Scheme and Syllabus

of

B. Tech.

Electronics and Communication Engineering

(2024-2025 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)

*Approved in the 3rd Meeting of Board of Studies of the Dept. of ECE, held on February 23, 2024 and in line with the recommendation of the Honourable Senate in the 17th Senate Meeting held on May 30, 2024.

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

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.

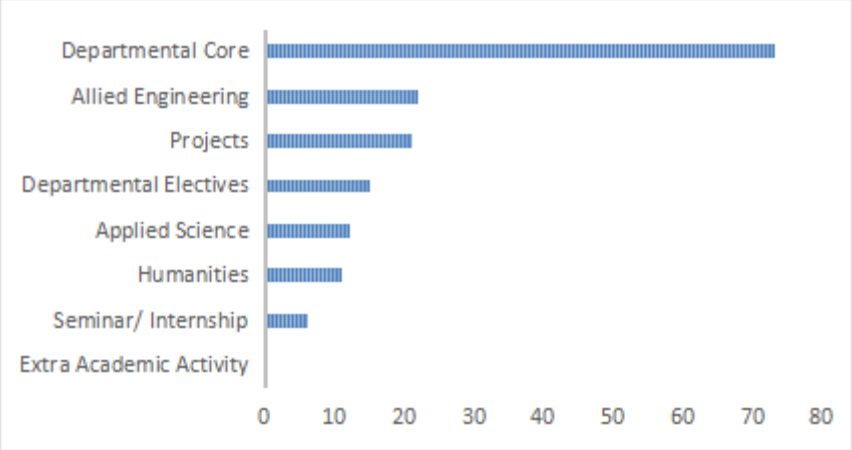
2.6 Program Specific Objectives (PSOs)

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.

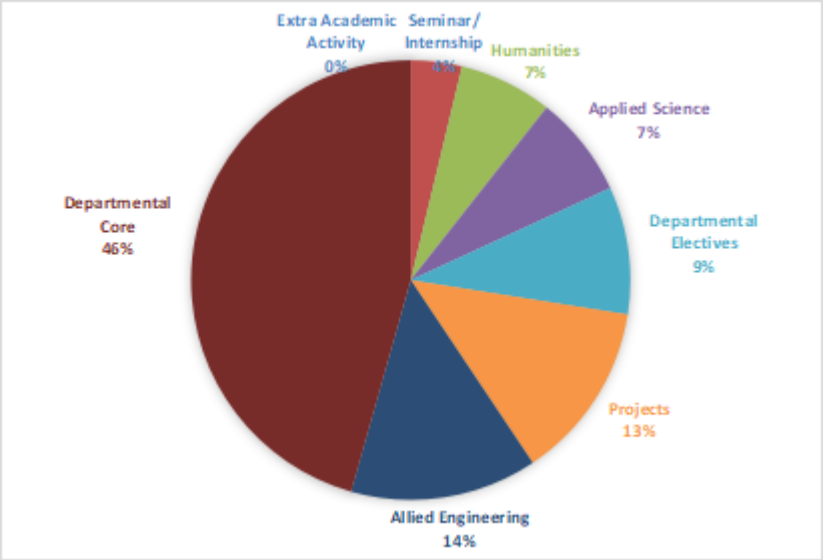
3.1 Semester wise Credit Structure

Sl. 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.	Departmental Core	04	07	19	12	16	11	04	0	73
2.	Departmental Electives	--	--	--	--	03	03	09	--	15
3.	Allied Engineering	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 %)



Y = Year Number (1

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

= 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

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
ECBB 101	Basics of Electronics and Electrical Engineering	Departmental Core	3	0	2	4
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
HMPB 102	Communication Skills	Humanities and Management	0	0	2	1
HSPB 151	Holistic Health and sports	Extra Academic Activity	0	0	2	1
Total Credits			**14**	**1**	**12**	**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
ECLB151	Basic Communication Systems	Departmental Core	3	0	0	3
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
ECPB 151	Mini Project	Departmental Core	0	0	2	1
Total Credits			**15**	**1**	**8**	**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

Sl. 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 385	Nano Electronics & Nano Photonics	3	0	0	3	
8.	ECLB 386	Introduction to Plasmonics and Meta-materials	3	0	0	3	
9.	ECLB 421	Integrated Optics	3	0	0	3	Elective III + Elective IV + Elective V
10.	ECLB 422	Optical Networks	3	0	0	3	
11.	ECLB 423	Non- Linear Fibre Optics	3	0	0	3	
12.	ECLB 424	Advanced Optical Communication Systems	3	0	0	3	
13.	ECLB 447	Photonics Materials & Devices for Communications	3	0	0	3	

Specialization: Circuit Design and Networks

Sl. 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

Sl. 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

Sl. 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

Sl. 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

Sl. 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

Sl. 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	Millimetre 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

Sl. 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 +
5.	ECLB 446	Neural Networks	3	0	0	3	Elective V

List of Open Electives to be offered to Other Departments

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECLB 387	Introduction to Nano science and Nano technology	3	0	0	3
2.	ECLB 388	Growth, Fabrication and Manufacturing of Electronic Devices	3	0	0	3
3.	ECLB 389	Neural Networks and Fuzzy Logic	3	0	0	3
4.	ECLB 390	Electronic Materials and their Applications	3	0	0	3
5.	ECLB 391	Optimization Techniques	3	0	0	3
6.	ECLB 448	Green Technologies	3	0	0	3
7.	ECLB 449	Machine Learning and Pattern recognition	3	0	0	3
8.	ECLB 450	Wireless Communication and Sensor Networks	3	0	0	3
9.	ECLB 451	Data Communication and Networking	3	0	0	3
10.	ECLB 452	Micro-electronics and VLSI Technology	3	0	0	3

Course Code: MALB 101	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**ADVANCED CALCULUS**			
Course Coordinator:				
Course objectives:	This course is aimed to cover differential, integral and vector calculus for functions of one and more than one variable. These mathematical tools and methods are used extensively in physical sciences, engineering, and computer graphics.			

