for MOS devices	**9**
Module-II	CMOS inverter, static characteristics, noise margin, Dynamic Characteristic, Power, propagation delay equations and parameters. Static and dynamic power dissipation, energy & power delay product, pull up and pull-down concept, CMOS based gate design NAND, NOR, XOR, XNOR, Transistor sizing, BiCMOS inverter. Pseudo NMOS inverter and logic design. **Combinational MOS Logic circuits:** Static CMOS Design – Complementary CMOS, Complex logic circuits, Ratioed Logic,	**9**

	Pass-Transistor Logic, Transmission gate-based design, Logic design with transmission gate concept.	
Module-III	**Sequential circuit design:** Behaviour of Bistable element, SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, Clocked JK latch, CMOS D-Latch and Edge- Triggered Flip-Flops, Master slave DFF, dynamic CMOS design, speed and power considerations, Domino logic and its derivatives, Voltage Bootstrapping, C2MOS, NORA CMOS, Zipper CMOS circuits, TSPC registers.	**9**
Module-IV	CMOS adder design, Schmitt triggers circuit, Clocking and clock schemes, CMOS memory design-SRAM and DRAM. DRAM cell types, SRAM cell types, Overview of Power Consumption, Introduction to Low-Power Design approaches, Switching power dissipation, short circuit power dissipation, leakage power dissipation.	**9**

Learning Resources:

Text Books:	
Reference Books:	Analysis and Design of Digital Integrated Circuits David A. Hodges, Horace G. Jackson, and Resve A. Saleh McGraw-Hill Third edition, 2004. CMOS circuit design, layout, and simulation R. J. Baker, H. W. Li, and D. E. Boyce Wiley-IEEE Press 2007 CMOS Digital Integrated Circuits – Analysis & Design Sung-Mo Kang & Yusuf Leblebici Tata McGraw Hill Third edition, 2003 CMOS VLSI Design: A Circuits and Systems Perspective Neil H.E. Weste, David Harris Pearson Education 2015
Other Suggested Readings:	Digital Integrated Circuits: A Design Perspective Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic Pearson Education 2003

List of Experiments:	Suggested list
1.	To study the NMOS and PMOS Drain and Gate characteristics.
2.	To design and study the DC characteristics of resistive inverter.
3.	To design and study the transient and DC characteristics of CMOS inverter.
4.	To design and study the output characteristic of BiCMOS inverter
5.	To design and study the characteristics of CMOS NAND gate
6.	To design and study the characteristics of CMOS NOR gate.
7.	To design and study the transient characteristics of CMOS XOR gate.
8.	To design and study the transient characteristics of CMOS XNOR gate.
9.	To design and study the characteristics of CMOS based multiplexer.
10.	To design any Given Boolean function using transmission gates and CMOS logic.
11.	To design and study the characteristics of CMOS based D Flip Flop.
12.	To design and study the characteristics of Schmitt trigger circuit.
13.	To design and study the characteristics of VCO circuit.
14.	To design a given Complex function with CMOS and transmission gate concept.

Course Title:	**DIGITAL SIGNAL PROCESSING**
Course Code:	**ECBB 353**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals & Systems (ECBB 204), Analog communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Represent discrete-time signals analytically and visualize them in the time domain. Explain the basic concept of Digital Signal Processing.	Understanding (Level - II)
CO-2	To apply and implement various transforms in real-time applications.	Applying (Level - III)
CO-3	To apply the efficient computation method of discrete Fourier, transform for the real-time applications. Understand the Transform domain and its significance and problems related to computational complexity	Applying (Level – III)
CO-4	Design different types of digital filters.	Evaluating (Level - V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-2	**3**	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Digital signal processing, Overview of Typical Digital signal processing in real-world applications, Discrete time signals and sequence operations, properties. Discrete time systems, their properties, Linear time invariant systems.	**10**
Module-II	Z-transforms by summation of left, right, and two-sided sequences, Regions of convergence and Z-transform properties, Inverse Z-transform, Stability and causality, Solution of Difference Equations Using Z-transform.	**10**
Module-III	Definition of Discrete Fourier Transform (DFT) and relation to Z-transform, Properties of the DFT, Matrix Formulation of the DFT and IDFT, Linear and periodic convolution using the DFT, zero padding, spectral leakage, resolution and windowing in the DFT.	**12**

Module-IV	Structures and properties of FIR and IIR filters, IIR– Direct, parallel and cascaded realizations, FIR – Direct and cascaded realizations, Coefficient quantization effects in digital filters. Digital filter design, Finite impulse response (FIR) filters- Window design techniques, Kaiser Window design technique, Equi-ripple approximations, Infinite impulse response (IIR) filters-Bilinear transform method, Examples of bilinear transform method	**16**

Learning Resources:

Text Books:	1	Digital Signal Processing: A Computer-Based Approach
		S. K. Mitra
		McGraw-Hill
		Third edition, 2006
	2	Discrete-Time Signal Processing
		A. Oppenheim and R. Schafer
		Prentice Hall
		Second edition, 1999
	3	Schaum's Outline of Digital Signal Processing
		M. Hays
		McGraw-Hill
		1999
	4	Digital Signal Processing: Principles, Algorithms and Applications
		J. Proakis, D. Manolakis
		Prentice-Hall
		4th edition, 2006
	5	A Course in Digital Signal Processing
		B. Porat
		J. Wiley and Sons
		1996
	6	Computer-Based Exercises for Signal Processing Using MATLAB 5
		J. McClellan (Ed.)
		Prentice Hall
		1997
Reference Books:	1	Theory and Application of Digital Signal Processing
		L.R. Rabiner and B. Gold
		Phi Learning
		1st Edition, 2008
Other Suggested Readings:		NPTEL Lectures, Research papers

List of Experiments:

1. Study of Floating-Point Digital Signal Processor & Fixed-Point Digital Signal Processor.
2. Realisation of Circular & Linear Convolution and Correlation of two sequences.
3. Computation of DFT & IDFT of a given Sequence using DSP Processors.
4. Classification, denoising of real time signals.
5. Radix-2 & Radix-4 algorithm FFT Calculation using DSP Processors.
6. FIR & IIR Filter Implementation using the DSP Processors.
7. Basics of MATLAB-Realisation of Unit Impulse, Unit Step & Unit Ramp signals.
8. Linear & Circular Convolution of two Sequences, Correlation of two sequences.
9. DFT & IDFT Computation.
10. Radix-2 algorithms FFT Calculation.
11. Generation of Gaussian Distributed Numbers.

Course Title:	**PROJECT**
Course Code:	**ECPB 351**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	

Course Outcomes:

Course Outcomes	Cognitive Levels
CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:
Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Identification of Problem Domain	10
II	Study of Existing Systems and establishing clear objectives	20
III	Planning of project and work distribution within the team	30
IV	Proper Documentation and Technical Writing	25
V	Presentation and Response to questions	15

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three. After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Semester VII

Course Title:	**RF AND MICROWAVE ENGINEERING**
Course Code:	**ECBB 401**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Control Theory (ECLB 205), Analog communication (ECBB 252), Digital communication (ECBB 303), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Explain the concepts of microwave circuits and scattering parameters.	Understanding (Level - II)
CO2	Determine measurement parameters of microwave components and understand the ISM applications of Microwave Energy.	Applying (Level - III)
CO3	Analyse the behaviour of microwave sources based on solid state devices and tubes at microwave frequencies.	Applying (Level - III)
CO4	Evaluate the performance of several waveguide components and determine their responses and applications.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	3	2						2			3	2
CO-2	2	2	2	3						2			2	2
CO-3	2	3	2	2	2					3			3	2
CO-4	2	2	3	2	2					3			2	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Electromagnetic Spectrum, Introduction, characteristic, features and applications of microwaves, Microwave Region and Band Designation, Advantage of microwaves matrix: Z, Y, h, ABCD Parameters-Cascaded networks, Circuit and S parameter representation of N port microwave networks, properties of S-matrix, Reciprocity Theorem- Lossless networks and unitary conditions. Hybrid Circuits: T junctions -E plane tee, H-plane Tee, Magic tee, Directional Coupler, Application of Magic Tee, Rat Race Junction, Directional coupler, isolator, circulators. Transmission Lines: Introduction, Two wire parallel transmission lines, Voltage and Current Relationship in a Transmission Line, Characteristic Impedance, Reflection Coefficient, Transmission Coefficient, Input Impedance, Standing Waves, VSWR.	**12**
Module-II	Transit time limitations: Transit time limitations in transistors, Microwave bipolar transistors, power frequency limitations microwave field effect transistors, Gunn Effect: HEMT, Gunn Effect – RWH theory, high – field domain and modes of operation microwave amplification Differential Negative Resistance, Two-Valley Model Theory. High-Field Domain, Modes of Operation, LSA Diodes, InP Diodes, CdTe Diode, Microwave Generation and Amplification.	**12**

Module-III	Avalanche transit-time devices: Introduction, Read Diode, Physical Description, Avalanche Multiplication, Carrier Current Io(t) and External Current, Output Power and Quality Factor, IMPATT Diodes: Physical Structures, Negative Resistance, Power Output and Efficiency, TRAPATT Diodes, Physical Structures, Principles of Operation, Power Output and Efficiency, BARITT Diodes, Physical Description, Principles of Operation, Microwave Performance, Parametric Devices, Physical Structures, Nonlinear Reactance. Manley – Rowe Power Relations, Parametric Amplifiers, Applications.	**12**
Module-IV	Microwave Linear Beam Tubes: Klystrons, Reentrant Cavities, Velocity-Modulation Process, Bunching Process, Output Power and Beam Loading, State of the Art, Multicavity Klystron Amplifiers, Beam-Current Density, Output Current Output Power of Two-Cavity Klystron, Output Power of Four-Cavity Klystron, Reflex Klystrons, Velocity Modulation, Power Output and Efficiency, Electronic Admittance, Helix Traveling-Wave Tubes (TWTs), Slow-Wave structures, Amplification Process, Convection Current, Axial Electric Field, Wave Modes, Gain Consideration, Microwave Crossed-Field Tubes: Magnetron Oscillators, Cylindrical Magnetron, Coaxial Magnetron, Tunable Magnetron, Ricke diagram.	**12**

Learning Resources:

Text Books:		
1.	Title	Microwave Devices and Circuits
	Author	Samuel Y. Liao
	Publisher	Prentice Hall of India
2.	Title	Microwave Engineering
	Author	David M. Pozar
	Publisher	John Wiley & Sons
3.	Title	Foundations for Microwave Engineering
	Author	R.E. Collin
	Publisher	Wiley
Reference Books:		
1.	Title	Microwave Engineering, Passive Circuits
	Author	P.A. Rizzi
	Publisher	Prentice Hall of India

List of Experiments for RF and Microwave Laboratory:	
1.	Characteristic of the Reflex klystron tube
2.	Characteristics of Gunn diode
3.	Characteristics of Multihole Directional coupler
4.	Determination of Standing Wave Ratio and Reflection
5.	Impedance and Frequency Measurement
6.	Attenuation Measurement
7.	Time Division Multiplexing
8.	Differential Phase Shift Keying
9.	Ask Modulation & Demodulation.
List of Experiments using CST Studio Suite, comprises the following modules: -	
1.	CST MICROWAVE STUDIO® (CST MWS) is the leading-edge tool for the fast and accurate 3D simulation of high frequency devices and market leader in Time Domain

	simulation. It enables the fast and accurate analysis of antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects etc.
2.	CST EM STUDIO® (CST EMS) is an easy-to-use tool for the design and analysis of static and low frequency EM applications such as motors, sensors, actuators, transformers, and shielding enclosures.
3.	CST PARTICLE STUDIO® (CST PS) has been developed for the fully consistent
4.	Simulation of free moving charged particles. Applications include electron guns, cathode ray tubes, magnetrons, and wake fields.
5.	CST CABLE STUDIO® (CST CS) for the simulation of signal integrity and EMC/EMI
6.	Analysis of cable harnesses.
7.	CST PCB STUDIO® (CST PCBS) for the simulation of signal integrity and EMC/EMI
8.	EMI on printed circuit boards.
9.	CST MPHYSICS® STUDIO (CST MPS) for thermal and mechanical stress analysis. CST DESIGN STUDIO™ (CST DS) is a versatile tool that facilitates 3D EM/circuit co-simulation and synthesis.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Title:	**MANAGEMENT PRINCIPLES AND PRACTICES**
Course Code:	**HMLB 401**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To concepts of the management process and the functions of management.	Understanding (Level - II)
CO-2	To create an understanding of effective planning and decision-making in the organization.	Applying (Level - III)
CO-3	To understand the concept of organizational structure and the process of departmentation and decentralization	Applying (Level - III)
CO-4	To Identify the conceptual framework of leadership dynamics and illustrate communication abilities to face professional challenges.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	-	-	1	-	-	1	1	2	1	-	3	1	-	1
CO-2	-	-	1	1	-	2	-	2	1	2	3	2	1	2
CO-3	-	-	-	-	1	2	1	-	2	-	3	1	-	1
CO-4	-	-	-	-	-	1	-	3	3	3	3	2	-	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction** Management Concept and Definition, Nature of Management, Objectives of Management, Significance of Management, Managerial Roles and Managerial Skills, Management and Administration, Levels of Management, Management Process and Functions, Functional Areas of Management, Management Principles-General and Scientific Management, Evolution of Management Thought, Approaches of Management Thought	**09**
Module-II	**Planning and Decision** Planning definition and nature, Importance of Planning, Planning Process, Need for Planning, Principlesof Planning, Types of Planning, Advantages and Disadvantages of Planning; Decision making concept, Characteristics of Decision Making, Types of Decisions, Decision Making Process, Characteristics of Effective Decisions, Rationality in Decision Making.	**09**
Module-III	**Organizing** Organizing definition. Organization as a Process, Organisation Structure, Principles of Organisation, Importance of Organisation, Types of Organisations. Departmentation- Meaning, Need, and Significance of Departments, Process	**09**

	involved in Departmentation, Methods or Basis of Departmentation; Span of Management; Centralization and Decentralisation; Delegation	
Module-IV	**Directing** Directing concept, Nature and Characteristics of Directing, Principles of Directing; Motivation- Concept and Theories of motivation; Concept of Leadership- Theories and Styles; Communication Process, Channels and Barriers, Effective Communication. Coordination- Concept and Nature of Coordination, Need for coordinating; Importance, Principles and Techniques of Coordination; Process of Coordination. Controlling- Definitions, Characteristics of Controlling, Steps in Control Process, Types of Controlling, Control Techniques.	**09**

Course Objective: To understand the basic Principles of Management for working in an organizational setup efficiently and effectively.

Learning Resources:

Text Books:	**1.** Drucker, F.Peter, "Management-Tasks, Responsibilities & Practices" **2.** Dubey, C.H, "Organizational Behaviour" Prentice Hall in India (PHI) Edition 2015. **3.** Gupta C.B., "Human Resource Management "Sultan Chand & Sons., New Delhi, Edition 2006. **4.** Koontz, HandWeilhrichH, "EssentialsofManagement",10thEdition, Tata McGraw Hill
Reference Books:	**1.** Prasad, LM,"PrinciplesandPracticesofManagement",6thEdition, Sultan Chand. **2.** Robbins, StephenP, Coutler, Mary,"Management"8thEdition, Pearson. **3.** Stoner,JAF, FreemanRE, Gilbert, DR,"Management"6thEdition, Pearson

Course Title:	**SEMINAR/ SUMMER INTERNSHIP II**
Course Code:	**ECPB 402**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	**Identification of Problem Domain**	**10**
II	**Study of Existing Systems and establishing clear objectives**	**20**
III	**Planning of project and work distribution within the team**	**30**
IV	**Proper Documentation and Technical Writing**	**25**
V	**Presentation and Response to questions**	**15**

Evaluation Criteria-CO Mapping:

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Semester VIII

Course Title:	**MAJOR PROJECT**
Course Code:	**ECPB 451**
L-T-P:	**0-0-0**
Credits:	**16**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:	
CO-1	Select appropriate Hardware for project work
CO-2	Identify the appropriate software tools for design & Simulation
CO-3	Apply appropriate Hardware & Software tools to execute the project work
CO-4	Write a technical project report & develop presentation, communication skills through the project work. Develop an ability to work in a team

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	2	3	1	2	1	2		2	1	3	1
CO-2	1	2	3	1	3	1	1		3	1	3	1	3	1
CO-3	1	2	3	1	3	1	1		3	1	3	1	3	1
CO-4	1	1	1	2	1	1	2		3	2	3	1	2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.
The B.Tech. Project work will be evaluated for 100 marks, with the following weightages:

Component	**Weightages**
Periodic evaluation by Guide	40 Marks
Mid-term review	20 Marks
End Semester viva-voce examination	40 Marks
Total	100 marks

The midterm review and the end semester viva-voce examination will be conducted by a committee constituted by the Head of the Department. If the performance of a student is not satisfactory, he/ she can be awarded 'F' grade. Such a student will be given a maximum time of three months to improve his/her performance. If the performance of such a student is not satisfactory even after the extended time period, he/ she will have to repeat the project work in the next academic year.

Course Title:	**INDEPENDENT STUDY AND SEMINAR**
Course Code:	**ECPB 452**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:
Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:
The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	**Identification of Problem Domain**	**10**
II	**Study of Existing Systems and establishing clear objectives**	**20**
III	**Planning of project and work distribution within the team**	**30**
IV	**Proper Documentation and Technical Writing**	**25**
V	**Presentation and Response to questions**	**15**

Evaluation Criteria-CO Mapping:

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Elective Courses

Specialization:

Photonics and Optical Communication

Course Title:	**SEMICONDUCTOR LASER THEORY**
Course Code:	**ECLB 321**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To describe the fundamental concepts of laser operation, laser properties, and different types of the laser as well as state different laser applications.	Understanding (Level-II)
CO-2	To Define some of the terms related to the basics of laser physics	Understanding (Level - II)
CO-3	To Define some of the terms related to the basics of laser physics	Analyzing (Level-IV)
CO-4	To Identify the most important characteristics and properties of lasers and to List the most important applications of lasers in industry and medicine	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	3	1	1							2	1
CO-2	3	2	1	1	2	3							2	2
CO-3	3	2	1	1	2	3							2	2
CO-4	2	1	3	3	1	2							2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Gaussian Beams, TEM Modes, Higher Order Modes, Ray Tracing, Ray Matrices, Rays Analysis of Cavities Cavity Stability. Resonant Optical Cavities, General Cavity Concepts, Gaussian Beams in Cavities Cavity Q and Finesse Photon Lifetime, Atomic Radiation, Blackbody Radiation, Einstein's A and B Coefficients.	**09**
Module-II	Line Shape Amplification Line Broadening Laser Oscillation and Amplification, Threshold Conditions, Gain Saturation, Amplified Spontaneous Emission, General Characteristics of Lasers, CW Lasers, Dynamics Laser, Mode Locking, Saturable Absorbers.	**09**
Module-III	Laser Excitation: Three and Four Level Lasers, Rare Earth Lasers, Tunable Lasers, Semiconductor Lasers Semiconductor Theory, Review Diode Lasers, Quantum Effects.	**09**
Module-IV	Semiconductor Photon Sources: Electroluminescence: The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation. Quantum-Well lasers; DFB, DBR and vertical-cavity surface emitting lasers (VCSEL); Laser diode arrays. Device packages and handling.	**09**

Learning Resources: The course is designed to provide an understanding of the basic principles of operation of the modern diode semiconductor lasers. The course provides the opportunity for students to extend their background in semiconductor physics and theory and undertake advanced study and research in the variety of different branches of semiconductor optoelectronics.

Text Books:	**1.** Fundamentals of Photonics, B. E. A. Saleh and M. C. Teich, John Wiley &Sons, 2nd Ed. (2007). **2.** Semiconductor Optoelectronic Devices, P. Bhattacharya, Prentice Hall of India (1997). **3.** Semiconductor Optoelectronics: Physics and Technology, J. Singh, McGraw-Hill Inc. (1995).
Reference Books:	**1.** Optical Fiber Communications, G. Keiser, McGraw-Hill Inc, 3rd Ed. (2000). **2.** Photonics: Optical Electronics in Modern Communications, A. Yariv and P. Yeh, Oxford University Press, New York (2007), 6thEdition.
Other Suggested Readings:	

Course Title:	**OPTICAL FIBRE COMMUNICATION**
Course Code:	**ECLB 322**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To recognize and classify the structures of Optical fiber and types.	Remembering (Level - I)
CO-2	To discuss the channel impairments like losses and dispersion.	Understanding (Level - II)
CO-3	To analyze various coupling losses.	Analyzing (Level-IV)
CO-4	To classify the Optical sources and detectors and to discuss their principle	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	2	2	1				2		1	3	2
CO-2	3	1	3	3	2	1				2		1	3	2
CO-3	3	3	3	3	2	3				1	1	2	3	3
CO-4	3	2	3	3	2	2				2		2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Optical processes in Semiconductors, Electron hole pair formation and recombination, Absorption and emission of light in semiconductors, Effect of electric field on Absorption, Franz-Keldysh and stark effects, Absorption in Quantum wells and Quantum confined stark effect, relation between Absorption and emission spectra, Stokes shift in optical transition, Deep level transitions, Quantum Structures, Materials for working at different wavelengths.	**09**
Module-II	Principles of light propagation through a fiber, Step index and graded index, mode theory. Fibre materials and their characteristics, Transmission characteristics of fibers. Attenuation in optical fibers absorption losses, scattering losses, Dispersion. Different types of modulators. Characteristic equation of step-index fibre, modes and their cut- off frequencies, single-mode fibres, weakly guiding fibres, Graded-index fibres - WKB and other analysis, propagation constant, leaky modes, power profiles, dispersions - material, modal & waveguide dispersions,	**09**

	impulse response.	
Module-III	Optical fiber systems, modulation schemes, Digital and analog fiber communication system, system design consideration, wavelength conversion, switching and cross connect, Semiconductor Optical amplifier (SOA), characteristics, advantages and drawback of SOA , Raman amplifier, erbium doped fiber amplifier, Brillouin fiber amplifier, Noise characteristics, amplifier spontaneous emission, Noise amplifier, Noise figure. Various receiver configurations, noise sources in optical communication, nonlinear effects in fiber optics, direct detection receiver, optimum gain in APD, signal- to-noise ratio (SNR) calculations, Optimization of SNR.	**09**
Module-IV	Introduction to optical communications, Optical signaling schemes viz., IM, PL, PCM, PCM/PL, digital PPM, PRM, PFM etc., electro-optic modulators, optical preamplifier design, Optical line coding schemes, performance evaluation of various optical receivers and their comparative study, Applications of optical amplifier in the system. Optical fiber, link design- power budget, time budget and maximum link length calculation, hybrid fiber co-axial/microwave links, sub-carrier multiplexing, WDM Systems.	**09**

Learning Resources: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

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Text Books:	**1.** John. M. Senior, Optical fiber communications: principles and practice, Prentice Hall of India. **2.** Gerd Keiser, Optical fiber communications, McGraw Hill, 3rd edition. **3.** Fiber Optic Communication Systems: G.P Agrawal, Johannian and Sons
Reference Books:	**1.** Optical Fiber Communications, G. Keiser, McGraw-Hill Inc, 3rd Ed. (2000). **2.** Photonics: Optical Electronics in Modern Communications, A. Yariv and P. Yeh, Oxford University Press, New York (2007), 6thEdition.
Other Suggested Readings:	

Course Title:	**OPTICAL, ELECTRONIC & PHOTONIC PROPERTIES OF NANOSTRUCTURES**
Course Code:	**ECLB 334**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To familiarize about the various properties of nanostructures.	Remembering (Level - I)
CO-2	To bring out the differences between nano and macro structures.	Understanding (Level - II)
CO-3	To discuss applications and specific properties of nanomaterials.	Analyzing (Level-IV)
CO-4	To apply and simulate various properties like electronic, optical, and photonic properties of nanostructures	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	2	2	1				2		1	3	2
CO-2	3	1	3	3	2	1				2		1	3	2
CO-3	3	3	3	3	2	3				1	1	2	3	3
CO-4	3	2	3	3	2	2				2		2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Optical properties, Photonic crystals, optical properties of semiconductors, band edge energy, band gap, dependence on nanocrystalline size, Quantum dots, optical transitions, absorptions, Interbrand transitions, quantum confinements.	**09**
Module-II	Fluorescence/luminescence, photoluminescence/fluorescence, optically excited emission, electroluminescence, Laser emission of quantum dot, Photo fragmentation and columbic explosion, phonons in nanostructures, luminescent quantum dots for biological labeling.	**09**
Module-III	Electronic properties, Energy bands and gaps in semiconductors, Fermi surfaces, localized particle, donors, acceptors, deep traps, excitons, mobility, size dependent effects, conduction electrons and dimensionality Fermi gas and density of states, semiconducting nanoparticles.	**09**
Module-IV	Electronic Properties of Copper and Silicon (NM): Direct and reciprocal lattices of the fcc structure, Brillouin zone for the fcc structure, Copper and alloy formation, Silicon. Silicon band structure. Nanophononics: Photonic crystals, Photonic Bandgap,	**09**

	Defects in Photonic Crystals: Localization of Light, Control of Dispersion and the Slowing and Storage of Light, High-Efficiency Optical Sources, Photonic Crystal Waveguides and Fibers.	