Course Outcomes Student will be able to:		**Cognitive Levels**
CO1	Understand the theory and methods of Differential, Integral and Vector Calculus	**Understanding (Level-II)**
CO2	Apply different methods for solving problems in Differential, Integral and Vector Calculus	**Applying (Level-III)**
CO3	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)**
CO4	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)**
CO5	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)**

Semester	**Autumn: Yes**		**Spring: No**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code					
Equivalent course codes as per proposed course and old course	MAL 101				

Overlap course codes as per proposed Course Code.					

Text Books:			
1.	Title	Thomas' Calculus	
	Author	G. Thomas, M. Weir, J. Hass	
	Publisher	Pearson Pub.	
	Edition	2010	
2.	Title	Introduction to Real Analysis	
	Author	R.G. Bartle, D.R. Sherbert	
	Publisher	John Wiley and Sons	
	EDITION	2011	
Reference Books:			
1.	Title	Advanced Engineering Mathematics	
	Author	E. Kreyszig	
	Publisher	John Wiley and Sons	
Content	**UNIT 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.		**12**
	UNIT 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.		**12**
	UNIT 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.		**12**
	UNIT 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.		**12**
Course Assessment	Continuous Evaluation 25%, Mid Semester 25% and End Semester 50%.		

Course Code: PHBB 101	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**ENGINEERING PHYSICS**			
Course Coordinator				
Course objectives:	Understand the basic concepts of electromagnetic theory through vector analysis and recall the fundamentals of optics (interference, diffraction, and polarization), lasers, and fiber optics. Also acquired the knowledge of the origin, evolution of quantum physics (mainly particle properties of light and wave properties of particles) and solid-state physics.			

Course Outcomes		**Cognitive Levels**
CO1	Recall the basic principles of physics related to optics, relativity, quantum mechanics, atomic physics and thermodynamics.	**Remembering (Level - I)**
CO2	Illustrate the various physical phenomena with interpretation based on the mathematical expressions involved.	**Understanding (Level - II)**
CO3	Apply the concepts/principles to solve the problems related to wave nature of light, relativity, quantum mechanics and atomic physics.	**Applying (Level - III)**
CO4	Analyze and examine the solution of the problems using physical and mathematical concepts involved.	**Analyzing (Level - IV)**

Semester	**Autumn: Yes**		**Spring: Yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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.		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

<table>
<tr><td rowspan="3">2.</td><td>Title</td><td colspan="2">Concepts of Modern Physics</td></tr>
<tr><td>Author</td><td colspan="2">A. Beiser</td></tr>
<tr><td>Publisher</td><td colspan="2">Tata McGraw-Hill Education</td></tr>
<tr><td>Content</td><td colspan="3">UNIT 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.</td><td>12</td></tr>
<tr><td colspan="3">UNIT 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.</td><td>12</td></tr>
<tr><td colspan="3">UNIT 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 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.</td><td>12</td></tr>
<tr><td colspan="3">UNIT 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.</td><td>12</td></tr>
<tr><td colspan="4">Tentative List of Experiments-

Characteristics of PN junction, Zener, and Light emitting diodes Determination of semiconductor bandgap through thermal variation Determination of Planck’s constant through LED Newton’s rings apparatus experiment Malus’ law verification for polarization Diffraction grating experiment</td></tr>
<tr><td>Course Assessment</td><td colspan="4">Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%
Lab: Continuous Evaluation 50% End Semester 50%
60% weightage to theory and 40 % weightage to laboratory for overall grading</td></tr>
</table>

Course Code: ECBB 101	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course and Lab Course			
Course Title	**BASICS OF ELECTRONICS AND ELECTRICAL ENGINEERING**			
Course Coordinator				
Course Objectives	To course aims to provide the field of electrical & electronics engineering, laws and principles of electrical/electronic engineering and to acquire fundamental knowledge in the relevant field.			

Course Outcomes		**Cognitive Levels**
CO1	Describe the fundamental physical processes and ballistics of electronics and the basic laws/ definitions.	**Remembering (Level - I)**
CO2	To understand the physics behind electronic devices based on the above processes and laws/ definitions.	**Understanding (Level - II)**
CO3	Explain and apply the basic principles of semiconductor based electronic devices such as PN Junction devices and related basic devices.	**Applying (Level - III)**
CO4	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)**

Semester	**1st**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course	EEB 101 (Introduction to Electrical and Electronics Engineering) in Old Scheme			

Text Books		
1.	Title	Electronic Devices and Circuits
	Author	Christos C. Halkias, Jacob Millman, SatyabrataJit
	Publisher	Tata McGraw Hill Education Pvt Ltd, 2010.
	Edition	3rd Edition
	Title	Solid State Electronic Devices
	Author	Ben G Streetman and S. K. Banerjee
	Publisher	Pearson India Pvt. Ltd., 2014
	Edition	7th Edition
2.	Title	Integrated Electronics - Analog and Digital Circuit and Systems
	Author	Millman, Halkias& Parikh
	Publisher	McGraw-Hill Education, 2012.
	Edition	2nd Edition

Reference Books			
1.	Title	Fundamentals of Electrical and Electronics Engineering	
	Author	S. Ghosh	
	Publisher	PHI Learning Pvt. Ltd., 2007.	
	Edition	2nd Edition	
2	Title	Electrical Engineering Fundamentals	
	Author	Vincent Del Toro.	
	Publisher	PHI Learning, 2015	
	Edition	2nd Edition	
3	Title	Basic Electrical Engineering,	
	Author	I.J. Nagrath& D P Kothari	
	Publisher	Tata Mcgraw Hill, 2009	
	Edition	3rd Edition	
Course Contents	**UNIT 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.		**12**
	UNIT II: Diode Applications: Rectifiers: Half wave, centre tapped and bridge full-wave, Zener diode regulator and voltage multiplier, clipping and clamping circuits.		**12**
	UNIT 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 of reactive power, power factor, 3-phase balanced and unbalanced supply, star and delta connections.		**12**
	UNIT 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.		**12**

Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Tentative List of Experiments	
S. No.	**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 Code: MEPB 121	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)
Type of Course	No	Yes	No
Course Title	PRODUCT DESIGN & REALIZATION LABORATORY		
Course Coordinator			
Course objectives:	The student will be able to identify the manufacturing processes required to manufacture an engineering product. The student will have a brief exposure of basic manufacturing machineries and processes, which arewidely utilized in industries to manufacture products and also introduce the basic principle of 3D modelling of products and develop 3D model using software such as SolidWorks etc.		