Learning Resources: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Text Books:	Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens. Wiley India Pvt. Ltd. Solid State physics by Pillai, Wiley Eastern Ltd. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.
Reference Books:	**1.** Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books
Other Suggested Readings:	

Course Title:	**LASERS AND OPTO-ELECTRONICS**
Course Code:	**ECLB 335**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To familiarize about the various opto-electronic properties.	Remembering (Level - I)
CO-2	To bring out the basic principle of operation of semiconductor lasers.	Understanding (Level - II)
CO-3	To implement the afore-mentioned opto-electronic properties in designing the structure of semiconductor lasers.	Analyzing (Level-IV)
CO-4	To discuss applications and specific properties of semiconductor lasers.	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	2	2	1				2		1	3	2
CO-2	3	2	3	3	1	2				1		2	2	1
CO-3	2	3	2	3	3	3				1	1	2	3	3
CO-4	3	2	3	3	2	2				2		2	2	3

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Quantum Theory of Atomic Energy Levels – Radiative and Nonradiative decay of excited state atoms – Emission Broadening and linewidth – Radiation and Thermal equilibrium – Conditions for laser action – Laser Oscillation above threshold - Laser Amplifiers – Requirements for obtaining population inversion – Rate Equations for three and four level systems – Laser pumping requirements – Laser Cavity modes – Stable resonators – Gaussian beams- Special Laser Cavities – Q-switching and Mode locking – Generation of ultra-fast Optical pulses- Pulse compression.	**07**
Module-II	Atomic Gas Lasers – He-Ne, Argon ion, He-Cd — Molecular Gas Lasers – CO_2, Excimer, Nitrogen—X-Ray Plasma Laser — Free-Electron Laser — Organic Dye lasers — Solid-state lasers – Ruby, Nd: YAG, Alexandrite, Ti:Sapphire.	**07**

Module-III	Electronic and Optical properties of semiconductors- electron-hole pair formation, PN Junction, diffusion, injection efficiency, quantum efficiency, homojunction and heterojunction, Excitation absorption, donor-acceptor and impurity band absorption, LED, Semiconductor lasers, Heterojunction Lasers, quantum well lasers, VCSEL, DFB and DBR Lasers.	**07**
Module-IV	Detection of Optical radiations – Basic Principle, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs, Image Intensifiers, Arrays, Solar Cells, noise considerations.	**07**

1 - Slightly; 2 - Moderately; 3 - Substantially

Learning Resources: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

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Text Books:	Laser Fundamentals – W.T. Silfvast, Second Edition, Cambridge University Press, 2004 Principles of Lasers – O. Svelto, Fourth edition, Springer, 1998 Photonics: Optical Electronics in Modern Communications – A. Yariv and P. Yeh, Sixth Edition, Oxford University Press, 2007 Semiconductor Optoelectronic devices – Pallab Bhattacharya, Prentice Hall of India, 1995
Reference Books:	Semiconductor Optoelectronics – Jasprit Singh, Tata Mc Graw Hill, 1995 Optoelectronics - an Introduction – Wilson and Hawkes, Prentice Hall, 1998.
Other Suggested Readings:	

Course Title:	**SEMICONDUCTOR DEVICE MODELING**
Course Code:	**ECLB 371**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To describe the properties of materials and Application of semiconductor electronics.	Understanding (Level - II)
CO-2	To apply the knowledge of semiconductors to illustrate the functioning of basic electronic devices	Applying (Level - III)
CO-3	To demonstrate the switching and amplification.	Analysing (Level-IV)
CO-4	To introduce applications of the semiconductor devices.	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**3**	**2**								**2**	**2**	**2**
CO-2	**3**	**1**	**3**	**2**								**2**	**2**	**2**
CO-3	**3**	**1**	**3**	**2**								**2**	**2**	**2**
CO-4	**3**	**1**	**3**	**2**								**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Modul-I	Review of semiconductor physics: Quantum foundation, Carrier scattering, high field effects; P- N junction diode modelling: Static model, large signal model and SPICE models;	**9**
Module-II	BJT modelling: Ebers Moll, Static, large-signal, small- signal models. Gummel - Poon model. Temperature and area effects. Power BJT model, SPICE models, Limitations of GP model; Advanced Bipolar models: VBIC, HICUM and MEXTARM;	**9**
Module-III	MOS Transistors: LEVEL 1, LEVEL 2, LEVEL 3, BSIM, HISIMVEKV Models, Threshold voltage modelling. Punch through. Carrier velocity modelling. Short channel effects. Channel length modulation. Barrier lowering, Hot carrier effects. Mobility modelling, Model parameters;	**9**
Module-IV	Analytical and Numerical modelling of BJT and MOS transistors: Introduction to various simulation techniques, Noise modelling; Modelling of heterostructure devices. Semi-classical Bulk Transport – Qualitative Model. Semi-classical Bulk Transport – EM field and Transport Equations. Drift- Diffusion Transport Model – Equations, Boundary Conditions, Mobility and Generation / Recombination. Characteristic times and lengths, details of Energy band diagrams, Types of Device Models – MOSFET models.	**9**

Learning Resources:

Text Books:	1. "Introduction to Semiconductor Device Modelling" by C. Snowden, World Scientific, 1986. **2.** "Fundamentals of Carrier Transport" by M. Lundstrom Cambridge University Press, 2000.
Reference Books:	
Other Suggested Readings:	

Course Title:	**FIBRE OPTIC SENSOR AND DEVICES**
Course Code:	**ECLB 372**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To expose the students to the basic concepts of optical fibres and their properties	Understanding (Level I)
CO-2	To provide adequate knowledge about the Industrial applications of optical fibres	Analysing (Level-IV)
CO-3	To expose the students to the Laser fundamentals	Analyzing (Level-IV)
CO-4	To provide adequate knowledge about Industrial application of lasers, holography and medical applications of Lasers.	Applying (Level - III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Optical Sources and Detectors**:** Light-emitting diode: Principles, Structures, LED characteristics, Modulation of LED.	**05**
Module-II	Lasers: Principles, Laser diode structures and radiation pattern, Laser characteristics, Modulation of Semiconductor Laser. Photo detectors: Principles, Quantum efficiency, Responsitivity of P.I.N photodiode, and Avalanche photodiode.	**05**
Module-III	Optical Fiber Sensors and Devices: Overview of fibre optic sensors – advantages over conventional sensors, broadband classification. Intensity Modulated Optical Fibre Sensors: Introduction, intensity modulation through light interruption shutter/ schlieren multimode fibre optic sensors – reflective fibre optic sensors, evanescent wave fibre sensors - microbend optical fibre sensors – fibre optic refractometers, intensity modulated fibre optic thermometers, distributed sensing with fibre optics.	**11**
Module-IV	Interferometric Optical Fibre Sensors: Introduction, basic principles of interferometric optical fibre sensors, components and applications of interferometric sensors. Fused Single Mode	**15**

	Optical Fibre Couplers: Introduction, physical principles (coupling coefficient) polarization effect, experimental properties, theoretical modeling, and comparison with experiment. Single Mode All Fibre Components: Introduction, directional couplers, polarizes, polarization splitters polarization controllers, optical isolators, single mode fibre filters wavelength multiplexers and demultiplexers, switches and intensity modulators, phase and frequency modulators. Fibre Optic Sensor Multiplexing. Introduction, general topological configuration, and incoherent and coherent detection.	

Learning Resources: To familiarize about fiber optic sensor technology. To study about Optical resonators. To acquire knowledge about magnetic sensors. To know about Chemical and Biosensors. To gain knowledge about smart structures.

Text Books:	1. Fundamentals of Fibre Optics in Telecommunication and Sensor Systems, Bishnu P PAL, Wiley Eastern Ltd. (1994). **2.** Fiber Optic Sensors: Fundamentals and Applications, David A. Krohn; Trevor W. MacDougall; Alexis Mendez, 4th Edition, SPIE, 2015.
Reference Books:	1.Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition. 2. Semiconductor Device Physics and Design, Umesh K Mishra, Jasprit Singh, Springer, 2008.
Other Suggested Readings:	

List of Experiments:	
1.	P-N JUNCTION DIODE CHARACTERISTICS
2.	ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR
3.	HALF -WAVE RECTIFIER WITH AND WITHOUT FILTER
4.	FULL - WAVE RECTIFIER WITH AND WITHOUT FILTER
5.	INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR CB CONFIGURATION
6.	INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR CE CONFIGURATION
7.	FET CHARACTERISTICS
8.	h-PARAMETERS OF CB CONFIGURATION
9.	h-PARAMETERS OF CE CONFIGURATION
10.	FREQUENCY RESPONSE OF CE AMPLIFIER
11.	FREQUENCY RESPONSE OF CC AMPLIFIER
12.	FREQUENCY RESPONSE OF COMMON SOURCE FET AMPLIFIER
13.	CHARACTERISTICS OF LDR, PHOTO DIODE, PHOTO TRANSISTOR
14.	V-I CHARACTERISTICS OF LED

Course Title:	**NANO-ELECTRONICS AND NANO-PHOTONICS**
Course Code:	**ECLB 390**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To know nanoelectronics holds the capacity for mass production of high-quality nanodevices with an enormous variety of applications from computers to biosensors, from cell phone to space shuttles and from large display screens to small electronic toys.	Remember (Level I)
CO-2	To know the scaling of transistors and other devices to smaller and smaller sizes, which has provided the basis for this exponential growth, has limits, physical (size of the atoms), technological (lithography) and economic, which will be reached by nanoelectronics in the next coming decade.	Understand (Level II)
CO-3	In the near future from photonics, molecular electronics or revolutionary engineering solutions, such as departure from two-dimensional ICs on the surface of silicon wafers to three-dimensional structures. All these gigantic challenges and potential nanotechnology solutions are actively debated.	Apply (Level III)
CO-4	To develop the circuit level concepts of above electronic and opto- electronic solid devices.	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Single-electron and few-electron phenomena and devices: Tunnel junction and applications of tunneling, Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces, Metal—Insulator, Metal-Semiconductor, and Metal-Insulator-Metal Junctions	**09**
Module-II	Applications of Tunneling; Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode.	**09**
Module-III	Coulomb Blockade: Coulomb Blockade, Coulomb Blockade in a Nanocapacitor, Tunnel Junctions, Tunnel Junction Excited by a Current Source, Coulomb Blockade in a Quantum Dot Circuit.	**09**

Module-IV	The Single-Electron Transistor: The Single-Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics. Spintronics: Spintronics and Foundations of nano-photonics.	**09**

Learning Resources: This course is intended to cover basics of electronics, transistor, band structure models, nanocapacitors, coulomb blockade, single electron transistor and nanophotonics.

Text Books:	1. Solid State Electronic Devices, Ben G Streetman and S. K. Banerjee, PHI Learning Pvt Ltd, 2009, Global Edition. 2. Electronic Devices and Circuits, Christos C. Halkias, Jacob Millman, Satyabrata Jit, Tata McGraw Hill Education Pvt Ltd., 2010, 3rd Edition. 3. Semiconductor Physics and Devices, Basic Principles, Donald A. Neamen, McGraw Hill Higher Education, 3rd Edition.
Reference Books:	1. Fundmentlas of nano electronics by George W Hanson Pearson publications ,India 2008{Unit-I- IV) 2. Nanophotonics by P.N.Prasad – Springer Education series. 3. Nanotechnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer
Other Suggested Readings:	

Course Title:	**INTEGRATED OPTICS**
Course Code:	**ECLB 421**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To be able to design and analyze an integrated optic waveguide.	Remembering (Level-I)
CO-2	To understand the working of various photonic components.	Understanding (Level - II)
CO-3	To be able to choose and analyze the technology suitable for the intended device.	Applying (Level - III)
CO-4	To understand the recent developments and to apply in the practical optical networks.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Planar isotropic waveguide theory: guided and radiation modes, strip waveguides, anisotropic waveguides, end fibre, beam.	**09**
Module-II	Waveguide couplers in semiconductors, electro-optic, acousto-optic modulators &switches, integrated opto-electronic sources and detectors, integrated optic circuits and their applications, integrated optic logic devices.	**09**
Module-III	Compensating TE modes of symmetric step index planar, understanding modes, TE modes of parabolic index planar waveguide, TM modes of a symmetric step index planar waveguide, waveguide theory, and Single mode fibres.	**09**
Module-IV	Pulse dispersion in single mode fibers, strip and channel wave guides, anisotropic waveguides, segmented waveguide, electro-optic and acoustic optic waveguide devices, directional couplers, optical switch phase and amplitude modulators, filters etc., Y junction, power splitters, arrayed waveguide devices, fiber pigtailing, fabrication and integrated optical waveguides and devices, waveguide characterization, end-fire prism coupling, grating and tapered couplers, nonlinear effects in integrated optical waveguides.	**15**

Learning Resources: This course contributes aims to provide the high levels of technical competence in the field and will help the students to apply for problem-solving approaches to work challenges and make decisions using sound engineering methodologies.

Text Books:	**1.** Integrated Optics-Theory and Technology, R G Hunsperger, 6th Edition, Springer, 2009. **2.** Optical Waveguide Theory, A W Snyder and J D Love, 2nd Edition, Chapman & Hall, London, 1983.
Reference Books:	1. Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition. 2. Semiconductor Device Physics and Design, Umesh K Mishra, Jasprit Singh, Springer, 2008.
Other Suggested Readings:	

Course Title:	**OPTICAL NETWORKS**
Course Code:	**ECLB 422**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To get a basic understanding of optical components and optical node design.	Remembering (Level-I)
CO-2	To get a profound understanding of protocols applied in optical networks: MPLS-TP, GMPLS, SDN, OTN, and Ethernet PBB-TE.	Understanding (Level - II)
CO-3	To get a profound understanding and analyzing of optical switching methods and networking techniques, circuit, packet, hybrid, burst and flow	Applying (Level - III)
CO-4	To be able to design optical networks, taking both physical transmission properties and optical networking constraints into account and to be able to evaluate performance and availability of optical networks using simulation methods applying above understandings.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network, construction, broadcast and select optical WDM network, wavelength routed optical WDM network, Challenges of optical WDM network.	**07**
Module-II	Components: Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photodectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements, OADM, OXC, CLOS architecture, MEMS, wavelength	**07**

	convertors.	
Module-III	Single and multi-hop networks: Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi- hop networks: Shufflenet, De Bruijn Graph, Hypercube. Optical switching: Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self-routing, examples on OPS node architecture, optical burst switching, signaling and routing protocols for OBS networks, contention resolution in OPS networks, multicasting, implementation and application. MEMs based switching, switching with SOAs	**14**
Module-IV	Optical access networks: Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network. Optical metro network: Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, Interconnected WDM networks, and packet communication is using tunable WADM, RINGOSTAR: architecture, proxy stripping, protect oration and network lifetime.	**08**

Learning Resources: To introduce the students to various optical fiber modes, configurations and various signal degradation factors associated with optical fiber.

Text Books:	**1.** Optical Networks, R. Ramaswami and K. Sivarajan, Â Morgan Kaufmann Publishers, 2002, 2nd Edition. **2.** Optical Switching Networks, Mayer & Martin, Cambridge University Press, 2008, 2nd Edition.
Reference Books:	1.Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition. 2. Semiconductor Device Physics and Design, Umesh K Mishra, Jasprit Singh, Springer, 2008.
Other Suggested Readings:	

Course Title:	**NON-LINEAR FIBRE OPTICS**
Course Code:	**ECLB 423**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To demonstrate a detailed physical and mathematical understanding of a variety of systems and processes in a range of advanced topics in physics.	Remembering (Level-I)
CO-2	To understand and apply the concepts and theories of a range of advanced topics in physics.	Understanding (Level - II)
CO-3	To analyze specialized analytical skills and techniques necessary to carry out advanced calculations in a range of advanced topics in physics.	Applying (Level - III)
CO-4	To approach and solve new problems in a range of advanced topics in physics. Further to understand the close relationship between scientific research and the development of new knowledge in a global context.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction - Nonlinear Refraction - Maxwell's Equations - Fiber Modes - Eigen value Equations - Single Mode Condition - Nonlinear Pulse Propagation - Higher Order Nonlinear Effects. Gaussian Pulse - Chirped Gaussian Pulse - Higher Order Dispersions - Changes in Pulse Shape	**08**
Module-II	Self-Phase Modulation (SPM) induced Spectral Broadening - Non-linear Phase Shift - Effect of Group Velocity Dispersion - Self Steepening - Application of SPM- Cross Phase Modulation (XPM) - Coupling between Waves of Different Frequencies - Non-linear Birefringence - Optical Kerr Effect - Pulse Shaping.	**10**
Module-III	Soliton Characteristics - Soliton Stability - Dark Solitons – Other kinds of Solitons-Effect of Birefringence in Solitons - Solitons based Fiber Optic Communication System (Qualitative treatment) – Demerits - Dispersion Managed Solitons (DMS).	**12**

	Non-linear Fiber Loop Mirrors - Soliton Lasers - Fiber Raman Lasers - Fiber Raman Amplifiers - Fiber Raman Solitons - Erbium doped fiber amplifiers.	
Module-IV	DMS for single channel transmission – WDM transmission - Fiber Gratings- Fiber Couplers – Fiber Interferometers – Pulse Compression–Soliton Switching – Soliton light wave systems.	**06**

Learning Resources: The major objective of this course is to present the underlying physical concepts and mechanisms of miscellaneous nonlinear optical phenomena.

Text Books:	**1.** Nonlinear Fiber Optics, Govind P. Agrawal, Academic Press, New York, 1995, 2nd Edition.
Reference Books:	1.Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition. 2. Semiconductor Device Physics and Design, Umesh K Mishra, Jasprit Singh, Springer, 2008.
Other Suggested Readings:	

Course Title:	**ADVANCED OPTICAL COMMUNICATION SYSTEMS**
Course Code:	**ECLB 424**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201), Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the basic concepts and advantages of fibre optics communication. To understand the concept and conditions for light guidance.	Remembering (Level-I)
CO-2	To calculate pulse spread in optical fibre and use it to calculate the bandwidth and data rate of an optical fibre link. To be able to solve the wave equation and apply it in the analysis of symmetric slab waveguide	Understanding (Level - II)
CO-3	To know the origin of fibre optics losses, including intrinsic and extrinsic loss and know how to calculate link losses.	Applying (Level - III)
CO-4	To design a basic optical fibre link and then to apply in designing various optical amplifiers, WDM systems and Soliton systems.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to optical communication systems, Signal Propagation in Optical Fibre, optical fibre principle, classification of fibres, fibre modes and related definitions, optical fibre as a waveguide and different waveguide equations. Attenuation and Dispersion.	**08**
Module-II	Loss and band width windows, various losses in optical fibres, dispersion effects, intermodal, chromatic, waveguide dispersions, dispersion compensation and shifted fibres. Fibre Non-Linear effects, Effective length and area, SBS and SRS effects, self-phase modulation, SPM induced chirp for Gaussian pulses, cross – phase modulation, four wave mixing, introduction to soliton and photonic crystal	**10**

	fibres.	
Module-III	Optical Components, Couplers, isolators, multiplexers and filters, optical amplifiers, wavelength converters, optical Transmitters and Detectors, LEDs, lasers, Tunable lasers, photo detectors, switch.	**06**
Module-IV	Modulation and Demodulation, Modulation, sub carrier modulation and multiplexing schemes, different modulation formats, spectral efficiency, demodulation, bit error rate and noise effects in receivers, coherent detection, errors and detection, cross talk. Power launches and Coupling, Source to fibre power launching, LED coupling to fibres, fibre splicing, and optical fibre connectors. Optical Networks, Client layers, SONET/ SDH, transport network, Ethernet, IP, protocols, WDM network elements.	**12**

Learning Resources: This course aims to present the state of the art in optical communication systems, either digital or analog.

Text Books:	**1.** Optical Networks – A Practical Perspective, R. Ramaswami, K. N. Sivarajan and G. H. Sasaki, Elsevier, 2010, 3rd Edition. **2.** Optical Fibre Communications, G. Keiser, Tata McGraw Hill, 2000, 3rd Edition.
Reference Books:	**1.** Semiconductor Devices - Basic principles, Jasprit Singh, John Wiely & Sons, 2001, 2nd Edition **2.** Fibre-Optic Communication Systems, G. P. Agarwal, John Wiley and Sons. Inc, 3rd Edition.
Other Suggested Readings:	

Course Title:	**PHOTONIC MATERIALS AND DEVICES COMMUNICATION**
Course Code:	**ECLB 447**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Electronics and Electrical Engineering (ECBB 101), Engineering Physics (PHBB 101), Solid State Devices (ECBB 201), Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To Develop an understanding of photonic components and optical fiber technology.	Remembering and Understanding (Level – I & II)
CO-2	To Classify the material system/technologies along with their fabrication processes to design efficient photonic devices for communication.	Analyzing (Level-IV)
CO-3	To Design and analyze different types of Photonic/Nano-photonic devices and components.	Applying (Level - III)
CO-4	Analytically evaluate the various photonic devices.	Evaluating (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1									2	1
CO-2	3	2	1	1									2	2
CO-3	3	1	2	1									2	2
CO-4	2	3	1	1									2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basics of Photonics, Optical fibers and Communication: Photonics, integrated photonics and their brief history, Basic photonic technologies and components, Brief introduction to Maxwell's equations, wave equation, Electromagnetic waves at different dielectric interfaces. Overview of Optical fibers, types (step-index and graded index), single-mode and multimode along with their condition, birefringent fiber, numerical aperture, Optical fiber communications, Dispersion and scattering losses in fiber, budget analysis.	**09**
Module-II	Optical waveguides and Photonic Devices: Optical waveguides classification, Guided modes in optical waveguides, Dispersion of guided modes, Single-mode 3-D optical waveguides. Basic integrated-optic devices: Optical power splitter, Directional coupler, thermo-optic	**09**

	switches, Mach-Zehnder interferometer, Arrayed Waveguide Grating (AWG)-based MUX/DEMUX, Add-drop multiplexer, Design of photonic devices: Beam Propagation Method and Marcatili's Method.	
Module-III	Fundamental of Nano-Photonic Devices and Components: Nano-photonics: Photonic crystal (PhC) technology, PhC waveguide, PhC resonator, PhC MUX/DEMUX, PhC Filters, PhC fibers, Nano-wires, Packaging of photonic devices. Recent studies on PhC based devices for communication applications.	**09**
Module-IV	Photonic Materials and Fabrication Technologies: Photonic materials, selection of materials like silicon, silica, Lithium Niobate, Compound Semiconductor and Polymers. Fabrication and process techniques like Lithography, Deposition, and Diffusion etc. Parameter measurement and techniques, recent studies on photonic materials.	**09**

Learning Resources: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Text Books:	1. Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000. 2. John M. Senior, Optical Fiber Communications, 2nd Edition, PHI, 2002. 3. H Nishihara, M Haruna and T Suhara, Optical integrated Circuits, McGraw-hill, 1989.
Reference Books:	**3.** C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003. **4.** D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005.
Other Suggested Readings:	

Specialization:
Circuit Design and Networks

Course Title:	**ANALYTICAL AND COMPUTATIONAL TECHNIQUES IN ELECTROMAGNETICS**
Course Code:	**ECLB-323**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electromagnetic Theory (ECLB 203), Signals and Systems (ECBB 204)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To understand the basic concept of electromagnetic field.	Understanding (Level - II)
CO2	To solve the complex integral problems for practical applications in electromagnetic fields	Applying (Level – III)
CO3	To understand the Computational techniques for electromagnetic fields.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**
CO-2	**1**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-3	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Complex Variables: Cauchy's integral theorem, Fourier transforms integrals with singularity, Singularity extraction technique, Branch point integrals. Saddle point, Stationary phase method for evaluation of radiation integrals.	**12**
Module-II	Special Functions: Bessel functions, Fresnel integrals, etc. Theorem.	**10**
Module-III	Computational Techniques: Classification based on integral and differential equation solution, time domain and frequency domain solutions. Introduction to Finite-difference, FDTD, finite element techniques in electromagnetics with applications.	**14**

Learning Resources:

Text Books:	Analytical and Computational Methods in Electromagnetics
	Ramesh Garg
	Boston, MA: Artech House
	2008
	Analytical Techniques in Electromagnetics
	Matthew N. O. Sadiku, Sudarshan R. Nelatury
	CRC Press
	2015
Other Suggested Readings:	NPTEL Lectures, Research papers

Course Title:	**DETECTION AND ESTIMATION THEORY**
Course Code:	**ECLB 324**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Linear Algebra and Complex Analysis (MALB 151)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To Acquire basics of statistical decision theory used for signal detection and estimation.	Understanding (Level - II)
CO-2	To formulate hypothesis for a given problem.	Applying (Level - III)
CO-3	Examine the detection of deterministic and random signals using statistical models.	Analyzing (Level - IV)
CO-4	Apply the techniques of detection and estimation for real life applications.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**1**				**1**					**1**	**3**	**2**
CO-2	**1**	**3**	**2**	**1**			**1**					**1**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**	**2**		**1**					**2**	**3**	**2**
CO-4	**1**	**1**	**2**	**3**	**1**		**1**					**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Representations and models for random processes, Probability Spaces, Random variables, distribution and density functions, expectation, conditional probability, Bayes theorem, General Gaussian models. Hypothesis testing: Binary hypothesis testing, MAP criteria, bayes risk, Neyman- Pearson theorem, multiple hypothesis tests, Performance of Binary Receivers in AWGN, Sequential Detection and Performance.	**08**
Module-II	Signal detection with random parameters: Detection of known signals in noise, Matched filter, Performance evaluations, Composite Hypothesis Testing, Unknown Phase, Unknown Amplitude, Unknown Frequency, White and Colored Gaussian Noise for Continuous Signals, Estimator Correlator.Detection of multiple hypotheses: Bayes Criterion, MAP Criterion, M-ary Detection Using Other Criteria, Signal-Space Representations, Performance of M- ary Detection Systems, Sequential	**09**

	Detection of Multiple Hypotheses, Linear models, Rayleigh fading sinusoid.	
Module-III	Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems. Properties of estimators: Unbiasedness, efficiency, Criteria for good estimators, Minimum variance unbiased estimation, Cramer-Rao lower bound, asymptotic properties.	**08**
Module-IV	Parameter estimation: Random parameter, Bayes estimation, Mean square error (MSE), linear minimum mean-square estimates, linear square estimation, Maximum Likelihood Estimation, Least Square Estimation, Generalized Likelihood Ratio Test, Linear minimum variance estimator, BLUE. Applications: Detection and Estimation in Non-Gaussian Noise Systems, Characterization of Impulsive Noise, Detector Structures in Non-Gaussian Noise,Selected Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters.	**11**

Learning Resources:

Text Books:

Title	Detection, Estimation, and Modulation Theory, Part I
Author	Harry L. Van Trees
Publisher	John Wiley & Sons, Inc.
Edition	2001
Title	Fundamentals of Statistical signal processing, volume-1: Estimation theory
Author	Steven M. kay
Publisher	Prentice Hall
Edition	1993
Title	Fundamentals of Statistical signal processing, volume-2: Detection theory
Author	Steven M. kay
Publisher	Prentice Hall
Edition	1993

Course Title:	**INFORMATION THEORY AND CODING**
Course Code:	ECLB 373
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Perform information theoretic analysis of communication system.	Understanding (Level - II)
CO-2	Design a data compression scheme using suitable source coding technique.	Applying (Level – III)
CO-3	Design a channel coding scheme for a communication system.	Analyzing (Level - IV)
CO-4	Apply error control techniques in communication networks.	Evaluating (Level –V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**3**	**2**	**1**								**1**	**3**	**2**
CO-2	**1**	**2**	**3**	**1**	**1**							**2**	**3**	**2**
CO-3	**1**	**2**	**3**	**2**	**1**	**1**			**1**	**1**		**2**	**3**	**2**
CO-4	**1**	**2**	**2**	**3**	**1**	**1**			**1**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Modul-I	Information: Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding, Joint and conditional entropies, Mutual information, Discrete memoryless channels, BSC, BEC Channel capacity, Shannon limit. SOURCE CODING: Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I, II, III, Dolby AC3 - Speech: Channel Vocoder.	**09**
Module-II	Linear Predictive Coding SOURCE CODING: Image and Video Formats: GIF, TIFF, SIF, CIF, QCIF. Image compression: READ, JPEG, Video Compression: Principles I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard.	**09**
Module-III	ERROR CONTROL CODING: BLOCK CODES: Definitions and Principles: Hamming weight, Hamming distance, Minimum	**09**

	distance decoding, Single parity codes, Hamming codes, Repetition codes, Linear block codes, Cyclic codes, Syndrome calculation.	
Module-IV	Encoder and decoder– CRC ERROR CONTROL CODING: Convolutional codes code tree, trellis, state diagram, Encoding, Decoding: Sequential search and Viterbi algorithm, Principle of Turbo coding.	**09**

Learning Resources:

Text Books:	1:Title	Information Theory, Coding and Cryptography
	Author	R Bose
	Publisher	TMH
	Edition	2007
	2:Title	Multidedia Communications: Applications, Networks, Protocols and Standards
	Author	Fred Halsall
	Publisher	Perason Education Asia
	Edition	2002
	3:Title	Introduction to Data Compression
	Author	K Sayood
	Publisher	Elsevier
Reference Books:	1:Title	Introduction to Error Control Codes
	Author	S Gravano
	Publisher	Oxford University Press
	Edition	2007
Other Suggested Readings:	1: Code, S., 1963. Information theory and coding." 2: Yeung, R.W., 2008. *Information theory and network coding*. Springer Science & Business Media.	

Course Title:	**COMMUNICATION NETWORKS**
Course Code:	**ECLB 374**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Network Analysis and Synthesis (ECLB 202)**

Course Outcomes:

CO1	To Understand the Role of Queuing Theory Concepts in Communication Networks.	Understanding (Level II)
CO2	To Review the basic Networking Concepts and various design issues related to Data Link Layer	Understanding (Level II)
CO3	To analyse the role of various layers of ISO/OSI model and TCP/IP networks	Applying (Level III)
CO4	To analyze the Objectives and methods of Control of Networks and routing optimization for network scenario	Analyzing (Level IV)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	2	2	0	0	0	0	1	0	2	2	2
CO-2	3	3	2	2	2	0	0	0	0	1	1	2	3	2
CO-3	3	3	2	2	2	0	0	0	0	2	1	2	3	3
CO-4	3	3	3	2	2	1	0	0	0	2	1	2	3	3

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Queuing Theory: Discrete/continuous state and discrete/continuous parameter RP- independent RP– renewal process –Poisson and exponential processes – Markov process – birth-death process. Discrete and continuous parameter Markov chains– transition probabilities, limiting distributions – theory of M/M/1 and M/M/m queues – Little's theorem	**08**
Module-II	Review of Networking Concepts: Packet switched Networks: OSI and IP models, Ethernet (IEEE 802.3), token ring (IEEE802.5), fiber distributed data interface (FDDI), distributed-queue dual-bus (DQDB), Frame Relay and switched multimegabit data service (SMDS).	**06**
Module-III	Internet and TCP/IP networks: Internet protocol, IPV4, Algorithms, Multicast IP, Mobile IP, IPV6, TCP and UDP, FTP, performance of TCP/IP Networks. Circuit switched networks, SONET Frame structure -PON, PPL, Hybrid scheme, Intelligent network, Architecture, CATV, layered network, services. ATM Network: ATM network, features, addressing, signaling, routing, ATM header structure, ATM adaptation layer (AAL), management and control, BISDN, internetworking with ATM. Optical	**12**

	networks, WDM systems, and cross connects optical LAN, Optical paths and Networks.	
Module-IV	Control of Networks: Objectives and methods of control, Circuit switched networks, blocking, routing optimizations, Datagram networks, queuing models for delay analysis, routing optimization, congestion control, ATM networks, deterministic and statistical procedures, comparison, Control of networks, theory of Markov chains and queues, analysis of circuit switched networks, datagram networks and ATM networks.	**10**

Learning Resources:

Text Books:		
1.	Title	High Performance Communication Network
	Author	Jean Walrand & PravinVaraiya
	Publisher	Elsevier
	Edition	
2 2.	Title	Data Communication and Networking
	Author	Behrouz. a. Forouzan
	Publisher	Tata McGraw Hill
	Edition	

Course Title:	**RF COMPONENTS AND CIRCUIT DESIGN**
Course Code:	**ECLB 425**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Network Analysis and Synthesis (ECLB 202), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To study the operation and device characteristics of RF active components.	Remembering (Level-I)
CO2	To understand the operation of Oscillators and mixers used in RF design	Understanding (Level - II)
CO3	To discuss analysis of filters and amplifiers.	Applying (Level - III)
CO4	To design and analyse RF transistor amplifier.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	3	2					3			3	2
CO-2	3	3	2	2	3					2			2	3
CO-3	2	3		2	2					3			3	2
CO-4	2	3	2	3	2					2			2	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Importance of radiofrequency design, Dimensions and units, frequency spectrum. RF behavior of passive components: High frequency resistors, capacitors and inductors. Chip components and Circuit board considerations: Chip resistors, chip capacitors, surface mounted inductors. Transmission Line Analysis: Two-wire lines, Coaxial lines and Microstrip lines. Equivalent circuit representation, Basic laws, Circuit parameters for a parallel plate transmission line. General Transmission Line Equation: Kirchhoff voltage and current law representations, Traveling voltage and current waves, general impedance definition, Lossless transmission line model. Microstrip Transmission Lines. VSWR, Open circuit transmission line, Quarter wave transmission line.	**10**
Module-II	Sourced and Loaded Transmission Line: Phasor representation of source, Power considerations for a transmission line, input impedance matching, return loss and insertion loss. The Smith Chart: Reflection coefficient in Phasor form, Normalized Impedance equation, Parametric reflection coefficient equation, graphical	**8**

	representation, Impedance transformation for general load, Standing wave ratio, Special transformation conditions. Admittance Transformations: Parametric admittance equation, Additional graphical displays.	
Module-III	Parallel and series Connections: Parallel connections of R and L connections, Parallel connections of R and C connections, Series connections of R and L connections, Series connections of R and C connections, Example of a T Network. RF Filter Design: Filter types and parameters, Low pass filter, High pass filter, Bandpass and Bandstop filter, Insertion Loss.	**5**
Module-IV	Filter Implementation: Unit Elements, Kuroda's Identities and Examples of Micros trip Filter Design. Coupled Filters: Odd and Even Mode Excitation, Bandpass Filter Design, Cascading bandpass filter elements, Design examples. Active RF Components: Semiconductor Basics: Physical properties of semiconductors, PN- Junction, Schottky contact. Bipolar-Junction Transistors: Construction, Functionality, Temperature behaviour, Limiting values.	**10**

Learning Resources:

Text Books:		
1.	Title	Detection, Estimation, and Modulation Theory, Part I
	Author	Harry L. Van Trees
	Publisher	John Wiley & Sons, Inc.
	Edition	2001
2.	Title	RF Circuit Design
	Author	Christopher Bowick
	Publisher	Newnes
	Edition	2nd

Course Title:	**ANALOG AND MIXED SIGNAL IC DESIGN**
Course Code:	**ECLB 426**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Electronics (ECBB 251), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To study the basic building blocks of the Analog device.	Remembering (Level-I)
CO-2	Differentiate Analog, Digital and Mixed Signal CMOS Integrated Circuits.	Understanding (Level - II)
CO-3	To design and analyse the single stage MOS Amplifiers.	Applying (Level - III)
CO-4	Study and Design the Operational Amplifiers.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1								2	1	1
CO-2	2	2	1	1								1	2	1
CO-3	3	3	3	3								2	3	2
CO-4	2	3	1	2								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Concepts of Analog Design - General consideration of MOS devices – MOS I/V Characteristics – Second order effects – MOS device models. Common source stage- Source follower- Common gate stage- Cascode stage. Single ended and differential operation- Basic Differential pair- Common mode response-Differential pair with MOS loads- Gilbert Cell.	**12**
Module-II	CURRENT MIRRORS, AMPLIFIERS AND FEEDBACK Basic Concepts – Basic current mirrors- Cascode current mirrors- Active current mirrors large and small signal analysis- Common mode properties. Feedback- General Consideration of feedback circuits- Feedback topologies- Effect of loading- Effect of feedback on Noise.	**12**
Module-III	General considerations- Miller Effect and Association of Poles with Nodes, Common source stage- Source followers- Common gate stage- Cascode stage- Differential pair. Noise Statistical characteristics of noise- Types of noise.	**12**
Module-IV	General Considerations- One and Two Stage Op Amps- Gain Boosting- Comparison Common mode feedback- Input range limitations- Slew rate- Power Supply Rejection- Noise in Op Amps- General consideration of stability and frequency compensation- Multipole system- Phase margin- Frequency compensation- Compensation of two stage op Amps Other compensation techniques	**12**

Learning Resources:

Text Books:		
1.	Title	CMOS Analog Circuit Design
	Author	P. E. Allen and D. R. Holberg
	Publisher	Oxford University Press
	Edition	2004
2.	Title	"Design of Analog CMOS Integrated Circuits",
	Author	Behzad Razavi,
	Publisher	Tata McGraw Hill,
	Edition	2001
Reference Books:		
1.	Title	CMOS Circuit Design, Layout, and Simulation
	Author	R. J. Baker, H. W. Li, D. E. Boyce
	Publisher	PHI
	Edition	2002

Course Title:	**ARCHITECTURAL DESIGN OF ICS**
Course Code:	**ECLB 427**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Electronics (ECBB 251), IC Applications (ECLB 304), Basics of VLSI (ECBB 352)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To study the basic algorithmic design flow.	Understanding (Level - II)
CO-2	To analyse the trade-off between algorithm and architecture.	Applying (Level - III)
CO-3	To synthesise different architectures.	Analysing (Level-IV)
CO-4	To apply in the practical design of ASIC & ASISP.	Evaluating (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	2	1			1					2	2	1
CO-2	1	2	1	2			1					1	2	1
CO-3	3	3	3	3			3					2	3	2
CO-4	2	3	1	2			2					2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: VLSI Design flow, general design methodologies; Mapping algorithms into Architectures: Signal flow graph, data dependences, data path synthesis, control structures, critical path and worst-case timing analysis, concept of hierarchical system design;	**08**
Module-II	Data path element: Data path design philosophies, fast adder, multiplier, driver etc., data path optimization, application specific combinatorial and sequential circuit design, CORDIC unit;Pipeline and parallel architectures: Architecture for real time systems, latency and throughput related issues, clocking strategy, power conscious structures, array architectures.	**12**
Module-III	Control strategies: Hardware implementation of various control structures, micro programmed control techniques, VLIW architecture; Testable architecture: Controllability and Observability, boundary scan and other such techniques, identifying fault locations, self-reconfigurable fault tolerant structures.	**08**

Module-IV	Trade off issues: Optimization with regard to speed, area and power, asynchronous and low power system design, ASIC (application specific integrated circuits) and ASISP (application specific instruction set processors) design.	**08**

Learning Resources:

Text Books:	
Title	Digital Integrated Circuits: A Design Perspective
Author	J. Rabaey, A. Chandrakasan and B. Nikolic
Publisher	Prentice Hall
Edition	Second Edition, 2003.
Title	VLSI Array Processors
Author	S. Y. Kung
Publisher	Prentice, Prentice-Hall, 1988.

Specialization: Microprocessor and VLSI

Course Title:	**ANALOG VLSI CIRCUITS**
Course Code:	**ECLB 325**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Electronics (ECBB 251), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understanding the MOS Operation and small signal models.	Understanding (Level-II)
CO-2	To analyze single stage amplifiers with different loads.	Analyzing (Level-IV)
CO-3	To design single and differential CMOS amplifiers	Creating (Level-VI)
CO-4	Understanding the role of feedback in amplifier	Understanding (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**2**	**1**	**2**								**2**	**3**	**2**
CO-2	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-3	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-4	**3**	**3**	**3**	**2**								**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, MOSFET basics, Device Structure and Operation, General Considerations, MOS I/V Characteristics, Finite Output Resistance in Saturation, Transconductance, Second Order effects: body effect, Channel length modulation, Subthreshold conduction, MOS small signal models, SPICE, Short Channel Effects: DIBL, velocity saturation, hot carrier, impact ionization, surface scattering.	**9**
Module-II	Amplifiers: Basic concepts, Single Stage Amplifiers: Basic Concepts, Common Source Stage: resistive load, diode connected load, current source load, triode load, source degeneration. Source Follower, Common Gate Stage, Cascode Stage. Folded cascode. Differential Amplifiers: Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell.	**9**
Module-III	Basic current mirrors, Cascode current mirrors, Active current mirrors with large and small signal analysis, Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage), loading effect analysis, Negative feedback, Stability of negative feedback systems, Stability and	**9**

	frequency compensation. Frequency Response of Amplifiers: Amplifier transfer function, General Considerations, Miller Effect, Common Source Stage, Source Followers, Common Gate Stage.	
Module-IV	Design of the CMOS operational amplifiers: One-stage opamps and two- stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier, common mode feedback (CMFB) amplifier, Input Range limitations, Slew Rate, Power Supply Rejection, VCO Circuit design, OTA design.	**9**

Learning Resources:

Text Books:	Behzad Razavi, Design of Analog CMOS Integrated Circuits Phillip Allen and Douglas R. Holberg, CMOS Analog Circuit Design
Reference Books:	Yannis Tsividis, Operation and Modelling of the MOS Transistor
Other Suggested Readings:	

Course Title:	**DIGITAL VLSI CIRCUITS**
Course Code:	**ECLB 326**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital Electronics and Logic Design (ECBB 152), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Interpret the design of digital integrated circuits, MOS fundamentals and analysis of MOSFET based digital circuits.	Understanding (Level-II)
CO-2	Design and study the MOS inverters and combinational circuits,	Applying (Level-III)
CO-3	Design the CMOS based sequential circuit, dynamic logic circuits and MOS memories.	Creating (Level-VI)
CO-4	To understand the VLSI design flow and design styles.	Understanding (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**2**	**3**	**2**	**2**								**2**	**3**	**2**
CO-3	**2**	**3**	**2**	**2**								**2**	**3**	**2**
CO-4	**2**	**3**	**3**	**2**								**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Basic principle of MOS transistor, Introduction to large signal MOS models (long channel) for digital design. MOS Circuit Layout & Simulation and manufacturing: scaling, MOS SPICE model and simulation, CMOS layout: design rules, Transistor layout, Inverter layout, NMOS and CMOS basic manufacturing steps. CMOS latch-up and its prevention.	**9**
Module-II	The MOS Inverter: Inverter principle, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, switching characteristics, Propagation Delay, Power Consumption. Combinational MOS Logic Design: Static MOS design, Ratioed logic, Pass Transistor logic, complex logic circuits. CMOS Transmission Gates, Complementary Pass Transistor Logic,	**9**