Course Outcomes		Cognitive Levels
CO1	Define the basic of design (2D and 3D models) and associated tools.	Remembering (Level I)
CO2	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)
CO3	Demonstrate the working principle of lathe machine and able to fabricate the prototypes of desired shape and accuracies.	Understanding (Level II)

POs					
Semester	Autumn: NO		Spring: YES		
	Lecture	Tutorial	Practical	Credits	Total teachinghours
Contact Hours	0	0	2	1	22
Prerequisite course code asper proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposedcourse and old course	MEP 121				
Overlap course codes as perproposed course numbers					

Text Books:

1.	Title	Introduction to Basic Manufacturing Processes and Workshop Technology
	Author	Rajendra Singh
	Publisher	New Age International Publishers, India
	Edition	2006

Reference Books:		
1.	Title	A Textbook of Workshop Technology: Manufacturing Processes
	Author	R. S. Khurmi& J K Gupta
	Publisher	S. Chand Publications
	Edition	16/e
Content	**UNIT I:** 02 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. **UNIT II** 04 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. **UNIT III:** 04 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. **UNIT IV:** 04 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. **UNIT V:** 04 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. **UNIT VI:** 04 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.	
Course Assessment	**Continuous Evaluation 50%** **End Semester 50%**	

Exp. No.	Name of the Experiments
	INTRODUCTION TO PRODUCT DESIGN
1.	To study different tools used in SolidWorks.
2.	2D and 3D part design in SolidWorks.
	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
	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 lathe machine.
	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.
	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.
	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 Code: HMBB 101	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	Y	No	No
Type of Course	Theory and practical			
Course Title	**THEORY AND PRACTICES OF HUMAN ETHICS**			
Course Coordinator				
Semester	**Autumn: Yes**		**Spring:**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	2	0	2	3	**36**

Pre-requisite : Nil

Course Objective: Inculcating human values to grow as responsible human beings with a proper personality.

Course Outcomes		**Cognitive Levels**
CO1	Gain a comprehensive understanding of the concept of organization and organizational behaviour.	**Understanding (Level II)**
CO2	Develop ways to solve real-life problems related to human behaviour based on his understanding of morals, values and ethics.	**Applying (Level III)**
CO3	Understanding, developing and leveraging emotional, spiritual and social intelligence in the workplace.	**Understanding (Level II)**
CO4	Learn about the ethical and moral responsibilities of the engineers.	**Applying (Level III)**
CO5	Explain the conceptual framework of HRP and evaluate practical solutions of problems related to manpower planning in the organization.	**Evaluating (Level V)**

Course Contents

Unit I **09**

Introduction: Organization and Organizational Behavior- Concept and significance, Organizational Structures, Individual & Group Behavior; 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.

Unit II **09**

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.

Unit III **09**

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 Behavior.

Unit IV **09** Human Resource Policies& Procedures- Introduction, Importance of Policies, Policy Formation, Human Resources Planning. Decision-making & Ethics.	
List of Experiments: 1. Management Activities and Games 2. Case Studies 3. Group Discussion 4. Debate 5. Presentation 6. Skit	
Recommended 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. SenthilKumar "Engineering Ethics includes Human Values" - PHI Learning Pvt. Ltd- 2011 M.W. Martin, R. Schinzinger, "Ethics in Engineering", McGraw-Hill Education, 2005 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, G. Moorhead, "Organizational Behavior: Managing People and Organizations", Cengage Learning, 2013.
Course Assessment	Theory (60%): Continuous Evaluation 25%, Mid Semester 25% End Semester 50% Laboratory (40%): Continuous Evaluation 50%

Course Code: CELB 101	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course			
Course Title	**ENVIRONMENTAL SCIENCES**			
Course Coordinator				
Course Objectives	Create the awareness about environmental problems among people and imparting basic knowledge about the environment and its allied problems.			

Course Outcomes		**Cognitive Levels**
CO1	Gain a comprehensive understanding of the Environmental Science aspects.	**Understanding (Level II)**
CO2	Develop awareness of environment related issues.	**Applying (Level II)**
CO3	Learn about the ethical and moral responsibilities of the engineers towards environment.	**Understanding (Level II)**
CO4	Learn remedial measures to solve environmental issues.	**Remembering (Level I)**

Semester	**1st**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names	Nil				
Equivalent course codes as per proposed course and old course	Nil				

Course Contents		
	UNIT I: **Multidisciplinary nature of environmental studies:** Definition, scope and importance, need for public awareness.	**7**
	UNIT 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. Introduction, types, characteristic features, structure and function of the following ecosystems: - a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems, Biogeochemical cycles.	**8**
	UNIT 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. Inida 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	**7**

	biodiversity.	
	UNIT IV: **Environmental Pollution:** Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. nuclear hazards, Causes, effects and control measures of urban and industrial wastes. Pollution case studies. Solid waste	7
	Unit V: **Social Issues and the Environment:** From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Climate change, global warming, acid rain, ozone layer depletion and Eutrophication.	7
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: HMPB 102	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	Y	No	No
Type of Course	**Practical**			
Course Title	**COMMUNICATION SKILLS**			
Course Coordinator				
Semester	**Autumn: Yes**		**Spring: Yes**	

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	0	0	2	1	**28**

Pre-requisite	:	Nil

Course Outcomes		Cognitive Levels
CO1	To prepare engineering students to perform well in technical writing and presentation skills.	**Remembering (Level - I)**
CO2	To prepare engineering students for core engineering skills through soft skills	**Understanding (Level - II)**
CO3	To equip engineering students with writing skills.	**Applying (Level - III)**
CO4	To equip engineering students with presentation skills.	**Applying (Level - III)**
CO5	To equip engineering students with discussion and interview skills.	**Analyzing (Level - IV)**

Course Content:	**Unit I:** **WRITTEN COMMUNICATION** **06** 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).
	Unit II: **ORGANISATIONAL COMMUNICATION** **05** 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
	Unit III: **PRESENTATION SKILLS** **06** 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.