	Transistor sizing in static CMOS, logical effort, Pass-transistor logic, sizing issues.	
Module-III	Sequential Logic Circuits: Introduction, Static Latches and Registers, Dynamic Latches and registers, Pipelining. Timing issues in Digital Circuits: Timing classification of digital systems, Synchronous Design Timing basics, clock skew, clock jitter and their combine impact. Dynamic Logic Circuits: Voltage Bootstrapping, Synchronous Dynamic Logic, Dynamic CMOS Logic, High Performance Dynamic CMOS Circuits, Domino CMOS logic, NP-Domino Logic, Zipper CMOS Circuits, TSPC Dynamic CMOS.	**9**
Module-IV	VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concepts of Regularity, Modularity and Locality, VLSI Design Styles. CMOS Subsystem design: Adders,Multipliers, MOS memories: Introduction, DRAM and SRAM.	**9**

Learning Resources:

Text Books:	Sung-Mo Kang, Yusuf Leblebici CMOS Digital Integrated Circuits J.M Rabaey, A. Chandrakasan, B.Nikolic, Digital Integrated Circuits: A Design Perspective
Reference Books:	J. P. Uyemura, Introduction to VLSI Circuits and Systems
Other Suggested Readings:	

Course Title:	**DSP PROCESSORS AND ARCHITECTURE**
Course Code:	**ECLB 375**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Acquire the knowledge & concepts of digital signal processing techniques.	Understanding (Level - II)
CO-2	Acquire knowledge of DSP architecture or processor	Understanding (Level - II)
CO-3	Develop basic DSP algorithms using DSP processors	Applying (Level – III)
CO-4	Compare various DSP processors and their architecture.	Evaluating (Level –V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**1**									**1**	**3**	**2**
CO-2	**1**	**3**	**2**									**2**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**					**1**	**1**		**2**	**3**	**2**
CO-4	**1**	**2**	**2**	**3**	**1**				**1**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Digital Signal Processing: Review of a digital signal-processing system, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time Invariant Systems, Digital filters IIR and FIR, Decimation and interpolation. Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP implementations, ADC and DAC conversion errors, DSP computational errors, and Compensating filter.	**08**
Module-II	Architectures for Programmable DSP Devices: Basic Architectural features, DSP computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation unit, Programmability and program execution, Speed issues, Features for external interfacing. Execution Control and Pipelining: Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, Pipeline Programming models.	**08**

Module-III	Programmable Digital Signal Processors: Commercial DSP Devices, Data Addressing modes of TMS320C54XX, DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX Processors. Implementations of Basic DSP Algorithms: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum.	**11**
Module-IV	Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA), A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC-DSP interface example.	**09**

Learning Resources:

Text Books:	1:Title	Avtar Singh and S. Srinivasan
	Author	Digital Signal Processing
	Publisher	Thomson Publications
	Edition	2004
	2:Title	DSP Processor Fundamentals, Architectures & Features
	Author	Lapsley et al
	Publisher	S. Chand & Co
	Edition	2000
Reference Books:	1:Title	Digital Signal Processors, Architecture, Programming and Applications
	Author	B. VenkataRamani and M. Bhaskar
	Publisher	TMH
	Edition	2000
Other Suggested Readings:	1: Eyre, J. and Bier, J., 2002. DSP processors hit the mainstream. *Computer*, *31*(8), pp.51-59. 2: Boddie, J.R., Daryanani, G.T., Eldumiati, I.I., Gadenz, R.N., Thompson, J.S. and Walters, S.M., 1981. Digital signal processor: Architecture and performance. *The Bell System Technical Journal*, *60*(7), pp.1449-1462.	

Course Title:	**REAL TIME EMBEDDED SYSTEM**
Course Code:	**ECLB 376**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Ability to design and develop ARM processor-based systems.	Understanding (Level - II)
CO-2	Ability to comprehend and appreciate the significance and role of microcontrollers in embedded systems.	Applying (Level – III)
CO-3	Ability to analyze and demonstrate program design and optimization and proper process scheduling.	Analyzing (Level - IV)
CO-4	Ability to apply the concept of process, multi-processes and operating systems in embedded system design.	Evaluating (Level –V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**3**	**2**	**1**					**1**	**1**		**1**	**3**	**2**
CO-2	**2**	**3**	**2**	**1**	**1**				**1**	**1**		**1**	**3**	**2**
CO-3	**1**	**2**	**3**	**2**	**1**				**2**	**2**		**2**	**3**	**2**
CO-4	**1**	**2**	**2**	**3**	**1**				**2**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS** Complex systems and microprocessors – Embedded system design process – Formalism for system design– Design example: Model train controller- ARM Processor Fundamentals Instruction Set and Programming using ARM Processor.	**09**
Module-II	**COMPUTING PLATFORM** CPU: Programming input and output – Supervisor mode, exception and traps – Coprocessor – Memory system mechanism – CPU performance – CPU power consumption- CPU buses – Memory devices – I/O devices – Component interfacing- System Level Performance Analysis Parallelism. Design Example: Data Compressor.	**09**

Module-III	**PROGRAM DESIGN AND ANALYSIS** Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions.	**09**
Module-IV	**PROCESS AND OPERATING SYSTEM** Multiple tasks and Multi processes – Processes – Context Switching – Operating Systems – Priority-based Scheduling- RMS and EDF - Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes.	**09**

Learning Resources:

Text Books:	1:Title	Computers as Components - Principles of Embedded Computing System Design
	Author	Wayne Wolf
	Publisher	Morgan Kaufmann Publisher (An imprint of Elsevier)
	Edition	3rd Edition, 2008.
	2:Title	ARM System Developer's Guide- Designing and Optimizing System Software
	Author	Andrew N Sloss, Dominic Symes, Chris Wright
	Publisher	Elsevier/Morgan Kaufmann Publisher
	Edition	2008
Reference Books:	1:Title	*Real-time embedded systems.*
	Author	Wang, J.
	Publisher	John Wiley & Sons.
	Edition	2017
Other Suggested Readings:	1: Li, Q. and Yao, C., 2003. Real-time concepts for embedded systems. CRC press. 2: Stankovic, J.A., 1996. Real-time and embedded systems. ACM Computing Surveys (CSUR), 28(1), pp.205-208.	

Course Title:	**ADVANCED MICROCONTROLLERS**
Course Code:	**ECLB 428**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Ability to discriminate RISC and CISC processors, and work with PIC microcontrollers	Understanding (Level - II)
CO-2	Ability to work with the 16-bit microcontroller RL78 and design microcontroller-based systems for a Real-world application.	Applying (Level - III)
CO-3	Gaining design knowledge and concepts on the MSP430 family of microcontrollers.	Understanding (Level - II)
CO-4	Ability to design real-time systems by deploying the Interfacing peripherals.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**3**	**1**	**1**					**1**	**1**		**1**	**3**	**2**
CO-2	**1**	**3**	**2**	**1**	**1**				**1**	**1**		**1**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**	**1**				**1**	**2**		**2**	**3**	**2**
CO-4	**1**	**2**	**2**	**3**	**1**				**2**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**INTRODUCTION TO RISC AND CISC PROFESSOR 10** Advanced RISC microcontrollers, PIC18xx microcontroller family, Architecture, Instruction set, ROM, RAM, Timer programming, Serial port programming, Interrupt programming, ADC and DAC interfacing, CCP module and programming. RL78 16 BIT Microcontroller architecture, addressing modes, on-chip memory, ADC, interrupts, MAC unit, Barrel shifter, internal and external clock generation, memory CRC, on-chip debug function and self-programming.	**10**
Module-II	**MSP430 16-BIT MICROCONTROLLER** The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x. Low power aspects of MSP430: low power modes, active Vs standby current consumption, FRAM vs. flash for low power and reliability	**10**
Module-III	**PROGRAMMING AND PERIPHERAL INTERFACE USING MSP430 FAMILIES**	**08**

	Memory-mapped peripherals, I/O pin multiplexing, Timers, RTC, watchdog timer, PWM control, Analog interfacing and data acquisition, DMA, programming with the above internal peripherals using optimal power consumption. Case study: Remote control of air conditioner and home appliances.	
Module-IV	**COMMUNICATION INTERFACE USING MSP 430 MICROCONTROLLER** Serial and parallel communication, synchronous and asynchronous interfaces, Implementing and programming of UART, I2C and SPI protocol. wireless connectivity: NFC, Zigbee, Bluetooth and WiFi. MSP430 development tools. Case study: Implementing WiFi connectivity in smart electric meter.	**09**

Learning Resources:

Text Books:	1:Title	Creating fast, Responsive and energy efficient Embedded systems using the Renesas RL78 microcontroller
	Author	Alaxander G, James M. Conard
	Publisher	Micrium press, USA, Reprinted by S.P Printers
	Edition	2011
	2:Title	PIC Microcontroller and Embedded Systems
	Author	Muhammad Ali Mazidi, Rolind D. Mckinlay and Danny Causey
	Publisher	Pearson Education
	Edition	2008
Reference Books:	1:Title	MSP 430 Micro controller basics
	Author	John H. Davies
	Publisher	Elsevier
	Edition	2008
Other Suggested Readings:	1: Ibrahim, D., 2011. Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC 18F Series. Newnes. 2: Bai, Y. and Roth, Z.S., 2018. Classical and modern controls with microcontrollers: design, implementation and applications. Springer.	

Course Title:	**ANALOG AND MIXED SIGNAL IC DESIGN**
Course Code:	**ECLB 429**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Electronics (ECBB 251), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To study the basic building blocks of the Analog device	Understanding (Level - II)
CO-2	To analyse the characteristics of distinct devices.	Applying (Level - III)
CO-3	To design and analyse the behaviour of analog amplifiers.	Understanding (Level - II)
CO-4	To understand the working A/D & D/A Converter and to apply in the practical Mixed signal IC.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1								2	1	1
CO-2	2	2	1	1								1	2	1
CO-3	3	3	3	3								2	3	2
CO-4	2	3	1	2								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Analog IC Design, The Design Flow of Analog ICs, MOSFET Parameters, MOSFET models, MOS Diode, MOS Capacitors, MOS Switch, Noise in MOSFETs, MOS Current sources and current sink circuits, Voltage and Current reference circuits, MOS Gain stages, Source Followers, Amplifiers.	**9**
Module-II	Differential Amplifiers, Operation Amplifiers, Stability Theory and Compensation in CMOS Operational Amplifiers, Op-amp Design Techniques and practical consideration in design of op-amp, High Performance.	**9**
Module-III	CMOS Op-amp Design, Design of MOS Comparators, Data Converter Fundamentals, Digital-to-analog Converters, Analog-to-Digital Converters, Switch Capacitor Filters, Mismatch Issues in Analog Layouts, Phase locked loops, Introduction to RF IC Design.	**9**
Module-IV	General Considerations- Sampling switches- Switched Capacitor Amplifiers- Switched Capacitor Integrator- Switched Capacitor Common mode feedback. Phase Locked Loops Simple PLL-Charge pump PLLs - Non ideal Effects in PLLs- Delay locked loops- its applications.	**9**

Learning Resources:

Text Books:		
1.	Title	CMOS Analog Circuit Design
	Author	P. E. Allen and D. R. Holberg
	Publisher	Oxford University Press
	Edition	2004
2.	Title	Analog MOS Integrated Circuits for Signal Processing
	Author	R. Gregorian and G. C. Temes
	Publisher	John Wiley and Sons
	Edition	2004
Reference Books:		
1.	Title	CMOS Circuit Design, Layout, and Simulation
	Author	R. J. Baker, H. W. Li, D. E. Boyce
	Publisher	PHI
	Edition	2002

Course Title:	**VLSI INTERCONNECTS**
Course Code:	**ECLB 430**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**IC Applications (ECLB 304), Basics of VLSI (ECBB 352)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the basic interconnect parameters and its model.	Understanding (Level - II)
CO-2	To study different scaling issues in interconnects.	Applying (Level - III)
CO-3	To analyse theoretical and device level modelling of crosstalk.	Understanding (Level - II)
CO-4	To learn and repeat design methods and various advance interconnect techniques	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	2	2	3								2	1	1
CO-2	1	2	1	3								1	2	1
CO-3	3	3	3	3								2	3	2
CO-4	2	3	1	2								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Moore's law, Technological trends, Interconnect scaling, 3D interconnect view; Interconnect Parameters: Resistance, Inductance, and Capacitance, skin effect and its influence on resistance and inductance Interconnect RC Delays**:** Elmore Delay Calculation. Interconnect Models: The lumped RC Model, the distributed RC Model, the transmission line model. SPICE Wire Models: Distributed RC lines in SPICE, Transmission line models in SPICE.	**9**
Module-II	Scaling issues in interconnects: Gate and Interconnect Delay; CMOS Repeater: The Static Behavior- Switching Threshold, Noise Margins, The Dynamic Behavior- Computing the capacitances, Propagation Delay: First order Analysis, Propagation Delay from a Design perspective, Power, energy and Energy-Delay- Dynamic Power Consumption, Static Consumption, Analyzing Power Consumption using SPICE.	**9**
Module-III	Repeater Design: Driving Interconnects for Optimum speed and power; Short channel model of CMOS Repeater - Transient Analysis of an RC loaded CMOS repeater, Delay	**9**

	Analysis, Analytical power expressions: Dynamic power, Short circuit Power, Resistive Power Dissipation, CMOS Repeater insertion: Analytical expressions for delay and power of a repeater chain driving an RC load.	
Module-IV	Advanced Interconnect Techniques: Reduced-swing Circuits, Current-mode Transmission Techniques Crosstalk: Theoretical basis and circuit level modeling of crosstalk, Energy dissipation due to crosstalk: Model for energy calculation of two coupled lines. Contribution of driver and interconnect to dissipated energy, Crosstalk effects in logic VLSI circuits: Static circuits, Dynamic circuits and various remedies.	**9**

Learning Resources:

Text Books:	
Title	Analysis and Design of Digital Integrated Circuits– A design Perspective
Author	Jan M. Rabaey
Publisher	Tata Mc-Graw Hill (TMH)
Edition	2nd Edition 2003
Title	Interconnection Noise in VLSI Circuits
Author	F. Moll, M. Roca
Publisher	Kluwer Academic Publishers
Edition	
Reference Book:	
Title	Introduction to VLSI Circuits and Systems
Author	John P. Uymera,
Publisher	Wiley Student Edition
Title	CMOS Digital Integrated Circuits-Analysis and Design
Author	S.M. Kang and L. Yusuf
Publisher	Tata Mc-Graw Hill (TMH)
Edition	3rd Edition

Specialization:

RF and Microwave Engineering

Course Title:	**TELECOMMUNICATION SWITCHING AND NETWORKS**
Course Code:	**ECLB 327**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Network Analysis and Synthesis (ECLB 202), Analog Communication (ECBB 251)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Will be familiar with the basics of switching techniques and signaling.	Understand (Level II)
CO2	Analyze basic telecommunication traffic theory.	Analyze (Level IV)
CO3	Will be able to evaluate of probability of blocking for various switching networks.	Evaluate (Level V)
CO4	Apply different protocols to build a perfect communication network	Analyze (Level IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**2**	**2**	**1**	**1**					**2**			**3**	**2**
CO-2	**2**	**2**	**2**	**2**	**3**					**2**			**2**	**2**
CO-3	**2**	**3**	**2**	**2**	**3**					**2**			**3**	**2**
CO-4	**2**	**2**	**2**	**3**	**3**					**3**			**2**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basic Switching System, Simple Tele-Phone Communication, Telephone Transmitter, Telephone receiver, Telephone's bell &dialer pulsing mechanism, subscribers telephone sets, dialing types, signaling tones.	**07**
Module-II	Introduction to Electromagnetic Exchanges, Basic line circuits in telephony and telegraphy; long-haul communication circuits; statistical bandwidth sharing, principles of traffic switching.	**10**
Module-III	Crossbar switches; switching system hierarchy, SPC switching, basic call processing, Level l, 2 & 3 controls, interface controller, network control processor, central processor, single stage and multi-stage switching network, principles of large-scale, switch design. Space Division Switching Stored Programme Control – Centralized SPC, Distributed SPC, Software Architecture, Application Software – Enhanced Services, Multi Stage Switching Networks.	**10**
Module-IV	Basic terminologies: BHCA, BHCR, CCR, CCS, CM, Erlang, Grade	**08**

	of Service and Blocking Probability - Telephone Networks, Subscriber Loops, Switching Hierarchy and Routing, Signaling Techniques: In Channel, Common Channel. Transmission media, Markov process, birth death process, Erlang formulas, Queuing theory. Time Division space switching, Time Division Time Switching, Time multiplexed space switching, Time multiplexed Time Switching, Combination Switching.	

Learning Resources:

Text Books:

Title	Telecommunication Switching Systems and Networks
Author	Thiagarajan Viswanathan,
Publisher	PHI
Edition	2011
Title	Telecommunication system
Author	Roger L. Freeman
Publisher	Prentice Hall

Reference Books:

Title	Wireless Mobile Communication
Author	Theodore S. Rappaport
Publisher	Pearson
Edition	3rd
Title	RF Circuit Design
Author	R. Ludwig and P. Bretchko

Course Title:	**ANTENNA FOR WIRELESS COMMUNICATION SYSTEMS**
Course Code:	**ECLB 328**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECBB 204), Network Analysis and Synthesis (ECLB 202), Analog Communication (ECBB 251)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Determine the type and appropriate model of fading and diversity for wireless medium and determine the transceiver design of multi-antenna systems.	Understanding (Level-II)
CO2	Describe and differentiate capacity of non-coherent MIMO channels.	Applying (Level-III)
CO3	Analysis of patch antenna and different antenna parameters.	Analysing (Level-IV)
CO4	Understanding the functioning of different antennas system for wireless communication.	Understanding (Level-II)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	3	2					3			2	3
CO-2	2	3	3	3	2					3			2	2
CO-3	2	2	3	2	2					2			3	3
CO-4	2	3	3	2	2					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications	**9**
Module-II	Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels –Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.	**9**
Module-III	Patch antenna, microstrip array. Gain directivity, impedance, polarization and radiation pattern measurements.	**9**
Module-IV	Spatial processing for wireless systems: Vector channel impulse response & the spatial signature. Spatial processing receivers, fixed beam forming networks, switched beam systems, Adaptive antenna systems, Wide band smart antennas, Digital radio receiver & software radio for smart antennas. Non-coherent & coherent CDMA spatial processors, spatial processing rake receiver, Multi-user spatial processing, dynamic resectoring, downlink beam forming for CDMA.	**9**

Learning Resources:

Text Books:		
1.	Title	Antenna Theory Analysis and Design
	Author	Balanis A
	Publisher	ohn Wiley and Sons
	Edition	2004
2.	Title	Antenna theory
	Author	Collin R.E. and Zucker F.
	Publisher	Tata Mc Graw Hill
	Edition	2001
3.	Title	Coding for MIMO Communication system
	Author	Tolga M. Duman and Ali Ghrayeb
	Publisher	John Wiley & Sons
	Edition	2007
Reference Books:		
	Author	A.B. Gershman and N.D. Sidiropoulus
	Publisher	Wiley, Hoboken
	Edition	2005

Course Title:	**RADIO AND MICROWAVE WIRELESS SYSTEM**
Course Code:	**ECLB 377**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECBB 204), Network Analysis and Synthesis (ECLB 202), Analog Communication (ECBB 251), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand the concept of radio wave in wireless network.	Understanding (Level-II)
CO2	Understanding the concept of EM radiation and familiar with different antenna parameters.	Understanding (Level-II)
CO3	Discuss the phenomena of radio wave propagation in different conditions.	Analysing (Level-IV)
CO4	Discuss and evaluate the radio receiver architectures and its characteristics and understand the feature of terrestrial communication systems	Evaluating (Level-V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	2	2					3			2	2
CO-2	3	2	3	3	2					3			3	2
CO-3	2	2	3	3	2					2			2	3
CO-4	2	2	2	3	2					2			2	2

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Analysis and design of systems employing radio waves, covering both the underlying electromagnetic and the overall system performance aspects such as signal-to-noise ratios. Antennas	**9**
Module-II	Transmission/reception phenomena include: electromagnetic wave radiation and polarization; elementary and linear dipoles; directivity, gain, efficiency; integrated, phased-array and aperture antennas; beam-steering; Friis transmission formulas.	**9**
Module-III	Propagation phenomena include: diffraction and wave propagation over obstacles; multipath propagation; atmospheric and ionospheric effects.	**9**
Module-IV	Receiver design aspects include: radio receiver architectures, receiver figures of merit, noise in cascaded systems, noise figure, and noise temperature. System examples are: terrestrial communication systems; satellite communications; radar; radiometric receivers; software-defined systems.	**9**

Learning Resources:

Text Books:		
1.	Title	Microwave and RF Design of Wireless Systems
	Author	D. M. Pozar
	Publisher	Wiley
	Edition	2000
2.	Title	Radiowave Propagation: Physics and Applications
	Author	C. A. Lewis, J. T. Johnson, and F. L. Texeira
	Publisher	Wiley 2010
Reference Books:		
3.	Title	Field and Wave Electromagnetics
	Author	D. Cheng
	Publisher	Addison-Wesley
	Edition	1989

Course Title:	**RF INTEGRATED CIRCUITS**
Course Code:	**ECLB 431**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 251), Digital Communication (ECBB 303), Antena and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand the basic Characteristics of passive IC components at RF frequencies	Understanding (Level - II)
CO2	To design RF High frequency and low noise amplifiers	Applying (Level - III)
CO3	To design of RF power amplifiers, oscillator and synthesizer.	Applying (Level - III)
CO4	To study the RF power amplifiers, oscillator and synthesizer applications.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	3	2	2					2			3	2
CO-2	2	2	2	3	2					2			2	2
CO-3	2	2	2		2								2	2
CO-4	2	2	2	2	2								2	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Characteristics of passive IC components at RF frequencies: Interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components	**9**
Module-II	High frequency amplifier design: Zeros as bandwidth enhancers, shunt-series amplifier, fT doublers, and neutralization and unilateralization Low noise amplifier **design**: LNA topologies, power constrained noise optimization, linearity and large signal performance. Mixers: Nonlinear systems as linear mixers, multiplier-based mixers, subsampling mixers, diode-ring mixers	**9**
Module-III	RF power amplifiers: Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, design and linearity considerations.	**9**
Module-IV	Oscillators & synthesizers: Basic topologies, VCO, describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.	**9**

Learning Resources:

Text Books:		
1.	Title	The Design of CMOS Radio-Frequency Integrated Circuits
	Author	Thomas H. Lee
	Publisher	Cambridge, UK: Cambridge University
	Edition	2rd ed. (2004)
2.	Title	RF Microelectronics
	Author	BehzadRazavi
	Publisher	Prentice Hall
Reference Books:		
3.	Title	Integrated Circuits for Wireless Communications
	Author	A.A. Abidi, P.R. Gray, and R.G. Meyer
	Publisher	IEEE Press
	Edition	1999
4.	Title	RF Circuit Design
	Author	R. Ludwig and P. Bretchko
	Publisher	Pearson
	Edition	2000