	Unit IV: Group Discussion Skills **06** 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.
	Unit V: Job Interviews **05** Pre-interview Presentation Techniques Self-Analysis, Research the Organisation Job Analysis, Revise your Subject Knowledge, Develop your Interview file. Interview questions: types, Answering Strategies.

Suggested Books:

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Rizvi, M. A. Effective Technical Communication. New Delhi: McGraw HillsEducation	2005
2.	Jones, L &R. Alexander. New International Business English. UK: CUP	2006
4.	Spoken English: A Manual of Speech and Phonetics by R. K. Bansal & J. B. Harrison. Orient Blackswan. Hyderabad.	2013
5.	Hewings, M. English Pronunciation in Use. Advanced. Cambridge: CUP	2009
6.	Marks, J.English Pronunciation in Use. Elementary. Cambridge: CUP	2009
7.	Nambiar, K.C. Speaking Accurately. A Course in International Communication. New Delhi: Foundation	2011
8.	Soundararaj, Francis. Basics of Communication in English. New Delhi: Macmillan	2012

Course Code	**:**	**HMPB 151**				
Course Title	**:**	**Holistic Health and Sports**				
Type of Course	**:**	**Extra Academic Activity**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	2	0	-
Pre-requisite	**:**	Nil				
Physical activities, Sports, Yoga, meditation, Indore and outdoor games, etc.						

Course Code: MALB 151	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**LINEAR ALGEBRA AND COMPLEX ANALYSIS**			
Course Coordinator:				
Course objectives:	This course covers matrix theory and linear algebra. The concepts of linear algebra are extremely useful in physics, economics and social sciences, natural sciences, and engineering. Also, this course covers basic concepts of complex analysis, such as limit, continuity, differentiability and integration, having engineering applications.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the theory and methods of linear algebra and complex analysis.	**Understanding (Level-II)**
CO2	Apply different methods for solving problems in linear algebra and complex analysis.	**Applying (Level-III)**
CO3	Analyze the rank of a matrix, linear independence, orthogonal projections, transformations, and differentiability.	**Analyzing (Level-IV)**
CO4	Evaluate inverse, eigenvalues and eigenvector, line integrals and integrals using residue theorem.	**Evaluating (Level-V)**
CO5	Construct normal form of matrix, orthogonal and orthonormal bases, and Taylor and Laurent series.	**Creating (Level-VI)**

Semester	**Autumn: Yes**		**Spring: No**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code	MALB 101				
Equivalent course codes as per proposed course and old course	MAL 151				
Overlap course codes					

Text Books:		
1.	Title	Linear Algebra and its Applications
	Author	David C. Lay
	Publisher	Pearson Pub.
	Edition	2011

2.	Title	Complex variables and its applications
	Author	R. V. Churchill
	Publisher	McGraw Hill
	EDITION	1960
Reference Books:		
1.	Title	Advanced Engineering Mathematics
	Author	E. Kreyszig
	Publisher	John Wiley and Sons
Content	**UNIT I:** **12** **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.	
	UNIT II: **12** **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.	
	UNIT III: **12** **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.	
	UNIT IV: **12** **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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 151	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**BASICS COMMUNICATION SYSTEMS**			
Course Coordinator				
Course objectives:	To understand the concept and techniques of analog communication and digital communication.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the basics of communication system, transmitter/receiver block diagram, definition of basic terms related to communication.	**Understanding (Level - II)**
CO2	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.	**Applying (Level – III)**
CO3	To understand the fundamentals of digital communication, Introduction to digital modulation techniques, distinguish between analog and digital communication.	**Analyzing (Level - IV)**
CO4	To understand the basic concepts of optical communication systems, defining various terms, evaluating losses and other parameters of fibre	**Evaluating (Level –V)**

Semester	**Autumn: Yes**		**Spring: Yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **12**
	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.

	UNIT II: **12** **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.
	UNIT III: **12** **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.
	UNIT IV: **12** **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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%
List of experiments	At least 12 Experiments based on the basic communication systems.

Course Code: CSBB 181	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	NO
Type of course	**Elective**			
Course Title	**PROBLEM SOLVING AND COMPUTER PROGRAMMING**			
Course Coordinator				
Course objectives:	To help the student to become a better programmer by teaching the basic concepts underlying all computer systems.			

Course Outcomes		**Cognitive Levels**
CO1	Write efficient algorithms to solve various problems.	**Remembering (Level - I)**
CO2	Understand and use various constructs of the programming language such as conditionals, iteration, and recursion.	**Understanding (Level - II)**
CO3	Implement your algorithms to build programs in the C programming language.	**Applying (Level - III)**

Semester	**Autumn: Yes**		**Spring:**		
III	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3		2	4	**48**
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Computer Systems: A Programmer's Perspective
	Author	Bryant and O'Halloran
	Publisher	Pearson
	Edition	3

Reference Book:		
1.	Title	Advanced Programming in the Unix Environment
	Author	Richard Stevens
	Publisher	Addison-Wesley
	Edition	1992

Content	**UNIT I:** **8** Introduction to evolution of computers, computational Physics, transistors, photolithography, Moore's Law, bits, bytes, and logic, Introduction to CPU, Programming Languages. **UNIT II:** **14** Program Structure and Execution: Representing and manipulating information: information storage, integer representations, integer Arithmetic and floating points

	Machine- level representation of programs: A historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control flow, procedures, array allocation and access, heterogeneous data structures. Processor Architecture: micro-architecture, X-86-64 Extending IA32 to 64 bits, instruction set architecture, logical design and hardware control language HCL, implementations Program Optimization: Capabilities of operating compilers, expressing program performance, eliminating loop inefficiencies, reducing procedure calls, memory performance Memory Hierarchy: Storage technologies, locality, memory hierarchy, cache memories, impact of caches on program performance. **UNIT III** **14** **Running programs on a system:** Linking: Compiler Drives, Static linking, object files, relocatable object files, symbols and symbol tables, symbol resolution, relocation, executable object files, loading executable object field, dynamic linking with shared libraries Exceptional Control flow: Exceptions, process, system call error handling, process control, signals Virtual memory: Physical and virtual addressing, addressing space, VM as a tool for caching, memory management, address translation, memory mapping, dynamic memory allocation, garbage collection, common memory related bugs. **UNIT IV** **12** **Interaction and communication between programs:** System-level input output: Introduction to operating systems, types, Unix I/O, opening and closing files, reading and writing files, Reading file metadata, sharing files, I/O redirection, standard I/O, Networking Programming: Client server programming model, Networks, Global IP Internet, Sockets Interface, Web servers, Concurrency, Distributed Systems. **Advance topics:** Introduction to AI, Security needs, Management Information System, Cloud and Quantum Computing, etc
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: MEBB 162	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**No**
Type of Course	THOERY			
Course Title	**ENGINEERING VISUALIZATION**			
Course Coordinator				
Course objectives:	To enable the students with various concepts like dimension and conventions. theory of projection and standards related to working drawings in order to become professionally efficient.			

Course Outcomes		**Cognitive Levels**
CO1	Recall the use of different instruments used in Engineering Drawing and Importance of BIS and ISO codes.	**Remembering (Level – I)**
CO2	Illustrate various types of mathematical curves and scale.	**Understanding (Level – II)**
CO3	Classify different types of projection and Construct Orthographic projection of Point, Line, Plane and Solid.	**Applying (Level – III)**
CO4	Construct Isometric Projection and Conversion of Orthographic view to Isometric view and vice-versa.	**Applying (Level – III)**

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Engineering Drawing
	Author	N. D. Bhatt
	Publisher	Charotar Publishing House Pvt. Ltd.
	Edition	Fifty Third 2014
Reference Books:		
1.	Title	AutoCAD 2007 Bible
	Author	E. Finkelstein
	Publisher	Wiley Publishing Inc.
	Edition	2007

Content

OVERVIEW: Sketching concepts. Orthographic Projections and views: Principles of Axonometric projections and Development of Isometric, Dimensioning of Orthographic Views, Sectioning in Orthographic views and assembly drawings. Introduction: Overview of the course, Examination and Evaluation patterns.

UNIT I:

12

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. **UNIT II**: **12** **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. **UNIT III**: **12** **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. **UNIT IV:** **12** **Isometric views**: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects. Assembly drawings of the machine parts. **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.
Course Assessment	Continuous Evaluation 25%, Mid Semester 25% End Semester 50%

Course Code: ECBB 152	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	Yes	No	No
Type of course	Theory			
Course Title	**DIGITAL ELECTRONICS AND LOGIC DESIGN**			
Course Coordinator				
Course objectives:	To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. Students also perform the analysis and design of various digital electronic circuits.			

Course Outcomes		**Cognitive Levels**
CO1	To understand and examine the structure of various number systems and their application in digital design.	**Understanding (Level –II)**
CO2	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)**
CO3	The ability to understand, apply and design various combinational and sequential circuits.	**Applying (Level- III)**
CO4	Identify and prevent various hazards and timing problems in a digital design and develop skills to build and troubleshoot digital circuits.	**Remembering (Level- I)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Reference Books:

1.	Title	Digital Design, Principles and Practices
	Author	J. F. Wakerly

	Publisher	Pearson Education
	Edition	4th, 2005
2.	Title	Digital Computer Fundamentals
	Author	T.C. Bratee
	Publisher	McGraw Hill.
	Edition	2001
3.	Title	Digital Logic & Computer Design
	Author	M Morris Mano
	Publisher	Pearson
	Edition	5th, 2011
4.	Title	Digital Principles and Applications
	Author	A.P. Malvino and B.P. Leach
	Publisher	McGraw Hill.
	Edition	4th
Text Book:		
1.	Title	Digital Electronics
	Author	WH Gothmann
	Publisher	PHI
	Edition	2nd Edn
Content	**Unit I:** **12** 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.	
	Unit II: **12** 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. Encoders, Decoders, Multiplexers, Demultiplexers, code convertors, Binary address Digital comparator, parity checker/generator, programming logic Array (PLA).	

	Unit III: **12** **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.
	Unit IV: **12** **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.
Tentative 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 or de-multiplexer 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 Assessment	**Theory**: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course Code: ECBB 201	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course and Lab Course
Course Title	**SOLID STATE DEVICES**
Course Coordinator	
Course Objectives	Introduce students to the physics of semiconductors and the inner working of semiconductor devices. To Provide students the insight useful for understanding new semiconductor devices and technologies.

Course Outcomes		**Cognitive Levels**
CO1	Describe the fundamental physical processes related to electronic and photonic transitions in semiconductors and the basic laws/ definitions.	**Remember (Level I)**
CO2	To understand the advanced physics behind electronic and photonic devices based on the above processes and laws/ definitions.	**Understand (Level II)**
CO3	Application of above concepts to understand the physical processes and principle of operation of various electronic and opto-electronic solid devices.	**Apply (Level III)**
CO4	To develop the circuit level concepts of above electronic and opto-electronic solid devices.	**Evaluate (Level V)**

Semester	**2nd**	**Autumn**

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

Prerequisite course codes with course names	ECBB 101 (Basics of Electronics and Electrical Engineering), PHBB 101 (Engineering Physics)
Equivalent course codes as per proposed course and old course	ECB 201 (Solid State devices) in Old Scheme