Course Title:	**MICROWAVE DEVICES AND CIRCUITS**
Course Code:	**ECLB 432**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 251), Digital Communication (ECBB 303), Antena and Wave Propagation (ECLB 351), RF and Microwave Engineering (ECBB 401)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand the significance microwaves and microwave transmission lines.	Understanding (Level - II)
CO2	Design waveguide and micro strip transmission lines with given characteristics.	Applying (Level - III)
CO3	Analysis & design passive microwave components such as directional couplers, power dividers / Combiner and etc, with given characteristics	Analyzing (Level-IV)
CO4	Analysis the behaviour and evaluate the performance of the microwave components using Scattering matrix theory.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	3	2	2					2			3	3
CO-2	3	2	2	2	3					3			2	3
CO-3	2	2	2	2	3					3			2	3
CO-4	3	2	3	2	3					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction on Microwaves Frequency allocations and frequency plans, Microwave waveguide, rectangular waveguide and its analysis, circular waveguide, modes of propagation, dominant modes, cut off wavelength, mode excitation. Microwave generators and amplifiers Limitations of conventional tubes at microwave frequency, reflex klystron, two and multi cavity klystron amplifiers and oscillators and their analysis, Basics on Magnetrons and traveling wave tube and their applications.	**9**
Module-II	Microwave devices Scattering matrix of microwave waveguide junction, properties of S- matrix, E-plane tee, Hplane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators	**9**
Module-III	Gunn diode and its modes of operation, Avalanche IMPATT diode, TRAPATT diode, operations and V-I characteristics of	**9**

	Tunnel diode, Schottky diode, Backward diode and Varactor diodes, PIN diode and its applications.	
Module-IV	Micro-Strip Lines Introduction on Micro strip lines, characteristic impedance of micro strip lines, losses in micro strip lines, quality factor of micro strip, parallel strip lines, coplanar strip lines and shielded strip lines Microwave Link Microwave radio station, microwave transmitter and receiver, multiplexing equipment, microwave link.	**9**

Learning Resources:

Text Books:		
1.	Title	Microwave Devices and Circuits
	Author	Samuel Y Liao.
	Publisher	Pearson Pub.
	Edition	3rd
2.	Title	Microwave Engg
	Author	David M. Pozar
	Publisher	John Wiley and Sons
	Edition	3rd
Reference Books:		
1.	Title	Foundations for Microwave Engineering
	Author	R E. Collins
	Publisher	International student edition
	Edition	2008

Course Title:	**RF AND MICROWAVE NETWORKS**
Course Code:	**ECLB 433**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 251), Digital Communication (ECBB 303), Antena and Wave Propagation (ECLB 351), RF and Microwave Engineering (ECBB 401)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand and analyse transmission line lumped element circuits and waveguide.	Remembering (Level-I)
CO2	To apply S-parameters and smith chart for the design of passive circuits.	Understanding (Level - II)
CO3	To analyse the applications and limitations of microwave tube Generators and Amplifiers.	Applying (Level - III)
CO4	To evaluate and synthesize applications and limitations of microwave Semiconductor devices.	Analyzing (Level-IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	3	2	2					3			2	2
CO-2	2	3	2	3	3					3			2	3
CO-3	2	2	3	2	2					2			2	3
CO-4	2	3	2	2	2					2			3	2

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Microwave Circuits: One port junction, Terminal voltages and currents in multi-port junctions, Poynting's energy theorem, Normalized waves and scattering matrix, Properties of [S] matrix, Wave amplitude transmission matrix [A], Impedance matching techniques: Quarter-wave and Tapered line Impedance transformers, Two Port Networks analysis with Transmission matrices, S-Parameter and signal flow graphs	**9**
Module-II	Microwave Waveguide Components: Microwave junctions, Bends, Scattering matrix E and H plane tee junctions, Magic-T, Applications of Magic-T, Microwave propagation in ferrites, Principles of Faraday rotation, Gyrator, Isolator and Circulator. Waveguide Components, Mode transducers, Waveguide discontinuities, Terminations, Attenuators and Phase shifters, Rotary joints, Mechanical and gas type switches.	**9**

Module-III	Microwave Passive Components: Wave meters, Attenuators, Directional coupler, scattering matrix of directional couplers, Coaxial and Strip line components: Terminations, Connectors and Transitions, Attenuators and phase shifters, Transmission line discontinuations, DC Returns and blocks, Low pass filters, MICS.	**9**
Module-IV	Microwave Resonators and Filters: Review of resonant circuits, Principles of microwave resonators, Field analysis of cavity resonators, Narrow band microwave filters, Wideband microwave filters, some applications, Introduction to YIG filter, Scattering matrix of two- port gyrator networks.	**9**

Learning Resources:

Text Books:		
1.	Title	Foundations of Microwave Engg
	Author	R.E. Collins
	Publisher	Tata McGraw Hill Publication.
2.	Title	Microwave Engineering, Passive Circuits
	Author	P.A. Rizzi
	Publisher	Prentice Hall of India

Specialization:
Embedded System Design

Course Title:	**LOW POWER DEVICES AND SYSTEMS**
Course Code:	**ECLB 329**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the importance of low power design.	Remembering (Level - I)
CO-2	To study the various source of power consumption in CMOS circuits.	Understanding (Level - II)
CO-3	To apply the techniques to reduce the power dissipation in CMOS circuits.	Applying (Level - III)
CO-4	To analyse the circuit with probabilistic power technique.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**2**	**1**	**1**							**1**	**1**	**2**
CO-2	**3**	**1**	**2**	**1**	**3**							**1**	**1**	**2**
CO-3	**3**	**1**	**2**	**1**	**1**							**1**	**1**	**2**
CO-4	**3**	**1**	**2**	**1**	**1**							**1**	**1**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Motivation for low power VLSI design, Sources of power dissipation in Digital Integrated circuits. Emerging Low power approaches. Dynamic dissipation in CMOS, Effect of supply voltage and Threshold voltage, Impact of technology Scaling, Technology & Device innovation. Circuit Techniques for low power design: techniques for leakage power reduction. Low- Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance.	**9**
Module-II	SPICE circuit simulation, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.	**9**
Module-III	Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Logic level: Gate	**9**

	reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. Energy Recovery CMOS: energy dissipation in transistor channel using RC model, adiabatic dynamic logic circuit. Low-Voltage Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of RAM, Memory Cell.	
Module-IV	Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS (MTCMOS) approach Power gating Transistor stacking Dual-Vt assignment approach (DTCMOS), Architectural Level Approach –Pipelining and Parallel Processing Approaches	**9**

Learning Resources:

Text Books:	1. "CMOS Digital Integrated Circuits" by Sung Mo Kang, Yusuf Leblebici, Tata McGraw Hill, 2nd edition, 2003. 2. "Principles of CMOS VLSI Design" by Neil H. E. Weste and K. Eshraghian, Addison Wesley (Indian reprint). 2nd Edition
Reference Books:	"Low Power VLSI CMOS Circuit Design" by A. Bellamour, and M. I. Elmasri, Kluwer Academic Press, 1995
Other Suggested Readings:	

Course Title:	**FPGA BASED PHYSICAL DESIGN**
Course Code:	**ECLB 378**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the programmable logic devices and their architecture	Remembering (Level - I)
CO-2	To study the field programmable Gate array logics and their architecture.	Understanding (Level - II)
CO-3	To analyze SRAM Programmable FPGAs.	Applying (Level - III)
CO-4	To examine Anti-Fuse Programmed FPGAs.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	2	1	1							1	1	2
CO-2	3	1	2	1	1							1	1	2
CO-3	3	1	2	1	1							1	1	2
CO-4	3	1	2	1	1							1	1	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Programmable Logic Devices: Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex, Programmable Logic Devices – Architecture of Xilinx Cool Runner XCR3064XL CPLD.	**9**
Module-II	Field Programmable Gate Arrays: Organization of FPGAs, FPGA Programming Technologies, and Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.	**9**
Module-III	SRAM Programmable FPGAs: Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 andXC4000 Architectures.	**9**
Module-IV	Anti-Fuse Programmed FPGAs: Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3Architectures.Basic concept, Digital Design and FPGA, Permanently Programmed FPGA.s, Architecture of FPGA fabrics, Logic implementation of FPGA Architecture.	**9**

Learning Resources:

Text Books:	1. **"**Field Programmable Gate Array Technology" by Stephen M. Trimberger, Springer International Edition. **2.** "Digital Systems Design" by Charles H. Roth Jr, Lizy Kurian John, Cengage Learning, 2008
Reference Books:	
Other Suggested Readings:	

Course Title:	**MICRO FABRICATION TECHNOLOGY**
Course Code:	**ECLB 434**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain different basic fabrication techniques of crystal growth.	Remembering (Level - I)
CO-2	Explain the processes of different types of device fabrication.	Understanding (Level - II)
CO-3	Design various ICs, testing and their packaging.	Applying (Level - III)
CO-4	Evaluate and Apply appropriate IC fabrication process for a given problem.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**1**	**2**	**1**		**1**						**1**	**2**	**2**
CO-2	**1**	**1**	**2**	**1**		**1**						**1**	**2**	**2**
CO-3	**1**	**1**	**2**	**1**		**1**						**1**	**2**	**2**
CO-4	**1**	**1**	**2**	**1**		**1**						**1**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Silicon crystal growth and wafer preparation. Electronic grade silicon, theory of crystal growing, Czochralski technique, Testing, measurements of parameters of crystals and its characteristics, cleaning and processing considerations.	**9**
Module-II	Crystal growth for device applications epitaxial growth, Oxidation, Doping techniques: diffusion, ion implantation. Deposited thin films: polysilicon, silicon dioxide, silicon nitride, metals, Metallization and contacts, Lithography: optical, electron beam, X-ray. Etching techniques: wet chemical, dry plasma, Defects and Contamination.	**9**
Module-III	NMOS, PMOS process, control of threshold voltage, Silicon gate technology, isolation and wells. Self-aligned MOSFET structure, Short channel MOS structures, Twin well CMOS process, Monolithic resistors and capacitors. NPN, PNP fabrication, power transistors, P-N junction isolation, dielectric isolation, Integrated diodes, Resistors and capacitors, BiCMOS fabrication in an n-well process.	**9**

Module-IV	Introduction to GaAs technology, doping process, energy band structure. Advantages of IC and Types of IC, Fabrication of Monolithic and Hybrid IC, Testing and Bonding, Packaging-types and considerations, IC failure modes, soft errors, functionality tests, manufacturing tests, Reliability evaluation.	**9**

Learning Resources:

Text Books:	1. "VLSI Fabrication Principles" by S. K. Ghandhi, John wiley, 1994. 2. "VLSI Technology" by S.M. Sze, Tata. MH, 2017. 3. "Solid State Electronics Devices" by Ben G. Streetman & Sanjay Banerjee, PHI, 6th Edition
Reference Books:	"Silicon VLSI Technology" by James D. Plummer, Michael D. Deal, Peter B. Griffin, PHI, 1999.
Other Suggested Readings:	

Course Title:	**EMBEDDED SYSTEM DESIGN**
Course Code:	**ECLB 435**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To model embedded systems with appropriate hardware and software components	Understanding (Level - II)
CO-2	To analyse, program and use a typical ARM processor and its peripherals	Applying (Level - III)
CO-3	To categorize and classify operating system tasks with special emphasis on real time systems	Analyzing (Level - IV)
CO-4	To apply the study of embedded technology to product design	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**2**									**1**	**3**	**2**
CO-2	**1**	**3**	**2**									**1**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**	**2**				**1**			**2**	**3**	**2**
CO-4			**2**	**3**	**1**				**1**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	**09**
Module-II	Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off- The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.	**09**
Module-III	Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	**09**
Module-IV	RTOS Based Embedded System Design: Operating System	

	Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	

Learning Resources:

Text Books:	Title	Introduction to Embedded Systems
	Author	Shibu K. V
	Publisher	Mc Graw Hill
Reference Books:	1:Title	Embedded Systems
	Author	Lyla
	Publisher	Pearson
	Edition	2013
	2: Title	An Embedded Software Primer
	Author	David E. Simon
	Publisher	Pearson
Other Suggested Readings:	1: Hamblen, J.O., Smith, Z.C. and Woo, W.W., 2013, June. Introducing embedded systems in the first C/C++ programming class. In *2013 IEEE International Conference on Microelectronic Systems Education (MSE)* (pp. 1-4). IEEE. 2: Daniel Roggow, Paul Uhing, Phillip Jones, Joseph Zambreno, "A project-based embedded systems design course using a reconfigurable SoC platform", *2015 IEEE International Conference on Microelectronics Systems Education (MSE)*, pp.9-12, 2015.	

Course Title:	**CPLD AND FPGA ARCHITECTURES AND APPLICATIONS**
Course Code:	**ECLB 436**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Microprocessor and Microcontrollers (ECBB 301), IC Applications (ECLB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To create the knowledge of high-level VLSI design to carry out research and development in the area of digital IC design.	Applying (Level - III)
CO-2	To model the digital designs including FSMs to Processor architectures using the knowledge of HDL Language.	Analyzing (Level - IV)
CO-3	To apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs.	Evaluating (Level - V)
CO-4	To implement practical and state of the art of Digital VLSI design, suitable for real life and Industry applications.	Creating (Level – VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**3**	**2**									**1**	**3**	**2**
CO-2	**1**	**2**	**3**	**1**	**1**							**1**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**	**2**				**1**	**2**		**2**	**3**	**2**
CO-4	**1**	**1**	**2**	**3**	**1**				**1**	**2**		**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices – Architecture of Xilinx Cool Runner XCR3064XL CPLD, CPLD Implementation of a Parallel Adder with Accumulation.	**09**
Module-II	Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.	**09**
Module-III	Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures, Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures.	**09**

Module-IV	General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.	

Learning Resources:

Text Books:	1:Title	Field Programmable Gate Array Technology
	Author	Stephen M. Trimberger
	Publisher	Springer International Edition
	Edition	2013
	2:Title	Digital Systems Design
	Author	Charles H. Roth Jr ,Lizy Kurian John
	Publisher	Cengage Learning
	3:Title	Field Programmable Gate Arrays,
	Author	John V. Oldfield, Richard C. Dorf
	Publisher	Wiley India
	4:Title	Digital Design Using Field Programmable Gate Arrays
	Author	Pak K. Chan/SamihaMourad
	Publisher	Pearson Low Price Edition
	5:Title	FPGA based System Design
	Author	Wayne Wolf
	Publisher	Prentice Hall Modern Semiconductor
Reference Books:	1:Title	Field Programmable Gate Arrays
	Author	J. Old Field, R. Dorf
	Publisher	John Wiley & Sons
	Edition	New York, 1995
Other Suggested Readings:	1: Stephan, B.R.O.W.N., 1996. FPGA and CPLD Architecture: A Tutorial. *IEEE Design & Test of Computers*. 2: FPGA a:nd CPLD Architectures: A Tutorial; **Link:** https://www.eecg.toronto.edu/~jayar/pubs/brown/DTSurvey.pdf	

Specialization: Communication and Signal Processing

Course Title:	**DIGITAL IMAGE PROCESSING**
Course Code:	**ECLB-330**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the fundamentals Image Processing techniques.	Remembering (Level - I)
CO-2	To Choose appropriate technique for image enhancement both in spatial and frequency domains.	Understanding (Level - II)
CO-3	To be familiar with image compression and segmentation.	Applying (Level - III)
CO-4	To Explore of image processing algorithms for object detection.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**3**	**3**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-3	**3**	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-4	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Digital image fundamentals: Visual perception, image sensing and acquisition, sampling and quantization, basic relationship between pixels and their neighborhood properties; Image enhancement in spatial domain: Gray-level transformations, histogram equalization. Spatial filters- averaging, order statistics; Edge detection: first and second derivative filters, Sobel, Canny, Laplacian and Laplacian-of Gaussion masks.	**9**
Module-II	Image filtering in frequency domain: One and two-dimensional DFT, properties of 2-D DFT, periodicity properties, convolution and correlation theorems, Fast Fourier Transforms, Smoothing and sharpening filtering in frequency domain, ideal and Butterworth filters, homomorphic filtering. Image restoration: Degradation/ restoration process, noise models, restoration in presence of noise-only spatial filtering, linear position-invariant degradations, estimating the	**9**

	degradation function, inverse filtering, Wiener filtering, constrained least squares filtering, geometric transformations.	
Module-III	Color image processing: Color models RGB, HSI, YUV, pseudo-color image processing, full-color image processing, color transformation, color segmentation, noise in color images. Morphological Image Processing: Basic operations- dilation, erosion, opening, closing, Hit-Miss transformations, Basic morphological algorithms- boundary extraction, region filling, connected components, convex hull, thinning, thickening, skeletons, pruning, extensions to gray-scale morphology.	**9**
Module-IV	Image segmentation: Edge linking and boundary detection, Hough transforms, graph-theoretic techniques, global and adaptive thresholding, Region based segmentation, Segmentation by morphological watersheds, motion based segmentation; Texture Analysis: Co-occurrence matrix, Gabor filter.	**9**

Learning Resources:

Text Books:	1	Digital Image Processing using MATLAB
		Gonzalez, Woods, Eddins
		Gatesmark Publishing
		2nd Edition
Reference Books:	1	Fundamentals of Digital Image Processing
		Anil K Jain
		PHI Publication
		First Edition
	2	Digital Image Processing
		William K Pratt
		Wiley
Other Suggested Readings:		NPTEL Lectures, Research papers

Course Title:	**NEXT GENERATION NETWORKS**
Course Code:	**ECLB-331**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Demonstrate a comprehensive understanding of emerging network technologies, their applications advantages, disadvantages, and future potential.	Remembering (Level - I)
CO-2	Evaluate and select appropriate NGN technologies for specific applications, considering associated risks.	Understanding (Level - II)
CO-3	Articulate the architecture and technology options for Multi-Service Networks (MSNs).	Applying (Level - III)
CO-4	Analyze the benefits and limitations of key NGN technologies.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**
CO-3	**3**	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-4	**3**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Convergence: what is convergence and why is it possible now? Network convergence, service convergence, device convergence, convergence in content. From technology push to service pull. Introduction to Next Generation Networks (NGN): what is NGN? Evolution trends in ICT network platform towards NGN. Difference between existing telecommunication environment and next generation converged environment. Factors motivating NGN: economic, technological and social. Building blocks for NGN. NGN services, challenges, opportunities. NGN applications: Internet connectivity, e-commerce, call center, third party application service provision, integrated billing, security and directory enable networks.	**6**
Module-II	NGN: numbering, naming and addressing. Conceptual model for NGN: access layer, transport layer, control layer, service layer. NGN architecture: soft-switch based, IMS based and TISPAN. IMS architecture: nodes, S-CSCF, P-CSCF, I-CSCF, application servers, BGCF, PSTN/CS gateway, media resource functions. IMS advantages. NGN protocol stack: fundamental protocols: SIP, SDP,	**13**

	AAA, RTP, RTCP, Megaco/H.248. Supporting protocols: XCAP, SOAP. Fixed mobile convergence (FMC). Convergence using IMS- a case study. IMS based NGN IPTV architecture.	
Module-III	Next generation access network: wireline: fiber to the premises (FTTP), long-haul managed Ethernet. Broadband wireless access: Local area network (Wi-Fi), Wide area network (WiMAX), satellite networks, and mobile networks: 3G, 4G, LTE, and 5G. Next generation core network: role of core network, enabling control and re- configurability. VoIP: principles, how telephony is provided over IP network, various VoIP scenarios.	**10**
Module-IV	NGN management and provisioning- configuration, accounting, performance and security. Future enhancements- adaptive self-healing networks. Software defined networking (SDN): basic concepts, SDN software stack. Applications: network virtualization, data-center traffic management, wide area traffic management. SDN systems challenges: scalability, security, fault tolerance. Future of SDN.	**7**

Learning Resources:

Text Books:	1	Next generation Telecommunication Networks, Services and Management
		Edited by Thomas Plevyak, VeliSahin
		Wiley & IEEE Press Publications
		2012
	2	Next Generation Network Services.
		Robet Wood.
		Pearson Pvt. Ltd
		3rd Edition
	3	Next Generation Network Services
		Neill Wilkinson
		John Wiley Publications
		2002
Reference Books:	1	Next Generation Networks
		Monique J. Morrow
		CISCO Press
		2007
	2	Next Generation Networks: Perspectives and Potentials
		Jingming Li Salina, Pascal Salina
		John Wiley Publications
		2008
Other Suggested Readings:		NPTEL, Online resources etc

Course Title:	**STATISTICAL SIGNAL PROCESSING**
Course Code:	**ECLB-379**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Able to remember, understand and apply the theory, the basic methodologies and algorithms of statistical signal processing.	Remembering (Level - I)
CO-2	Masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.	Understanding (Level - II)
CO-3	Understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.	Applying (Level - III)
CO-4	Equipped to analyze, evaluate and create concepts, algorithms, and systems for the statistical estimation and detection of deterministic and random parameters applied to Radar, SONAR, Image processing, Acoustic Signal Processing, information and communication systems.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-3	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Review of random variables Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto- covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process. Random signal modeling: MA(q), AR(p), ARMA (p, q) models.	**6**
Module-II	Parameter Estimation Theory Principle of estimation and applications, Properties of estimates, unbiased and consistent	**13**

	estimators, Minimum Variance Unbiase Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties; Baysean estimation: Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation. Estimation of signal in presence of white Gaussian Noise Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non Causal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.	
Module-III	Adaptive Filtering: Principle and Application, Steepest Descent Algorithm Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters; RLS algorithm, derivation, Matrix inversion Lemma, Initialization, tracking of non -stationarity. Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.	**10**
Module-IV	Spectral analysis: Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.	**7**

Learning Resources:

Text Books:	1	Discrete Random Signals and Statistical Signal Processing,
		Charles W. Therrien
		Prentice Hall Signal Processing Series
		2004
	2	Statistical Digital Signal Processing and Modeling
		M. H. Hayes
		John Wiley & Sons, Inc
		2004
	3	Statistical and Adaptive Signal Processing
		D.G. Manolakis, V.K. Ingle and S.M. Kogon
		McGraw Hill,
		2000
Reference Books:	1	Statistical Digital Signal Processing and Modeling
		Monson Hayes
		John Wiley & Sons, Inc.,
		2002
Other Suggested Readings:		NPTEL, Online resources etc

Course Title:	**MULTIMEDIA COMMUNICATION SYSTEMS**
Course Code:	**ECLB 380**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand basics of different multimedia networks and applications.	Understanding (Level –II)
CO-2	Understand different compression techniques to compress audio and video.	Understanding (Level –II)
CO-3	Describe multimedia Communication across Networks.	Applying (Level – III)
CO-4	Analyse different media types to represent them in digital form.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	1		1	1					2	1	
CO-2	3	3	2	2		1						1	2	1
CO-3	3	3	3	3	1							2	3	2
CO-4	2	2	3	1	1		1					2	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Multimedia Communication: Introduction, Network requirements, multimedia terminals, multimedia Requirement for ATM networks, Multimedia terminals. Audio visual Integration. Audio to visual mapping.	**6**
Module-II	Multimedia Processing in Communications: Introduction, Digital Media, Signal processing elements, Challenges in multimedia information processing, Perceptual coding of Digital audio signals, Transform audio coders, Image coding, Video Coding.	**10**
Module-III	Distributed multimedia systems, Resource management of DMS, IP networking, Multimedia operating systems, distributed multimedia servers, Distributed multimedia applications, Multimedia File Formats..	**10**
Module-IV	Multimedia communication standards, MPEG-1, MPEG-2, MPEG-4Audio/Video, MPEG-4 Visual Texture coding (VTC), Multimedia communication across networks. Compression Techniques: JPEG, MPEG.	**10**

Learning Resources:

<table>
<tr><td>Text Books:</td><td>
<table>
<tr><td>Title</td><td>Multimedia Communication Systems</td></tr>
<tr><td>Author</td><td>Rao, Bojkovic, Milovanovic,</td></tr>
<tr><td>Publisher</td><td>PHI Learning Pvt. Ltd.</td></tr>
<tr><td>Edition</td><td>First Edition</td></tr>
<tr><td>Title</td><td>Multimedia System Design</td></tr>
<tr><td>Author</td><td>Andleigh, Thakrar</td></tr>
<tr><td>Publisher</td><td>PHI Learning Pvt. Ltd.</td></tr>
<tr><td>Edition</td><td>First Edition</td></tr>
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</td></tr>
<tr><td>Reference Books:</td><td>
<table>
<tr><td>Title</td><td>Multimedia Information Networking</td></tr>
<tr><td>Author</td><td>Sharda</td></tr>
<tr><td>Publisher</td><td>Prentice Hall Inc.</td></tr>
<tr><td>Edition</td><td>First Edition</td></tr>
<tr><td>Title</td><td>Multimedia making it work</td></tr>
<tr><td>Author</td><td>Vaughan</td></tr>
<tr><td>Publisher</td><td>Tata Mc Graw Hill</td></tr>
<tr><td>Edition</td><td>First Edition</td></tr>
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<tr><td>Other Suggested Readings:</td><td></td></tr>
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Course Title:	**SATELLITE COMMUNICATION**
Course Code:	**ECLB 381**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the history of satellite communication systems.	Understanding (Level-II)
CO-2	To analyse the orbital and functional principles of satellite communication systems	Analysing (Level-IV)
CO-3	To adapt and evaluate a satellite link and suggest enhancements to improve the link performance	Evaluation (Level-V)
CO-4	To select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.	Applying (Level-III)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	1		1	1					2	1	
CO-2	3	3	2	2		1						1	2	1
CO-3	3	3	3	3	1							2	3	2
CO-4	2	2	3	1	1		1					2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Satellite Communication Origin, Brief History, Current state and advantages of Satellite Communication, Active & Passive satellite, Orbital aspects of Satellite Communication, Angle of Evaluation, Propagation Delay, Orbital Spacing, System Performance Satellite Link Design Link design equation, system noise temperature, C/N & G/T ratio, atmospheric & econospheric effects on link design, complete link design, interference effects on complete link design, earth station parameters.	**12**
Module-II	Earth space propagation effects, Frequency window, Free space loss, Atmospheric absorption, Rainfall Attenuation, Ionospheric scintillation, Telemetry, Tracking and command of satellites.	**6**
Module-III	Satellite Multiple Access System FDMA techniques, SCPC & CSSB systems, TDMA frame structure, burst structure, frame efficiency,	**10**

	super-frame, frame acquisition & synchronization, TDMA vs FDMA, burst time plan, beam hopping, satellite switched, Erlang call congestion formula, DA-FDMA, DA-TDMA. Satellite Services INTELSAT, INSAT Series, VSAT, Weather forecasting, Remote sensing, LANDSAT, Satellite Navigation, Mobile satellite Service.	
Module-IV	Laser & Satellite Communication Link analysis, optical satellite link Tx& Rx, Satellite, beam acquisition, tracking & pointing, cable channel frequency, head end equation, distribution of signal, n/w specifications and architecture, optical fibre CATV system.	**8**

Learning Resources:

1.	**Title**	Satellite Communications
	Author	Trimothy Pratt, Charles W. Bostian
	Publisher	John Wiley & Sons
	Edition	1986
2.	**Title**	Satellite Communications
	Author	Dr. D.C. Aggarwal
	Publisher	Khanna Publishers
	Edition	2001
3.	**Title**	Satellite Communications
	Author	Dennis Roddy
	Publisher	McGraw Hill
	Edition	1996

Course Title:	**WIRELESS AND ADHOC NETWORKS**
Course Code:	**ECLB-438**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the challenges and constraints of wireless sensor network and its subsystems	Remembering (Level - I)
CO-2	To examine the physical layer specification, modulation and transceiver design considerations	Understanding (Level - II)
CO-3	To adapt and analyse the protocols used at the MAC layer and scheduling mechanisms	Applying (Level - III)
CO-4	To evaluate and synthesize the application areas and practical implementation issues.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-2	**2**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-3	**2**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-4	**2**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to adhoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models.	**6**
Module-II	MAC Protocols: design issues, goals and classification. Contention based protocols- with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.	**6**
Module-III	Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.	**10**
Module-IV	Transport layer: Issues in designing- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols.	**14**

	Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective. Integration of adhoc with Mobile IP networks.	

Learning Resources:

Text Books:	1	Ad hoc Networking
		Charles E. Perkins
		Pearson Education. 2007
		Wesley, 2000nd Edition
	2	Adhoc Wireless Networks Architectures and Protocols
		C.Siva Ram Murthy and B.S. Manoj
Reference Books:	1	Mobile Adhoc Networking
		Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic
		Wiley-IEEE press
		2004
	2	Cross Layer Design Optimization in Wireless Protocol Stacks
		V.T. Raisinhani and S. Iyer
		Comp. Communication
		Vol. 27 no. 8, 2004
Other Suggested Readings:		Online resources, NPTEL etc

Course Title:	**OPTICAL SIGNAL PROCESSING**
Course Code:	**ECLB-439**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand basic concepts of light propagation, spatial frequency and Spectral analysis.	Remembering (Level - I)
CO-2	To study and design different domain filtering techniques.	Understanding (Level - II)
CO-3	Apply the transform domain approach for study of light behaviours.	Applying (Level - III)
CO-4	Ability to develop optical filters, modulators and detectors for various applications of light processing	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**2**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Characterization of a General signal, examples of signals, Spatial signal. Basic laws of geometrical optics, Refractions by mirrors, the lens formulas, General Imaging conditions, the optical invariant, Optical Aberrations.	**5**
Module-II	Physical optics: The Fresnel Transforms, the Fourier transform, Examples of Fourier transforms, the inverse Fourier transform Extended Fourier transform analysis, Maximum information capacity and optimum packing density, System coherence.	**7**
Module-III	Spectrum Analysis and Spatial Filtering: Light sources, spatial light modulators, The detection process in Fourier domain, System performance parameters, and Dynamic range. Some fundamentals of signal processing, Spatial Filters.	**8**
Module-IV	Binary spatial filters: Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometry	**16**

	techniques for constructing Spatial Filters. Optical signal processor and filter generator, Applications for optical signal processing. Acousto-optic cell spatial light modulators: Applications of acousto-optic devices. Basic Acousto-optic power spectrum analyzer. Heterodyne systems: Interference between two waves, the optical Radio.	

Learning Resources:

Text Books:	1	Optical signal processing
		Anthony Vanderlugt
		Wiley-Interscience
		First Edition
	2	Ultrafast All-Optical Signal Processing Devices
		Hiroshi Ishikawa
		Wiley
		First Edition, 2008
Reference Books	1	Optical data Processing-Applications
		D. Casasent
		Springer-Verlag, Berlin
		First Edition
	2	Optical Signal Processing, Computing, and Neural Networks
		Francis T. S. Yu, SugandaJutamulia
		Krieger Publishing Company
		2nd Edition
Other Suggested Readings:		Online resources, lectures etc

Course Name:	**ERROR CONTROL CODING**
Course Code:	**ECLB-440**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the fundamental limits on the error free representation of information signals and the transmission of such signals over a noisy communication channel.	Remembering (Level - I)
CO-2	To design and analyse lossless data compression techniques with varying efficiencies as per problem requirements.	Understanding (Level - II)
CO-3	To investigate the mathematical tools for source coding and error correction coding and design error correction codes.	Applying (Level - III)
CO-4	To design various decoding strategies for block and convolutional codes.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basics of vector algebra Galois Filed arithmetic in detail, Implementation of Galois Field Arithmetic.	**6**
Module-II	BCH Codes, Decoding of BCH Codes, implementation of error correction, Non binary BCH and Recd-Solomon Codes, error detection of binary BCH codes.	**8**
Module-III	Burst error correcting codes, decoding of single burst error correcting cyclic codes, Fire code interleaved codes, phased burst error correcting codes, Concatenated codes.	**8**
Module-IV	Convolutional codes, Maximum likelihood decoding of convolutional codes, sequential decoding convolutional codes - stack and fano algorithm Application of Viterbi decoding. Turbo codes - Coding - Performance - BCJR algorithm – Applications.	**14**

Learning Resources:

Text Books:	1	Error Control Coding
		Shu Lin & D.J. Costello
		PHI, 2004.
		2rd edition
Reference Books:	1	Application of Error Control
		Shu Lin
		PHI
		1974 edition
	2	Digital Communication
		Simon Haykin
		John Wiley and Sons
		1988
Other Suggested Readings:		Online resources, lectures etc

Course Title:	**DIGITAL COMMUNICATION TECHNIQUES**
Course Code:	**ECLB-441**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO-1	To comprehend the development of communication systems	Remembering (Level - I)
CO-2	To apply the matched filter concept and find signal-to-noise ratio.	Understanding (Level - II)
CO-3	To study and analyse different digital modulation techniques, should analyse and propose solutions for different real time communication problems.	Applying (Level - III)
CO-4	To analyse and investigate different source coding and channel coding techniques should analyse real time digital communication problems.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-2	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Power spectrum and communication over memoryless channel: PSD of a synchronous data pulse stream; M-ary Markov source; Convolutionally coded modulation; Continuous phase modulation – Scalar and vector communication over memoryless channel – Detection criteria.	**8**
Module-II	Coherent and non- Coherent communication: Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherent receivers in random phase channels; M-FSK receivers – Rayleigh and Rician channels – Partially coherent receives – DPSK; M-PSK; M-DPSK, BER Performance Analysis.	**8**
Module-III	Band-limitted Channels and Digital Modulation: Eye pattern; demodulation in the presence of ISI and AWGN; Equalization	**12**

	techniques – IQ modulations; QPSK; QAM; QBOM; - BER Performance Analysis. – Continuous phase modulation; CPFM; CPFSK; MSK, OFDM. Block coded digital communication: Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators – Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes.	
Module-IV	Convolutional coded digital communication: Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.	**8**

Learning Resources:

Text Books:	1	Digital communication techniques
		M.K. Simon, S.M. Hinedi and W.C. Lindsey
		Prentice Hall India, New Delhi, 1995
	2	Digital communications
		Simon Haykin
		John Wiley and sons, 1998
Reference Books:	1	Modern Digital Communication Technique – Fundamental & Applications
		Bernard Skler
		Prentice Hall, 2001 edition, ISBN – 0130847881
	2	Digital Communications
		Ian Glover & Peter Grant
		Prentice Hall 2003 edition
		Online resources, lectures etc
Other Suggested Readings:		Online resources, Lectures etc

Course Title:	**BIO-MEDICAL ELECTRONICS**
Course Code:	**ECLB-453**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECBB 204), Analog Communication (ECBB 252), Electronic Measurement and Instrumentation (ECBB 253) Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain the principles of human physiology, bioelectric signals, and the basic components of biomedical instruments.	Remembering (Level - I)
CO-2	Analyze the bioelectric potentials and their measurement using electrodes in the cardiovascular system.	Understanding (Level - II)
CO-3	Apply techniques for measuring biological parameters, including blood pressure, heart sounds, temperature, and bioelectric signals like ECG, EEG, and EMG.	Applying (Level - III)
CO-4	Evaluate the design and functionality of patient monitoring systems, including intensive care and remote monitoring systems.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-2	**3**	**3**	**2**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-3	**3**	**3**	**2**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Human Physiology and Basics: Introduction to human physiology, Basic components of Biomedical instruments, bioelectric signals.	**9**
Module-II	Bio Electric Potential Measurements: Bio potential Electrodes, Action and Resting Potentials, Electrode theory, Microelectrodes, surface electrodes and needle electrodes, The Heart and Cardiovascular System, Electrical activity of heart, Electrocardiography	**9**
Module-III	Measurements of Biological Parameters: Measurement of Blood Pressure and Flow, Plethysmography, Measurement of Heart Sound, Measurement of Temperature, Ultrasonic Diagnosis, Analysis of ECG, EEG, EMG and their characteristics, Bio-potential amplifiers for ECG, EMG EEG etc.	**9**

Module-IV	Patient Monitoring System: The Elements of Intensive Care Monitoring system, Remote monitoring through telephone, internet, satellite link,	**9**

Learning Resources:

Text Books:	1	Biomedical Instrumentation & Measurement by L. Cromwell, F.J. Weibell and E.A. Pfeiffer, 2nd Ed., PHI.
	2	Principles of Medical Electronics & Biomedical Instrumentation, C Raja Rao & S.K Guha, University Press.
Reference Books:	1	Electronics in Medicine and Biomedical Instrumentation – Nandini K. Jog, PHI
	2	Biomedical Instrumentation – Dr. A. Arumugam, Anuradha Agencies, Chennai.
	3	Handbook of Biomedical Instrumentation by R.S. Khandpur, TMH Pub. Co.
	4	Introduction to Biomedical Engineering, Domach, Pearson Education
Other Suggested Readings:	5	NPTEL, Online resources etc

Specialization:

Antenna Theory

Course Title:	**RF INTEGRATED CIRCUITS**
Course Code:	**ECLB 332**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand the MOS fundamentals, small signal models and analysis of MOSFET based circuits.	Understanding (Level - II)
CO2	Able to analyze and design analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits.	Analyzing (Level – IV)
CO3	Able to analyze and design mixed mode circuits such as Comparator, ADCs, DACs, PLL.	Analyzing (Level - IV)
CO4	Solve practical and state of the art analog IC design problems to serve VLSI industries.	Solve (Level – VI)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	2	2	2					2			2	2
CO-2	3	2	3	2	3					2			2	3
CO-3	2	3	2	3	2					2			2	2
CO-4	2	3	3	2	3					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Characteristics of passive IC components at RF frequencies: Interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components.	**9**
Module-II	High frequency amplifier design: Zeros as bandwidth enhancers, shunt-series amplifier, fT doublers, neutralization and unilateralization**Low** noise **amplifier design**: LNA topologies, power constrained noise optimization, linearity and large signal performance.	**9**
Module-III	Mixers: Nonlinear systems as linear mixers, multiplier-based mixers, subsampling mixers, diode-ring mixers. RF power amplifiers: Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, design and linearity considerations.	**9**
Module-IV	Oscillators & synthesizers: Basic topologies, VCO, describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations	**9**

Learning Resources:

Text Books:		
1.	Title	The Design of CMOS Radio-Frequency Integrated Circuits
	Author	Thomas H. Lee
	Publisher	Cambridge, UK: Cambridge University
	Edition	2rd ed. (2004)
2.	Title	RF Microelectronics
	Author	BehzadRazavi
	Publisher	Prentice Hall
Reference Books:		
3.	Title	Integrated Circuits for Wireless Communications
	Author	A.A. Abidi, P.R. Gray, and R.G. Meyer
	Publisher	IEEE Press
	Edition	1999
4.	Title	RF Circuit Design
	Author	R. Ludwig and P. Bretchko
	Publisher	Pearson
	Edition	2000

Course Title:	**RADAR SIGNAL PROCESSING**
Course Code:	**ECLB 381**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Able to Learn advanced signal processing technics for Radar applications.	Understand (Level - II)
CO2	Able to learn different signal models in radar.	Understand (Level - II)
CO3	Able to Analyze the pulse compression concept and doppler processing.	Analyze (Level - IV)
CO4	Able to evaluate the data received from radar and learn beam forming and space time processing.	Evaluate (Level - V)

Course Articulation Matrix:

	PO -1	PO-2	PO -3	PO -4	PO -5	PO -6	PO-7	PO -8	PO -9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**2**	**2**	**3**	**2**					**2**			**2**	**2**
CO-2	**2**	**2**	**2**	**3**	**3**					**3**			**3**	**2**
CO-3	**2**	**3**	**2**	**3**	**2**					**2**			**2**	**2**
CO-4	**2**	**3**	**3**	**2**	**2**					**3**			**2**	**3**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Analysis of discrete time signal, sampling theorem, estimation of frequency content in a signal, discrete Fourier transform, random discrete signal analysis. Review of probability, auto and cross correlation, power spectral density, cross spectra.	**07**
Module-II	The Radar System, the radar range equation, scattering and RCS, RCS models, propagation, antennas, receivers, noise figure.	**10**
Module-III	Radar Signal Processing Fundamentals, detection and likelihood ratio, binary detection, matched filtering, radar ambiguity functions, pulse compression and radar waveforms, radar resolution. Neyman-Pearson criteria for radar application to air traffic control, radar sub optimum processor, detection of variable amplitude signals, matched filters, detection of random signal and estimation of signals in noise.	**10**
Module-IV	Applications of Radar Signal Processing: Pulse-Doppler radar, CFAR detection, synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), moving target indication	**08**

	(MTI), displaced-phase-center-antenna technique (DPCA), adaptive radar, super resolution (MUSIC), space-time adaptive processing (STAP).	

Learning Resources:

Text Books:		
	Title	Rader Adaptive signal processing
	Author	I. Haykin, Simon S
	Publisher	John Wiley & Sons
	Title	Fundamentals of Radar signal processing
	Author	Mark A Richards
	Publisher	M C Graw Hill
Reference Books:		
	Title	Radar Principles
	Author	Peyton Z. Peebles
	Publisher	Wiley
	Title	Radar Principles
	Author	Nadav Levanon
	Publisher	Wiley

Course Title:	**MILLIMETER WAVE TECHNOLOGY**
Course Code:	**ECLB 382**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand millimeter wave circuits, devices, and system.	Understanding (Level - II)
CO2	Understand design of millimeter Integrated Circuit.	Understanding (Level - II)
CO3	To Analyze the design of LNA, Mixer, Oscillator, Power amplifier	Analyzing (Level - IV)
CO4	Solve problems related to it.	Solve (Level – VI)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	2	2	2					2			2	2
CO-2	3	2	3	2	2					2			2	3
CO-3	2	3	2	2	3					2			3	3
CO-4	2	2	3	2	2					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Analysis of rectangular and circular waveguides and resonators, TE and TM modes, Q of the cavity, loss mechanisms, scattering matrix, directional coupler, waveguide tees, hybrid couplers, Faraday rotation in ferrites, isolator, circulator. Passive microwave circuits: Microstrip and stripline, filter implementation with transmission lines and strip lines.	**6**
Module-II	Klystron – velocity modulation and bunching, Travelling wave tube – slow wave structure and Brillouin diagram. Maser – population inversion, pumping and stimulated emission.	**6**
Module-III	BJTs, MESFETs, tunnel diode, parametric amplifiers – Principle and analysis of amplifier configurations and parameters like gain, bandwidth, noise figure, dynamic range - Single stage and broad band transistor amplifier designs – stability.	**6**
Module-IV	Reflex klystron, magnetron, Gunn diode, IMPATT and TRAPPAT diodes, parametric oscillators – Principle and analysis of oscillator configurations, efficiency, tunability.	**6**

Learning Resources:

Text Books:		
1.	Title	Microwave, Millimeter wave and sub-millimeter wave vacuum electron devices
	Author	Rajeshwari Chatterji
	Publisher	Affiliated East - West Press
Reference Books:		
1.	Title	Foundations for Microwave Engineering
	Author	R E Collin
	Publisher	IEEE
2.	Title	Microwave Engineering
	Author	David M Pozar
	Publisher	John Wiley
	Edition	2nd

Course Title:	**ANTENNA THEORY AND DESIGN**
Course Code:	**ECLB 442**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To outline important and fundamental antenna engineering parameters and terminology	Remembering (Level-I)
CO2	To interpret the basic concepts of electromagnetic wave radiation and reception	Understanding (Level-II)
CO3	To develop and analyse the basic skills necessary for designing a wide variety of practical antennas and antenna arrays.	Application (Level-III)
CO4	To identify the atmospheric and terrestrial effects on radio wave propagation.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	3	2	3					3			3	3
CO-2	3	3	2	3	3					3			2	3
CO-3	2	3	3	2	2					3			2	2
CO-4	2	3	2	2	2					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Fundamental Concepts: Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.	**9**
Module-II	Wire Antennas and Antenna Arrays: Wire antennas: Short dipole, Radiation resistance and Directivity, Half wave Dipole, Monopole, Small loop antennas. Antenna Arrays: Linear Array and Pattern Multiplication, Two-element Array, Uniform Array, Polynomial representation, Array with non-uniform Excitation-Binomial Array.	**9**
Module-III	Types of Antennas: Traveling - wave antennas, Helical antennas, Biconical antennas, sleave antennas, and Principles of frequency independent Antennas, spiral antennas, and Log - Periodic Antennas. Aperture Antennas- Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector	**9**

	antennas, gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice.	
Module-IV	Radio Wave Propagation: Calculation of Great Circle Distance between any two points on earth, Ground Wave Propagation, Free-space Propagation, Ground Reflection, Surface waves, Diffraction, Wave propagation in complex Environments, Tropospheric Propagation, Tropospheric Scatter. Ionospheric propagation: Structure of ionosphere, Sky waves, skip distance, Virtual height, Critical frequency, MUF, Electrical properties of ionosphere, Effects of earth's magnetic fields, Faraday rotation, Whistlers.	**9**

Learning Resources:

Text Books:		
1.	Title	Antenna Theory and Design
	Author	Warren L Stutzman and Gary a Thiele
	Publisher	John Wiley and Sons Inc.
	Edition	2ndEd, 1998
2.	Title	Antenna Theory- Analysis and Design
	Author	Constantine. A. Balanis
	Publisher	Wiley India
	Edition	2nd Edition, 2008
3.	Title	Antennas
	Author	Kraus
	Publisher	Tata McGraw Hill, New Delhi
	Edition	3" Edition, 2003