Text Books		
1.	Title	Solid State Electronic Devices
	Author	Ben G Streetman and S. K. Banerjee
	Publisher	PHI Learning Pvt Ltd, 2009.
	Edition	6th Edition
2	Title	Electronic Devices and Circuits
	Author	Christos C. Halkias, Jacob Millman, Satyabrata Jit
	Publisher	Tata McGraw Hill Education Pvt Ltd., 2010.
	Edition	3rd Edition
Reference Books		
1.	Title	Semiconductor Devices - Basic principles
	Author	Jasprit Singh
	Publisher	John Wiely & Sons, 2001
	Edition	2nd Edition

Course Contents	**UNIT 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.	**12**

	UNIT 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.	**12**
	UNIT 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: 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	**12**
	UNIT IV: Photonics Devices: Electro-optic conversions processes, photoconductive devices, Light emitting diodes, semiconductor lasers, photo detectors, solar cells, etc.	**12**
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course Code: ECLB 202	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Theory			
Course Title	**NETWORK ANALYSIS AND SYNTHESIS**			
Course Coordinator				
Course Objectives	To introduce the fundamentals of network analysis using matrices, two-port, and network synthesis.			

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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code as per proposed course numbers	EEBB 100				
Prerequisite credits	4				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:

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

Course Contents	**UNIT I:** Introduction: KCL, KVL, Network theorems and its application in the analysis of networks.	**10**
	UNIT II: Network Functions and Response Analysis: Concept of complex frequency, driving point and transfer functions for one port and two port network, poles & zeros of network functions, Restriction on Pole and Zero locations of network function, Impulse response and complete response, Time domain behavior form pole-zero plot, Two port parameters, relationships among different network parameters, inter connections of networks.	**15**
	UNIT III: Poly-Phase Circuits: Introduction to polyphase system, Generation of three-phase voltages, Interconnection of 3 phase sources and loads, Star-to-Delta and Delta-to-Star transformation, Voltage, current and power in a star and delta connected system, three phase balanced and unbalanced circuits.	**11**
	UNIT IV: Network Synthesis: Realizability concept, Hurwitz property, positive realness, properties of positive real functions, properties of one port immittance functions and their synthesis, Foster and Cauer forms, RLC synthesis, Introduction to two-port network synthesis.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 203	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory		**Core Engineering Course**	
Course Title	**ELECTROMAGNETIC THEORY**			
Course Coordinator				
Course objectives:	Understand the fundamentals of vector calculus, Electrostatics, Magneto statics, Maxwell's Equations.			

Course Outcomes		**Cognitive Levels**
CO1	Explain the concepts of vector calculus to solve complex problems and relate among different coordinate systems for electromagnetic fields.	**Understand (Level II)**
CO2	To apply the basic principles of electrostatics and magnetostatics and relate the electric and magnetic fields.	**Apply (Level III)**
CO3	To analyze the static electric and magnetic fields, their behavior in different media, associated laws, boundary conditions and electromagnetic potentials.	**Analyze (Level IV)**
CO4	To use integral and point form of Maxwell`s equations for solving the problems of electromagnetic field theory.	**Apply (Level III)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	**48**
Prerequisite course code as per proposed course numbers	PHLB 100				
Prerequisite Credits	4				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Engineering Electromagnetics
	Author	William H. Hayt and John A. Buck
	Publisher	McGraw Hill Education
	Edition	8th Edition, 2012

2.	Title	Theory and Computation of Electromagnetic Fields	
	Author	Jian-Ming Jin	
	Publisher	John Wiley & Sons	
	Edition	Second revised edition, 2015.	
Course Contents	**UNIT 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**
	UNIT 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**
	UNIT 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 Charges, Property Potential Gradient, The Electric Dipole Energy Density in the Electrostatic Field Conductors and Dielectrics		**10**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECBB 204	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of Course	Theory		**Core Engineering Course**		
Course Title	**SIGNALS AND SYSTEMS**				
Course Coordinator					
Course objectives:	This course covers the fundamentals of signal and system analysis, focusing on representations of continuous-time signals and linear, time-invariant systems.				

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)**

Semester	**Autumn: Yes**		**Spring: No**			
	Lecture	**Tutorial**	**Practical**	**Credits**		**Total Teaching Hours**
Contact Hours	3	0	2	4		**48**
Prerequisite course code as per proposed course numbers						
Prerequisite Credits						
Equivalent course codes as per proposed course and old course						
Overlap course codes as per proposed course numbers						

Text Books:			
1.	Title	Signals and Systems	
	Author	Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab	
	Publisher	PHI Publications	
	Edition		

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		
Content	**UNIT 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**
	UNIT 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**
	UNIT 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 differential equations and system behavior. z-Transform, definition, ROC, inverse z-Transform, properties.		**11**
	Unit 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**
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading		

Course Code: ECLB 205	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory		**Core Engineering Course**	
Course Title	**CONTROL THEORY**			
Course Coordinator				
Course objectives:	To understand time domain and frequency domain analysis of control systems required for stability analysis.			

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)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers	EELB-201				
Prerequisite Credits	4				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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 Contents	**UNIT 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**
	UNIT 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**
	UNIT 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**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%.		

Course Code: ECBB 251	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course and Lab Course
Course Title	**ANALOG ELECTRONICS**
Course Coordinator	
Course Objectives	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.

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	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)**
CO3	Design and analysis of common source FET amplifier and its frequency response. Design and analysis of negative feedback amplifiers and oscillators.	**Evaluate (Level V)**
CO4	Design and analysis of different types of power amplifiers and tuned amplifiers and Behaviour of noise in an amplifier.	**Apply (Level III)**

Semester	**4**	**Autumn**

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

Prerequisite course codes with course names	ECBB 201 (Solid State Devices)
Equivalent course codes as per proposed course and old course	4

Reference 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,

	New Delhi.	
4.	Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits, International Student Edition, Oxford University Press, 2006.	
Course Contents	**UNIT 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**
	UNIT 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.	**12**
	UNIT 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 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.	**14**
	UNIT 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, Multivibration 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.	**14**
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50%, 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course Code: ECBB 252	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course and Lab Course			
Course Title	**ANALOG COMMUNICATION**			
Course Coordinator				
Course Objectives	To understand the basic concepts of Amplitude modulation, Frequency modulation, Phase modulation techniques.			