Course Title:	**MODERN RADAR AND AVIONICS SYSTEM**
Course Code:	**ECLB 443**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To comprehend with the basics of radar systems using radar equation and block diagram.	Remembering/ Understanding (Level-I/Level-II)
CO2	To differentiate different navigation techniques used in aerospace system such as Celestial navigation, GPS based navigation, Inertial Navigation, Integrated navigation systems	Analysis (Level-IV)
CO3	To design the avionic architecture system for its application in Civil and Military Aircraft systems	Application (Level-III)
CO4	To adapt to the trends of avionic display technology.	Evaluation/ Synthesis (Level-V/Level-VI)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	3	2	3					2			2	2
CO-2	2	2	2	3	3					2			2	3
CO-3	2	3	3	3	2					3			3	2
CO-4	3	2	2	2	2					2			2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to radars; Radar equation. Block Diagram and Operation; Radar Frequencies. Application of Radars; Range performance of radars. Minimum detectable signal; Noise effects. Continuous wave and Frequency modulated radars; Doppler effect. CW Radar.	**6**
Module-II	Guided missiles; Classifications; Description of tactical missiles. Guidance phases during flight; Categories of Homing and command guidance. The kinematic equations.	**6**
Module-III	Aircraft Navigation; Kinds of navigation - Position Fixing and Dead-reckoning systems. LORAN; DECCA; OMEGA. Very High Frequency Omni-Directional Range (VOR). Celestial navigation and GPS based navigation; Inertial Navigation Systems. Integrated navigation systems Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems and design, defining avionics System/subsystem	**12**

	requirements, Avionics system architectures.	
Module-IV	Trends in avionics display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit-Civil and Military Electrical Power requirement standards, comparing the Military and Civil Requirements and Tips for Power System Design.	**12**

Learning Resources:

Text Books:		
1.	Title	Introduction to Radar Systems
	Author	M.I. Skolnik
	Publisher	Tata McGraw-Hill 2007
2.	Title	Digital Avionics Systems
	Author	Spitzer, C. R
	Publisher	Prentice Hall, Englewood Cliffs, N.J., U.S.A.
	Edition	1987
3.	Title	Avionics Navigation System
	Author	M. Kayton and W. Fried
	Publisher	Wiley Inter science
	Edition	1997

Reference Book:	
Title	The Avionics Handbook
Author	Cary R. Spitzer
Publisher	CRC Press
Edition	2000
Title	Introduction to Avionics
Author	Collinson R. P. G
Publisher	Chapman and Hall
Edition	1996

Course Title:	**RADAR ENGINEERING**
Course Code:	**ECLB 444**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand the fundamental concepts of the working principle of modern radar system.	Remembering (Level I)
CO2	To apply digital signal processing in radar system.	Application (Level-III)
CO3	To analyse CW radar, FM-CW radar, MTI radar and non-coherent MTI pulse Doppler radar	Analysis (Level-IV)
CO4	To assess different tracking techniques of radar.	Evaluation (Level-V)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	3	2	3	2					2			2	2
CO-2	3	3	2	2	3					2			2	3
CO-3	2	2	3	2	2					3			3	2
CO-4	2	3	2	3	2					2			2	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Radar Range Equation: Radar fundamentals, Derivation of range equation, the search radar equation, Jamming and radar range with jamming, Radar clutter and radar range with clutter, Radar range with combined interferences sources.	**7**
Module-II	Theory of Target Detection: Noise and false alarms, Detection of one sample of signal with noise, Integration of pulse trains, Detection of fluctuating targets, CFAR, Optimum and matched filter Theory, Loss factors in detection.Targets and Interference: Definition of radar cross section, Radar cross section of simple and complex objects, Spatial distribution of cross section, Bistatic cross section.	**10**
Module-III	CW and FM Radar: Doppler Effect, CW and FMCW Radar, Airborne Doppler Navigation, Multi frequency CW Radar. MTI Radar: Delay lines and line cancellers, Subclutter Visibility. MTI using range gates and filters, Pulse Doppler radar, Non- coherent MTI radar, Application of Digital signal processing to radar system.	**9**
Module-IV	Tracking Radar: Different types of tracking techniques, tracking in range, Tracking in Doppler, Search Acquisition radar, Comparison of Trackers. Introduction to Pulse Compression Radar: Height finding radars, Air traffic control Radars and data handling, Atmospheric effects of radar, Electromagnetic compatibility aspects, Airborne Radars, Synthetic Aperture Radar, Secondary surveillance Radars.	**10**

Learning Resources:

Text Books:		
1.	Title	Modern Radar System Analysis
	Author	David Barton. K
	Publisher	Artech House
	Edition	1988
2.	Title	Radar Design Principles Signal Processing and The Environment
	Author	Fred Nathanson E,
	Publisher	McGraw Hill
	Edition	1969
3.	Title	Radar Signals
	Author	Cook CE. Bernfield. M
	Publisher	Academic Press
	Edition	1967

Specialization:

Machine Learning and Internet-on-Things

Course Title:	**WAVELET TRANSFORMS**
Course Code:	**ECLB 333**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303)**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO1	Acquire the basic concepts, theory, and algorithms behind wavelet transforms.	Understanding (Level - II)
CO2	To apply the modern signal processing tools using signal spaces, bases, operators and series expansions.	Applying (level – III)
CO3	Apply wavelets, filter banks, and multi-resolution techniques to a problem at hand	Analyzing (level - IV)
CO4	To acquire the knowledge about different wavelets	Understanding (Level - II)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	1	2	0	0	0	0	0	0	2	2	2
CO-2	3	2	2	2	3	0	0	0	0	0	0	2	3	2
CO-3	3	3	3	2	3	0	0	0	1	1	1	2	3	3
CO-4	3	2	1	1	2	0	0	0	0	0	0	2	2	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Signal representation with continuous and discrete STFT, concept of time- frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, wavelet transform.	**05**
Module-II	The origins of wavelets, Wavelets and other wavelet like transforms, History of wavelet from Morlet to Daubechies via Mallat, Different communities and family of wavelets, Different families of wavelets within wavelet communities.	**07**
Module-III	Wavelet Transform-A first level introduction, Continuous time-frequency representation of signals, Properties of wavelets used in continuous wavelet transform, Continuous versus discrete wavelet transform.	**08**
Module-IV	Haar scaling functions and function spaces, Translation and scaling of $\phi(t)$, Orthogonality of translates of $\phi(t)$, Function space *V0,* Finer Haar scaling functions, Concepts of nested vector spaces, Haar wavelet function, Scaled and translated Haar wavelet functions, Orthogonality of $\phi(t)$ and $\psi(t)$, Normalization of Haar bases at different scales, Refinement relation with respect to normalized bases, Support of a wavelet system, Daubechies wavelets, Plotting the Daubechies wavelets.	**08**
Module-V	Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients,	**08**

Learning Resources:

Text Books:		
1.	Title	Insight into Wavelets: From Theory to Practice
	Author	K. P. Soman, K. I. Rmachandran, N. G. Resmi
	Publisher	PHI Learning Pvt. Ltd.
	Edition	Third Edition, 2010
2.	Title	Multiresolution signal Decomposition: Transforms Sub-bands and Wavelets
	Author	A.N. Akansu and R.A. Haddad
	Publisher	Academic Press, Oranld, Florida, 1992
	Edition	First Edition
3.	Title	Digital Signal Processing
	Author	John G. Proakis, Dimitris G. Manolakis
	Publisher	Pearson Prentice Hall
	Edition	First Edition
4.	Title	Digital Image Processing
	Author	Rafael C. Gonzalez, Richard E. Woods
	Publisher	Pearson International Edition
	Edition	Third Edition, 2009.
Reference Books:		
1.	Title	Introduction to Wavelets and Wavelet Transform,
	Author	C. S. Burrus, Ramose and A. Gopinath,
	Publisher	Prentice Hall Inc.
	Edition	First Edition

Course Title:	**PATTERN RECOGNITION AND MACHINE LEARNING**
Course Code:	**ECLB 383**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes

Course Outcomes		**Cognitive Levels**
CO1	To understand the basics of the machine learning and pattern recognition.	Understanding (Level-II)
CO2	To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning and pattern recognition.	Remembering (Level-I)
CO3	To enable the students to know deep learning techniques to support real-time applications.	Applying (Level- III)
CO4	To apply machine learning techniques for various problem solving.	Analysing (Level-III)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	1	2	0	0	0	0	0	0	2	3	2
CO-2	3	3	2	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction of Pattern Recognition, Feature vectors and features spaces, prototypes and the nearest neighbourhood method, Discriminant Functions: Linear discriminant functions, piece-wise linear discriminant function, quadratic discriminant functions, over fitting. Statistical Learning: Bayes decision, loss function, maximum likelihood estimation, normal distribution, parametric learning.	**06**
Module-II	Discriminant Learning: Non-parametric learning, perceptrons, neural networks, support vector machines. Feature Extraction: feature normalization, KL expansion, principal component analysis, discriminant analysis.	**10**
Module-III	Machine Learning from Discrete Data: Decision Tree, Bag of words, N-gram Model, Distance and Clastering: hierarchical clustering, distances between discrete data, the K-means method, the EM algorithm.	**10**
Module-IV	Validation and Evaluation: cross validation, ROC, precision and recall Association Rules: theApri-ori algorithm, maximal frequent item sets, the FP- growth algorithm (a divide-and-conquer algorithm), closed item sets learning from various types of Data: finding frequent substrings, teating tree structure.	**10**

Learning Resources:

Text Books:		
1.	**Title**	Pattern Classification
	Author	Richard O. Duda, Peter E. Hart, David G. Stork
	Publisher	John Wiley and Sons Interscience Publication
	Edition	2001
2.	**Title**	Pattern Recognition
	Author	M. Narasimha Murthy, V. Susheela Devi
	Publisher	Springer Science & Business Media
	Edition	2011
3.	**Title**	Data Mining (Practical Learning Tools and Techniques)
	Author	Ian H. Witten, Eibe Frank
	Publisher	Morgan Kaufmann Publishers
	Edition	2005
4.	**Title**	Big Data, Data mining and machine Learning
	Author	Jared Dean
	Publisher	Wiley Big Data Series
	Edition	2014
Reference Books:		
1.	**Title**	Machine Learning for Big Data
	Author	Jason Bell
	Publisher	John Wiley and Sons
	Edition	2015

Course Title:	**SIGNATURE ANALYSIS AND RADAR IMAGING**
Course Code:	**ECLB 384**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To become familiar with fundamentals of radar and its functions.	Remembering (Level - I)
CO2	Able to learn different signal models in radar.	Understanding (Level – II)
CO3	Students acquire knowledge on the different types of filtering techniques radars and radar signal detection techniques.	Remembering (Level-I)
CO4	Students will demonstrate the ability to design a system component or process as per needs and specifications.	Evaluating (Level – V)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	1	2	0	0	0	0	0	0	2	3	2
CO-2	3	2	2	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	3	3	2	3	1	1	0	0	1	1	2	3	3
CO-4	3	3	3	3	3	1	1	0	0	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Resolution, spatial frequency, Fourier transforms, sampling theorem and spectrum replication, vector representation of signals, data integration, correlation, components of a radar signal, amplitude models, clutter, noise model and SNR, jamming, Frequency models: the Doppler shift, spatial models, spectral model.	**05**
Module-II	Radar equation and Radar Cross Section. Methods for RCS estimation: GO, PO, GTD and PTD techniques. Ray tracing. RCS of simple and complex targets. RCS enhancement Scattering by imperfectly conducting surfaces; Maliuzhinets' formulation and characterization of Absorbers. Methods of RCS reduction	**07**
Module-III	Waveform matched filter, matched filtering of moving targets, frequency-modulated pulse compression waveforms, range side lobe control for fm waveforms, Costas Frequency domain target signatures. Real array Imaging radars. Synthetic array Radars. Signal processing methods.	**08**
Module-IV	Moving target indication (MTI), pulse Doppler processing, dwell-to-dwell stagger, pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, mti for moving platforms: adaptive displaced phase centre antenna processing.	**08**
Module-V	radar detection as hypothesis testing, threshold detection in coherent systems, threshold detection of radar signals constant false alarm rate (CFAR) detection, the effect of unknown interference power on false	**08**

	alarm probability, cell averaging cfar, the effect of varying pfa, analysis of cell averaging cfar, ca cfar limitations.	

Learning Resources:

Text Books:		
1.	Title	Fundamentals of radar signal processing
	Author	Mark A Richards
	Publisher	TMH
	Edition	2005
2.	Title	Introduction to radar systems
	Author	Merrill I. Skolink
	Publisher	Tata McGraw hill Publications 2001
Reference Books:		
1.	Title	Radar Signal Principles
	Author	Nathanson
	Publisher	Mcgraw hill publications
	Edition	1964

Course Title:	**EMBEDDED REAL TIME OPERATING SYSTEMS**
Course Code:	**ECLB 445**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	To understand the basics of Real time operating Systems (RTOS).	Remembering (Level-I)
CO2	To develop real-time algorithm for task scheduling.	Understanding (Level - II)
CO3	To understand the working of real-time operating systems and real- time database.	Applying (Level –III)
CO4	To work on design and development of protocols related to real-time communication.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	2	3	0	0	0	0	0	0	2	3	2
CO-2	3	3	2	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-4	3	3	2	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Real life examples of Embedded system, Basics of Developing for Embedded system, Embedded system Initialization.	**06**
Module-II	Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, Tasks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use.	**09**
Module-III	Other Kernel Objects: Pipes, Event Registers, Signals, Condition Variables, Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem, Port-mapped v/s Memory mapped I/O and DMA, Exceptions and Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations, RT Linux, Micro C/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.	**09**
Module-IV	Memory management, Dynamic Memory Allocation in Embedded	**12**

	Systems, Fixed size memory management in Embedded systems, Blocking v/s non-blocking memory functions, Synchronizations and Communications, Resource Classification, Deadlocks Detection and Recovery, Priority Inversions.	

Learning Resources:

Text Books:		
1.	Title	Real Time Concepts for Embedded Systems
	Author	Qing Li, Elsevier
	Edition	2011
	Title	Embedded Systems- Architecture, Programming and Design
2.	Author	Rajkamal
	Publisher	TMH
	Edition	2007
	Title	Embedded Linux: Hardware, Software and Interfacing
3.	Author	Dr. Craig Hollabaugh
	Publisher	Addison-Wesley Professional
	Edition	2002
	Title	Real Time Concepts for Embedded Systems
Reference Books:		
1.	Title	Advanced UNIX Programming
	Author	W. Richard Stevens
	Publisher	Addison-Wesley Professional
	Edition	3rd Edition, originally published in 1992

Course Title:	**NEURAL NETWORKS**
Course Code:	**ECLB 446**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECBB 252), Digital Communication (ECBB 303), Digital Signal Processing (ECBB 353), Antenna and Wave Propagation (ECLB 351)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand the difference between biological neuron and artificial neuron	Understanding (Level - II)
CO2	Understand building blocks of Neural Networks.	Understanding (Level - II)
CO3	Develop neural network models	Understanding (Level - II)
CO4	Design and develop applications using neural networks.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	1	2	0	0	0	0	0	0	2	3	2
CO-2	3	3	2	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Review of linear algebra, norms and distance concepts, classical optimization techniques, Lagrange multiplier method, derivative free optimization methods, no free lunch theorem, basics of probability theory, state variable analysis of dynamical systems. What is a neural network? Human Brain, Models of a Neuron, Neural networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks.	**06**
Module-II	Error Correction learning, Memory based learning, Hebbian learning, Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process, Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perception –convergence theorem, Relation between perception and Bayes classifier for a Gaussian Environment.	**08**
Module-III	Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection, BACK PROPAGATION - back propagation and	**10**

	differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, Accelerated convergence, supervised learning.	
Module-IV	Two basic feature mapping models, Self-organization map, SOM algorithm, properties of feature map, computer simulations, learning vector quantization, Adaptive patter classification, Hierarchal Vector quantizer, contexmel Maps, Dynamical systems, stability of equilibrium states, attractors, neurodynamical models, manipulation of attractors' as a recurrent network paradigm, Hopfield models.	**12**

Learning Resources:

Text Books:		
1.	Title	Neural Networks: A comprehensive foundation.
	Author	Simon Haykin
	Publisher	Pearson Education
	Edition	2nd Edition, 2004
2.	Title	Artificial Neural Networks
	Author	B. Vegnanarayana
	Publisher	Prentice Hall of India, Pvt. Ltd
	Edition	2005
3.	Title	Neural Networks in Computer Intelligence
	Author	Li Min Fu
	Publisher	Tata McGraw Hill
	Edition	2003
Reference Books:		
1.	Title	Neural Networks
	Author	James A Freeman David M S kapura
	Publisher	Pearson Education
	Edition	2004

Open Elective Course - I

Course Title:	**INTRODUCTION TO NANO SCIENCE AND NANO TECHNOLOGY**
Course Code:	**ECLB 385**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understanding of the basic science behind the properties of materials at the nanometre scale	Remembering (Level - I)
CO-2	To Analyze several important nanoscale materials for chemical engineering applications.	Understanding (Level - II)
CO-3	Understanding of the differences between the properties of micro and nano levels.	Applying (Level - III)
CO-4	To Analyze the characterization techniques of nanoscale materials.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**2**	**1**								**1**	**2**	**2**
CO-2	**3**	**1**	**2**	**1**								**1**	**2**	**2**
CO-3	**3**	**1**	**2**	**1**								**1**	**2**	**2**
CO-4	**3**	**1**	**2**	**1**								**1**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Background to Nanoscience: Definition of Nano, Scientific Revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.	**9**
Module-II	Types of nanostructure and properties of nanomaterials: One dimensional, Two dimensional and three-dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical- physical-chemical properties.	**9**
Module-III	Application of Nanomaterial: Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane-based application, polymer-based application.	**9**
Module-IV	Recent special nanomaterials: Carbon based nanomaterials – CNT- graphene- core-shell structures- Micro and Mesopores Materials- Organic- Inorganic Hybrids- ZnO- Silicon -- DNA-RNA- Nanoproducts.	**9**

Learning Resources:

Text Books:	1. "Chemistry of nanomaterials: Synthesis, properties and applications" by CNR Rao et.al., 2004. 2. "Nanoparticles: From theory to applications" by G. Schmidt, Wiley Weinheim 2004.
Reference Books:	"Processing & properties of structural naonmaterials" by Leon L. Shaw, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.
Other Suggested Readings:	Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.

Learning Resources: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

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Text Books:	Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens. Wiley India Pvt. Ltd. Solid State physics by Pillai, Wiley Eastern Ltd. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.
Reference Books:	Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books
Other Suggested Readings:	

Course Title:	**GROWTH, FABRICATION AND MANUFACTURING OF ELECTRONIC DEVICES**
Course Code:	**ECLB 386**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To Understand crystal structures of elements used for fabrication of semiconductor Devices and study energy band structure.	Remembering (Level - I)
CO-2	To Analyze fermi levels, movement of charge carriers, Diffusion current and Drift current.	Understanding (Level - II)
CO-3	To Evaluate the behaviour of semiconductor junction under different biasing Conditions. Fabrication of different semiconductor devices.	Applying (Level - III)
CO-4	To study the VI Characteristics of devices and their limitations in factors like current, power frequency and photoelectric effect and fabrication of opto electronic devices.	Analyzing (Level - IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**2**	**1**								**2**	**2**	**2**
CO-2	**3**	**1**	**2**	**1**								**2**	**2**	**2**
CO-3	**3**	**1**	**2**	**1**								**2**	**2**	**2**
CO-4	**3**	**1**	**2**	**1**								**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Miniaturization & its impact on characterization of Electronic Systems: Introduction, Trends & Projections in IC Design & Technology. Comparison between semiconductor materials. Basics of Thick and thin Film Hybrid Technology and monolithic chips. Advantages, limitations & Classification of ICs. Bipolar & MOS Techniques: Flow chart of Bipolar, NMOS and CMOS technologies. Basics of VLSI Design & Process Simulation, SUPREM.	**9**
Module-II	Monolithic Techniques: Silicon Refining for EGS, Single Silicon Wafer Preparation & Crystal Defects, Epitaxial Process, Diffusion, Ficks' Laws, Oxidation, Ion-Implantation, Photolithography, Basics of Vacuum Deposition & CVD, Etching techniques, Plasma Etching, Metallization and Isolation Techniques. Monolithic Components: Diodes and Transistors, JFETs, MOSFETs, Resistors, Capacitors, MESFETs, Basics of VLSI CMOS technology, Reliability issues in CMOS VLSI, Latching, and Electromigration.	**9**
Module-III	Assembly Techniques & Packaging of VLSI Devices: Introduction to packaging, Package design considerations, VLSI Assembly	**9**

	techniques, Packaging fabrication technology. Surface Mount Technology (SMT): Through hole technology, Surface Mount Technology, applications & SM Components.	
Module-IV	Special Techniques for Modern Processes: Self-aligned silicides, hallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.	**9**

Learning Resources:

Text Books:	1. "Solid State Electronic Devices" by Ben. G. Streetman & Sanjan Banerjee, PHI Private Ltd, 5th Edition, 2003. 2. "Operation & Mode line of The MOS Transistor" by Yannis T. sividis, Oxford University Press, 2nd Edition, 1999.
Reference Books:	"Semiconductor Devices Modeling a Technology" by Nandita Das Gupta &Aamitava Das Gupta, PHI Private Ltd, 2004.
Other Suggested Readings:	

Course Title:	**NEURAL NETWORKS AND FUZZY LOGIC**
Course Code:	**ECLB 387**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Comprehend the concepts of feed forward neural networks.	Understanding (Level - II)
CO2	Analyze the various feedback networks.	Applying (Level – III)
CO3	Understand the concept of fuzziness involved in various systems and fuzzy set theory.	Understanding (Level - II)
CO4	Comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.	Analyzing (Level –IV)
CO5	Analyze the application of fuzzy logic control to real-time systems.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	1	1	3	0	0	0	0	0	0	2	3	2
CO-2	3	2	2	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	2	3	3	3	1	1	0	1	1	1	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-5	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Neural Networks Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin- Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.	**05**
Module-II	Essentials of Artificial Neural Networks Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.	**05**
Module-III	Single Layer Feed Forward Neural Networks Introduction, Perceptron Models: Discrete, Continuous and Multi-Category,	**09**

	Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.	
Module-IV	Multilayer Feed Forward Neural Networks Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.	**08**
Module-V	Associative Memories Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory), Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network Summary and Discussion of Instance/Memory Based Learning Algorithms, Applications.	**09**