Course Outcomes		**Cognitive Levels**
CO1	Gain the knowledge of components of analogue communication system.	**Remembering (Level I)**
CO2	To analyze various methods of baseband/band pass Analog transmission and detection.	**Analyzing (Level IV)**
CO3	Analyze and allocate performance objectives to components of an analogue communication system and to design analogue communication systems.	**Analyzing (Level IV)**
CO4	To evaluate the performance of analogue communications in the presence of noise.	**Evaluating (Level V)**

Semester	**2nd**	**Spring**

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

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	ECBB-203

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	
Course Contents	**UNIT 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.		**12**
	UNIT 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.		**12**
	UNIT 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.		**12**
	UNIT 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).		**12**
	Tentative 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 Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading		

Course Code: ECBB 253	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory		**Core Engineering Course**	
Course Title	**ELECTRONIC MEASUREMENT AND INSTRUMENTATION**			
Course Coordinator				
Course objectives:	Understand the internal structure of all instruments that are used in measuring parameters related to electronics and also difference between analog meters and digital meters and their performance characteristics.			

Course Outcomes		**Cognitive Levels**
CO1	Analyze instrument characteristics, errors and generalized Measurement system.	**Understand (Level II)**
CO2	Analyze and use the circuit for the measurement of R, L, C, F, I, V etc.	**Analyze (Level IV)**
CO3	Use of Ammeters, Voltmeter and Multimeters and CRO for measurement.	**Evaluate (Level V)**
CO4	Analyze and interpret different signal generator circuits for the generation of various waveforms.	**Analyze (Level IV)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers	EEBB 100 EELB 201				
Prerequisite Credits	04 + 04				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Electronic Instrumentation
	Author	H S Kalsi
	Publisher	Tata McGraw Hill
	Edition	3rd
2.	Title	Modern Electronic Instrumentation and Measurement techniques

	Author	W D Cooper	
	Publisher	Prentice Hall of India	
	Edition	2nd	
3.	Title	Principles of Measurement & Instrumentation	
	Author	Morris	
	Publisher	Prentice Hall of India	
	Edition	2nd	
Reference Books:			
1.	Title	Transducers & Instrumentation	
	Author	D.U. S Murthy	
	Publisher	Prentice Hall of India	
	Edition	3rd	
Course Contents	**UNIT 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**
	UNIT 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 frequency generators, Measurement Technique, Wave Analyzers, and Frequency - selective wave analyser, heterodyne wave analyzer, Harmonic distortion analyser, and Spectrum analyser.		**12**
	UNIT 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**
	UNIT 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, echocardiograph, comparison of ECG, VCG and ECHO.		**12**
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading		

Course Code: CSBB 255	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	NO
Type of course	**Core**			
Course Title	**DATA STRUCTURES**			
Course Coordinator				
Course objectives:	This course aims to provide the students with a foundation in computer programming. The goals of the course are to develop the basic programming skills in students, and to improve their proficiency in applying the basic knowledge of programming to solve problems related to their field of engineering.			

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)**

Semester	**Autumn:**		**Spring: Yes**		
IV	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Book:		
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	
Course Contents	**UNIT 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**
	UNIT 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**
	UNIT 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 applications. Directed acyclic graphs; topological sort.		**12**
	UNIT 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**
Course Assessment	**Theory**: Continuous Evaluation 25% Mid Semester 25% End Semester 50% **Lab**: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading		

Course Code: HMBB 251	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)		DE (Y/N)
	No	Yes	No		No
Type of Course	Theory				
Course Title		PROFESSIONAL COMMUNICATION			
Course Coordinator					
Course objectives:		To inculcate linguistic skills in students.			

Course Outcomes		Cognitive Levels
CO1	Understand and apply communication theory.	Understand (Level II)
CO2	Critically think about communication processes and messages.	Analyze (Level IV)
CO3	Write effectively for a variety of contexts and audiences.	Evaluate (Level V)
CO4	Develop and deliver professional presentations.	Analyze (Level IV)

Semester	Autumn: Yes		Spring: No			
	Lecture	Tutorial	Practical	Credits		Total Teaching Hours
Contact Hours	2	0	2	3		36
Prerequisite course code as per proposed course numbers						
Prerequisite Credits						
Equivalent course codes as per proposed course and old course						
Overlap course codes as per proposed course numbers						

	Text Books:		
1.	Title		Technical Communication: Principles and Practice
	Author		Raman, Meenakshi and Sharma, Sangeeta,
	Publisher		Delhi: Oxford University Press
	Edition		2004
2.	Title		Technical Writing and Professional Communication,
	Author		Thomas N Huckin and Leslie &Oslen
	Publisher		McGraw Hills
	Edition		2004

Course Content	**UNIT 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.	**9**
	UNIT 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.	**9**
	UNIT 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.	**9**
	UNIT IV: Laboratory Work: Speaking and Listening Skills- Practice in Speaking and Listening Activities with a view to improving their oral and listening skills. Individual speech sounds, Stress and Intonation patterns, Personality Development Questionnaires, Role Play, Extempore, Group Discussions, Facing Interviews, Presentation Skills.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECBB 301	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	N	N
Type of Course	Theory & Practical			
Course Title	**MICROPROCESOR AND MICROCONTROLLER**			
Course Coordinator				
Course Objectives	To study the architecture of 8085, 8086, 8051 and ARM.			