Learning Resources:

Text Books:		
1.	Title	Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications
	Author	Rajasekharan and Rai
	Publisher	PHI Publication
	Edition	
2.	Title	Introduction to Neural Networks using MATLAB 6.0
	Author	S. N. Sivanandam, S. Sumathi, S. N. Deepa
	Publisher	TMH
	Edition	2006

Course Title:	**ELECTRONIC MATERIALS AND THEIR APPLICATIONS**
Course Code:	**ECLB 388**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:		**Cognitive Levels**
CO-1	To Understand the quantum mechanics of electron in crystals and to Understand the basic electrical and magnetic properties of crystalline solids and amorphous materials.	Understanding (Level - II)
CO-2	To Understand the difference between electronic structures and physical properties of semiconductors, metals, and dielectrics.	Applying (Level – III)
CO-3	To analyze the electronic and optical transport characteristics of semiconductors and to understand the Understand the physics behind solid state electronics and optoelectronic devices.	Understanding (Level - II)
CO-4	To apply the basic design of major microelectronic and optoelectronic devices, their features, and limitations.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**1**	**1**								**2**	**1**	**3**
CO-2	**3**	**1**	**1**	**1**								**2**	**1**	**3**
CO-3	**3**	**1**	**1**	**1**								**2**	**1**	**3**
CO-4	**3**	**1**	**1**	**1**								**2**	**1**	**3**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction: Structure: atomic structures and bonding, types of bonding, band formation. Defects and imperfections in solids: Point, Line and Planer defects; Interfacial defects and volume defects. Classification of materials based on bonding: conductors, semiconductors and insulators.	**9**
Module-II	Conducting materials: Introduction, factors affecting the conductivity of materials, classification based on conductivity of materials, temperature dependence of resistivity, Low resistivity materials (graphite, Al, Cu and steel) and its applications, high resistivity materials (manganin, Constantin, nichrome, tungsten) and their applications. Superconductors: Meissner effect, classification and applications.	**9**
Module-III	Semiconductors: Introduction, types of semiconductors, temperature dependence of semiconductors, compound semiconductors, basic ideas of amorphous and organic semiconductors. Magnetic Materials: classification of magnetic	**9**

	materials, ferromagnetism-B-H curve (Qualitative), hard and soft magnetic materials, magneto materials applications.	
Module-IV	Dielectric Materials: Introduction, classification, temperature dependence on polarization, properties, dielectric loss, factors influencing dielectric strength and capacitor materials, applications. Insulators: Introduction, thermal and mechanical properties required for insulators, Inorganic materials, organic materials, liquid insulators, gaseous insulators and ageing of insulators, applications. Optoelectronic materials: Introduction, properties, factor affecting optical properties, role of optoelectronic materials in LEDs, LASERs, photodetectors, solar cells. Nano electronic Materials: Introduction, advantage of nanoelectronics devices, materials, fabrication, challenges in Nano electronic materials.	**9**

Learning Resources:

Text Books:	1. S.O. Kasap "Principles of Electronic Materials and Devices", 3rd edition, McGraw-Hill Education (India) Pvt. Ltd., 2007. 2. W D Callister, "Materials Science & Engineering – An Introduction", Jr., John Willey & Sons, Inc, New York, 7th edition, 2007.
Reference Books:	B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th edition, PHI Learning, 2009.
Other Suggested Readings:	Eugene A. Irene, Electronic Materials Science, Wiley, 2005

Course Title:	**OPTIMIZATION TECHNIQUES**
Course Code:	**ECLB 389**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	Comprehend the techniques and applications of Engineering Optimization.	Understanding (Level - II)
CO2	Analyze characteristics of a general linear programming (LP) problem.	Applying (Level – III)
CO3	Apply basic concepts of mathematics to formulate an optimization problem.	Applying (Level – III)
CO4	Analyze various methods of solving the unconstrained minimization problem.	Analyzing (Level –IV)
CO5	Analyze and appreciate a variety of performance measures for various optimization problems.	Evaluating (Level –V)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	2	2	1	3	0	0	0	0	0	0	2	3	2
CO-2	3	3	3	2	3	0	0	0	0	0	0	2	3	3
CO-3	3	2	3	2	3	0	0	0	0	0	0	2	3	2
CO-4	3	3	3	3	3	0	0	0	0	1	1	2	3	3
CO-5	3	3	3	3	3	0	0	0	0	2	2	2	3	3

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Preliminaries: Vector Spaces and Matrices, Linear Transformations, Eigenvalues and Eigenvectors, Orthogonal Projections, Quadratic Forms, Matrix Norms, Concepts from Geometry, Elements of Calculus.	**05**
Module-II	Unconstrained Optimization: Basics of Set Constrained and Unconstrained Optimization, One Dimensional Search Methods, Golden Section Search, Fibonacci Search, Newton's Method, Secant Method, Solving Ax = b	**07**
Module-III	Linear Programming: Introduction to Linear Programming, Simplex Method, Duality	**08**
Module-IV	Nonlinear Constrained Optimization: Problems with Equality Constraints, Problems with Inequality Constraints, Karush Kuhn Tucker Condition, Convex problems Optimization.	**08**

Module-V	Algorithms for Constrained Optimization: Projections, Project gradient methods, Penalty methods.	**08**

Learning Resources:

Text Books:		
1.	Title	An Introduction to Optimization
	Author	Edwin K.P. Chong, Stanislaw H. Zak,
	Publisher	Wiley
	Edition	
2.	Title	Convex Optimization
	Author	Stephen Boyd and LievenVandenberghe
	Publisher	Cambridge University Press
	Edition	
3.	Title	Modern Optimization with R (Use R)
	Author	Paulo Cortez
	Publisher	Springer
	Edition	20104

Course Title:	**STANDARDIZATION AND QUALITY ECOSYSTEM**
Course Code:	**ECLB 390**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the clean room technology and basic fabrication process flow of semiconductor devices.	Remembering/Understanding (Level-I/Level-II)
CO-2	To implement digital circuits such as CMOS inverter, Pseudo NMOS, DCVS, Domino etc.	Application (Level-III)
CO-3	To design the layout and stick diagram of various logic gates.	Analysis (Level-IV)
CO-4	To evaluate the static and dynamic switching characteristics of CMOS inverter.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-2	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-3	**3**	**1**	**2**	**2**								**2**	**1**	**2**
CO-4	**3**	**1**	**2**	**2**								**2**	**1**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Accreditation & International Standardization Bodies** • International Accreditation Forum (IAF) – Introduction and Structure • ISO/IEC 17011 -Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies • ISO (International Organization for Standardization) • IEC (International Electrotechnical Commission) • ITU (International Telecommunication Union) Regional Standardization	**01**
Module-II	**Quality Council of India (QCI) and Bureau of Indian Standards (BIS)** • Introduction and Role of QCI • Boards/Divisions under QCI • Overview of BIS and its activities Organizational Structure and Goals of BIS	**02**
Module-III	**Basic Concepts of Standardization**	**03**

	• What is a STANDARD? • Need, Aims and Benefits of Standards • Types of Standards • What is STANDARDIZATION? History of Standardization – international level and national level	
Module-IV	**Laboratory Operations at BIS** • Basics of Laboratory Operations • Role of Labs in conformity assessment • BIS Testing Labs • Inter Laboratory Comparison and Proficiency Testing Concept of 'One Nation One Standard' and Standard Developing Organization (SDO)	**04**
Module-V	**Overview of Conformity Assessment in BIS** • What is CERTIFICATION? • Key Pillars of Certification • BIS Conformity Assessment Legal Framework • Overview of BIS Conformity Assessment Schemes • Voluntary and Mandatory Certification • Product Certification Schemes Foreign Manufacturer's Certification Scheme	**05**
Module-VI	**Addressing Sustainability Through Standards** • Concept of Sustainability • Need for Sustainability and Role of Standards • United Nations Sustainable Development Goals (UN SDGs) • ISO Guidelines for Addressing Sustainability and Climate Change in Standards • Consultative Groups on Sustainability Approach to address Sustainability in Standards	**06**
Module-VII	**BIS – Academia Collaboration** • Research-based standardization - R&D Projects and Action Research Projects • Annual Programme for Standardization • Standardization Cells • State-Level Committee on Standardization (SLCS) • Partnering with Academic Institutes • Manak Manthan and Manak Mantrana • Importance of concepts on standards for students • Role of Faculty and Research Scholars in Standardization and Quality Ecosystem of the country Training and Capacity Building	**07**
Module-VIII	**In these lectures, the important standards, their requirement and development procedures will be discussed** Students can select one of the sections mentioned below according to his/her background/branch and choice SECTION I - Chemical, Environment and Ecology, Food and Agriculture, Petroleum, Coal and Related Products SECTION II - Electronics and Information Technology, Medical Equipment, Electrical, AI and Computer Science	**08-11**

	SECTION III- Civil, Structure, Building, Water Resources and Transport SECTION IV – Mechanical, Metallurgical, Production and General Engineering SECTION V- Service Sector, Management and Systems	
Module-IX	Exercise on the drafting of Indian Standard as per IS 12 - Guide for Drafting and Presentation of Indian Standards, Workshop/Assignment	**12-13**

Learning Resources:

Text Books:	1. ISO Standards Handbook, International Organization for Standardization. 2. Alan Bryden and Dr. Samad El-Hout, Conformity Assessment: Fundamentals and Practices.
Reference Books:	3. Russell, J.P. The ISO 9001-2015 Handbook 4. Jacobson Kai, The Role of Standards in Today's Society and in the future. 5. John. G. Keogh, Hakan Anderson, International Conformity Assessment: Current Practices and Future Directions. 6. BIS Standards catalogue by Bureau of Indian Standards. 7. ISO/IEC 17000: Conformity Assessment -Vocabulary and General Principles.
Other Suggested Readings:	

Open Elective Course – II

Course Title:	**GREEN TECHNOLOGIES**
Course Code:	**ECLB 448**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand basic concepts of green technology.	Remembering (Level-I)
CO-2	Explain the different types of wastes and minimization techniques.	Understanding (Level - II)
CO-3	Specific understanding of Green reagents and solvents.	Applying (Level –III)
CO-4	Correlate the greener approach to industrial application and effect of green house.	Analyzing (Level –IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**1**	**1**								**2**	**2**	**2**
CO-2	**3**	**1**	**2**	**2**								**2**	**2**	**2**
CO-3	**3**	**1**	**2**	**2**								**2**	**2**	**2**
CO-4	**3**	**1**	**2**	**2**								**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction of Green Technologies: Ecosystem, need, Goal & Limitation of Green Technology, Principle with their explanation and examples of sustainable development, atom economy, reaction of Toxicity.	**9**
Module-II	Waste: Quantification of different waste products, analysis technique, production, prevention, problems Bio waste, chemical, industrial, electronics, agricultural waste, waste minimum technique & 3R technique (3R=Reduce, Reuse, Recycle) waste treatment and recycling.	**9**

Module-III	Green reagents and solvents: Green oxidation reaction, photochemical reaction, microwave, ultrasound assisted reactions, green reagents and solvents.	**9**
Module-IV	Industrial case studies: Greener approach of acetic acid manufacture, leather manufacture, greener approach of dyeing, polyethylene echo friendly pesticides, paper and pulp industry, and pharmaceutical industry. Case study: Ranitidine/omeprazole. Greenhouse effect and Global warming: Impact of green house, effect on global climate, and consequence of greenhouse effect.	**9**

Learning Resources:

Text Books:	1. **"**Green Chemistry: Environmentally Benign" by V. K. Ahluwalia, Ane Books India, New Delhi, 2006 **2.** "Green chemistry: Environment Friendly Alternatives Reactions" Rashmi Sanghi and M M Srivastava, Narosa Publishing House
Reference Books:	
Other Suggested Readings:	

Course Title:	**MACHINE LEARNING AND PATTERN RECOGNITION**
Course Code:	**ECLB 449**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To understand the basics of the machine learning and pattern recognition.	Remembering (Level-I)
CO2	To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning and pattern recognition.	Understanding (Level - II)
CO3	To enable the students to know deep learning techniques to support real- time applications.	Applying (Level –III)
CO4	To understand the need for machine learning for various problem solving	Analyzing (Level –IV)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-2	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-3	3	3	3	3	3	1	1	0	1	2	2	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Basic definition: Machine Learning, Pattern, and Pattern Recognition. Feature vector and Feature space, Features of pattern recognition, Classifier and Decision Boundary, Phases of pattern recognition, its advantage and disadvantage, Design Principles of	**06**

	Pattern Recognition: Statistical and Structural approach. Feature Extraction: different shape and region-based methods, Overfitting and Under- fitting.	
Module-II	Bayesian Learning: Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks. Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces; Normal density and discriminant functions. Maximum- Likelihood estimation: Gaussian case, Maximum a Posteriori estimation, Bayesian estimation: Gaussian case, Problems of dimensionality, Dimensionality reduction: Principle component analysis, Linear Discriminant Analysis (LDA), KL expansion. Regression: Linear Regression and Logistic Regression.	**12**
Module-III	SUPPORT VECTOR MACHINE: Introduction, Types of support vector kernel – (Linear kernel, polynomial kernel, and Gaussian kernel), Hyperplane – (Decision surface), Properties of SVM, and Issues in SVM. DECISION TREE LEARNING - Decision tree learning algorithm, Inductive bias, Inductive inference with decision trees, Entropy and information theory, Information gain, ID-3 Algorithm, Issues in Decision tree learning. Instance-based learning – k-Nearest Neighbor Learning. Clustering approach: K-means, GMM. REINFORCEMENT LEARNING– Introduction to Reinforcement Learning, Learning Task, Example of Reinforcement process, Q Learning - Q Learning function, Q Learning Algorithm), Application of Reinforcement Learning, Introduction to Deep Q Learning. Bootstrapping, Boosting, Bagging and Combining Classifiers.	**12**
Module-IV	ARTIFICIAL NEURAL NETWORKS – Perceptron's, Multilayer perceptron, Gradient descent and the Delta rule, Multilayer networks, Derivation of Backpropagation Algorithm, Generalization, Unsupervised Learning – SOM Algorithm and its variant. DEEP LEARNING - Introduction, concept of convolutional neural network, Types of layers (Convolutional Layers, Activation function, pooling, fully connected), Concept of Convolution (1D and 2D) layers, Training of network, Case study of CNN for e.g. on Diabetic Retinopathy, Building a smart speaker, Self-deriving car etc.	**06**

Learning Resources:

Text Books:		
1.	Title	Machine Learning,
	Author	Tom M. Mitchell
	Publisher	McGraw-Hill Education (India) Private Limited,
	Edition	2013
2.	Title	Pattern Recognition and Machine Learning
	Author	Bishop, C.
	Publisher	Springer
	Edition	2006
3.	Title	Introduction to Machine Learning
	Author	Alpaydin,E.

	Publisher	MIT Press
	Edition	2004
Reference Books:		
1.	Title	Neural Networks
	Author	James A Freeman David M S kapura
	Publisher	Pearson Education
	Edition	2004
2	Title	Pattern Classification, 2nd edt.
	Author	R. O. Duda, P. E. Hart and D. G. Stork
	Publisher	Wiley India
	Edition	2007

Course Title:	**WIRLESS COMMUNICATION AND SENSOR NETWORKS**
Course Code:	**ECLB 450**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To explain different types of wireless channels, examine the effects of mobile radio propagation environment, and discuss modern wireless systems.	Remembering/Understanding (Level-I/Level-II)
CO2	To analyse Network Architecture, Sensor Networks Scenarios Design Principle, Physical Layer and Transceiver Design Considerations.	Analysis (Level-IV)
CO3	To evaluate the impact of mobile/wireless channels and performance enhancement techniques on communication systems, and justify the findings	Application/Evaluation (Level-III/Level-V)
CO4	To modify existing communication technologies or design & develop new technologies for enhanced spectral efficiency and quality of experience, so as to meet the growing demand for mobile communication	Evaluation/Synth-esis (Level-V/Level-VI)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	3	1	1	0	1	1	1	2	3	3
CO-2	3	3	3	3	3	1	1	0	1	1	1	2	3	3
CO-3	3	3	3	3	3	1	1	0	1	2	2	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:

Module	Detailed Syllabus	Contact Hours
Module-I	Single Node Architecture Hardware Components Network Characteristics unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks Types of wireless sensor networks.	**08**
Module-II	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 Internet to WSN Communication.	**08**
Module-III	MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts – SMAC, BMAC 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.	**08**
Module-IV	Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node level software platforms, Node level Simulators, State centric programming.	**12**

Learning Resources:

Text Books:		
1.	Title	Protocols and Architectures for Wireless Sensor Networks
	Author	Holger Karl & Andreas Willig
	Publisher	John Wiley
	Edition	5th Edition, 2005
2.	Title	Fundamentals of Wireless Sensor Networks - Theory and Practice
	Author	WaltenegusDargie, Christian Poellabauer
	Publisher	John Wiley & Sons Publications
	Edition	5th Edition, 2011
3.	Title	Wireless Sensor Networks-Technology, Protocols, and Applications
	Author	KazemSohraby, Daniel Minoli, &TaiebZnati,
	Publisher	John Wiley
	Edition	5th Edition, 2007
Reference Books:		
1.	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.	
	Feng Zhao & Leonidas J.Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.	
	WaltenegusDargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks - Theory and Practice”, John Wiley & Sons Publications, 2011	
	Kazem Sohraby, Daniel Minoli, &Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, and Applications”, John Wiley, 2007.	

Course Title:	**DATA COMMUNICATION AND NETWORKING**
Course Code:	**ECLB 451**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To understand overview of data communication and networking aspect.	Remembering/Understanding (Level-I/Level-II)
CO2	To apply various multiple access techniques to understand the modern communication methodologies	Application (Level-III)
CO3	To analyse the different routing algorithms needed.	Analysis (Level-IV)
CO4	To evaluate the different protocols used in transport and application layer.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	3	0	0	0	1	1	1	2	3	2
CO-2	3	3	3	2	3	0	0	0	1	1	1	2	3	3
CO-3	3	3	3	3	3	0	0	0	1	1	1	2	3	3
CO-4	3	3	3	3	3	1	1	0	1	2	2	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to data communication and networking: Why study data communication? Data Communication, Networks, Protocols	**08**

	and Standards, Standards Organizations. Line Configuration, Topology, and Transmission Modes, Categories of Networks Internet works, history and development of computer networks. **Basic Network Architectures**: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit-switched, packet-switched, message switched, extranet, intranet, Internet, wired, wireless)	
Module-II	Study of Signals: Analog and Digital, Periodic and Aperiodic Signals, Analog Signals, Time and Frequency Domains, Composite Signals, Digital Signals, **Physical layer**: line encoding, block encoding, scrambling, and Different types of transmission media. **Data Link Layer services**: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.	**08**
Module-III	Guided Media, Unguided Media, Transmission Impairments, Performance Wavelength, Shannon Capacity, Media Comparison, PSTN, Switching, Local Area Network Technology: Token Ring. Error detection (Parity, CRC), Ethernet, Fast Ethernet, Gigabit Ethernet, Personal Area Network: Bluetooth and Wireless Communications Standard: Wi-Fi (802.11) and WiMAX.	**08**
Module-IV	**Network layer**: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Supernetting, Classless addressing, Network Address Translation. Introduction to networks and devices: Network classes, Repeaters, Hub, Bridges, Switches, Routers, Gateways Brouters Routing Algorithms, Distance Vector Routing, Link State Routing, Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little's formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP.	**12**

Learning Resources:

Text Books:		
1.	Title	Data and Computer Communications
	Author	William Stallings
	Publisher	Pearson
	Edition	TENTH EDITION
2.	Title	Computer Networks
	Author	AS Tanenbaum, DJ Wetherall
	Publisher	Prentice-Hall
	Edition	5th Edition, 2010
3.	Title	Data Communication and Network
	Author	Behrouz A. Forouzan
	Publisher	McGraw Hill

	Edition	5th Edition, 2012

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Reference Books, Journals, Reports, Websites etc. in the IEEE format**)**

1.	Data Communications and Networking - Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2.	Data Communication & Networking by Forouzan, Tata McGraw Hill
3.	Kurose and Ross, "Computer Networking- A Top-Down Approach", Pearson.
4.	Computer Network, 4e, by Andrew S. Tenenbaum, Pearson Education/ PHI.

Course Title:	**MICROELECTRONICS AND VLSI TECHNOLOGY**
Course Code:	**ECLB 452**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the clean room technology and basic fabrication process flow of semiconductor devices.	Remembering/Understanding (Level-I/Level-II)
CO-2	To implement digital circuits such as CMOS inverter, Pseudo NMOS, DCVS, Domino etc.	Application (Level-III)
CO-3	To design the layout and stick diagram of various logic gates.	Analysis (Level-IV)
CO-4	To evaluate the static and dynamic switching characteristics of CMOS inverter.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-2	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-3	**3**	**1**	**2**	**2**								**2**	**1**	**2**
CO-4	**3**	**1**	**2**	**2**								**2**	**1**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Clean Room Technology, Clean Room Classifications, Design concepts, Clean Room Installations and Operations, Automation related facility systems, future trends. Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning, Epitaxy, Fundamental Aspects, Conventional silicon epitaxy, low	**9**

	temperature, Epitaxy of silicon, selective epitaxial growth of Si, Characterization of epitaxial films.	
Module-II	Process simulation, Introduction, Ion-implantation, Monte Carlo method, Diffusion and Oxidation, two-dimensional LOCOS simulation example, Epitaxy, Epitaxial doping model, Lithography, Optical projection lithography, Electron-beam lithography, Etching and deposition, future trends.	**9**
Module-III	Transistors and layouts - Transistors, Wires and Vias, Design Rules, Layout Design and Stick Diagrams - example, Logic Gate – Pseudo NMOS, DCVS, Domino. Delay through Resistive Interconnect. CMOS Inverter: Basic Circuit and DC Operation – DC Characteristics.	**9**
Module-IV	Inverter Switching Characteristics- Static behavior– Switching threshold, Noise Margin, CMOS Inverter Dynamic Behavior-capacitances, propagation delay - High-to-Low time, Low to High time, Sources of Power Consumption, Power Consumption Static and dynamic. Logic Gate - Switch Logic.	**9**

Learning Resources:

Text Books:	1. "VLSI Technology" by S M Sze, McGraw Hill, 2nd Edition, 2000. 2. "Modern VLSI Design Systems on Silicon" by Wayne Wolf Pearson Education Asia, 2nd Edition, 2004. 3. "CMOS Digital Integrated circuits- Analysis and design" Sung- Mo Kang and Yusuf Leblenici, McGraw Hill, 2nd Edition, 2009.
Reference Books:	"Digital Integrated Circuits-(A design perspective)" by Jan M. Rabaey, P.M.I, 2nd Edition.
Other Suggested Readings:	