Course Outcomes		**Cognitive Levels**
CO1	Ability to analyze and develop the assembly language program for microprocessor 8085, 8086 and microcontroller 8051.	**Understanding (Level - II)**
CO2	Ability to interface peripherals with Microprocessors and Microcontrollers	**Applying (Level – III)**
CO3	Ability to design and create Microprocessor/Microcontroller-based system.	**Analyzing (Level - IV)**
CO4	Ability to analyze architecture and develop assembly language program for ARM 32-bit processor.	**Evaluating (Level –V)**

Semester	**5th**	**Autumn**

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

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

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

	Publisher	Pearson Education	
	Edition	Second	
Course Contents	**UNIT 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**
	UNIT 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**
	UNIT 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**
	UNIT 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**
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 microcontroller. 9. Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller. 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 Assessment	Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%		

Course Code: ECBB 302	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory & Practical
Course Title	**COMPUTER NETWORKS**
Course Coordinator	
Course Objectives	To build a strong understanding of the fundamental concepts of computer networking, Fiber optics and wireless communication.

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	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)**
CO3	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) (Level VI)**
CO4	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)**

Semester	**5th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	ECBB 205 (Credit = 4)
Equivalent course codes as per proposed course and old course	

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	
Course Contents	**Unit-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**
	Unit-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**
	Unit-III Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Sub netting, Super netting, Classless addressing, Network Address Translation		**12**
	Unit-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**
Tentative 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 command 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 Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECBB 303	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory + Practical			
Course Title	**DIGITAL COMMUNICATION**			
Course Coordinator				
Course Objectives	To understand the basic concepts of Digital Communication System, need of digital communication, Various Waveform Coding Techniques and Baseband line coding.			

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	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)**
CO3	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)**
CO4	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)**

Semester	**5th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	4	4	**48**
Prerequisite course codes with course names	ECBB-252				
Equivalent course codes as per proposed course and old course					

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

Course Contents	**UNIT I:**	**12**
	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, Statistical averages, Random processes, types of random processes.	
	UNIT 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.	**12**
	UNIT 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.	**12**
	UNIT 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	**12**
Tentative 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECBB 304	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	N	N
Type of Course	Theory Course			
Course Title	**IC APPLICATIONS**			
Course Coordinator				
Course Objectives	This course is aimed to cover OP AMP basic characteristics, AC and DC parameters. It also covers OP AMP linear as well as nonlinear applications.			

Course Outcomes		**Cognitive Levels**
CO1	Study of basics of operational amplifier ideal and practical.	**Understanding (Level - II)**
CO2	Application of operational amplifier.	**Analyzing (Level - IV)**
CO3	Study and analysis of op-amp filters.	**Evaluating (Level - V)**
CO4	Comparator, convertor circuit analysis.	**Analyzing (Level - IV)**

Semester	**5th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

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

Course Contents	**UNIT I:** **INTRODUCTION TO OPERATIONAL AMPLIFIERS:** The basic operational amplifier & its schematic symbol, Block diagram representation of OP-AMP, Power supply requirements of an OP-AMP, Evolution of OP-AMP., Specification of a typical OP-AMP (741). Input offset voltage, input bias current, input offset current. Total output offset voltage, thermal drift, error	**12**

	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.	
	UNIT 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 converters, integrators & differentiators, logarithmic & anti logarithmic amplifiers.	**12**
	UNIT 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.	**12**
	UNIT 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.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 351	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N

Type of Course	Theory
Course Title	**ANTENNAS AND WAVE PROPAGATION**
Course Coordinator	
Course Objectives	To introduce the principles and theory of different types of antennas using in communication systems. Further, different mechanisms of wave propagation in free space will be discussed.

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**

Semester	**6th**		**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

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 Contents	**UNIT 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**
	UNIT II: **Antenna Array:** Array factorization. Array parameters. Broad side and end fire arrays. Yagi-Uda arrays Log-periodic arrays.		**9**
	UNIT III: **Aperture Antenna:** Fields as sources of radiation. Horn antennas. Babinet's principle. Parabolic reflector antenna. Microstrip antennas.		**9**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECBB 352	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory + Practical
Course Title	**BASICS OF VLSI**
Course Coordinator	
Course Objectives	To understand the MOS operation, SPICE models and design the VLSI circuits with standard CMOS and dynamic MOS logic-based approach.

Course Outcomes		**Cognitive Levels**
CO1	Understand MOS transistor theory, circuit models and short channel effects.	**Understanding (Level - II)**
CO2	To study and design the static and dynamic characteristics of CMOS inverter.	**Analyzing (Level - IV)**
CO3	To design the combinational and sequential CMOS circuit.	**Creating (Level - VI)**
CO4	To study the operation of MOS based SRAM and DRAM Cells.	**Understanding (Level - II)**

Semester	**6th**	**Spring**

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

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

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

Course Contents	**UNIT 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.	**12**
	UNIT 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, Pass-Transistor Logic, Transmission gate-based design, Logic design with transmission gate concept.	**12**
	UNIT 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.	**12**
	UNIT 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.	**12**
List of experiments of VLSI Design Laboratory	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 Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECBB 353	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory + Practical
Course Title	**DIGITAL SIGNAL PROCESSING**
Course Coordinator	
Course Objectives	Represent discrete-time signals analytically and visualize them in the time domain. Understand the meaning and implications of the properties of systems and signals. Understand the Transform domain and its significance and problems related to computational complexity. Be able to specify and design any digital filters using MATLAB

Course Outcomes		**Cognitive Levels**
CO1	Represent discrete-time signals analytically and visualize them in the time domain. Explain the basic concept of Digital Signal Processing.	**Understanding (Level - II)**
CO2	To apply and implement various transforms in real-time applications.	**Applying (Level - III)**
CO3	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)**
CO4	Design different types of digital filters.	**Evaluating (Level - V)**

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	**ECBB 204 (credit =4)**
Equivalent course codes as per proposed course and old course	

Text Books

1.	**Title**	Digital Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	**Title**	Discrete-Time Signal Processing
	Author	A. Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999
3.	**Title**	Schaum's Outline of Digital Signal Processing
	Author	M. Hays
	Publisher	McGraw-Hill
	Edition	1999
4.	**Title**	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis
	Publisher	Prentice-Hall
	Edition	4th edition, 2006

5.	**Title**	A Course in Digital Signal Processing	
	Author	B. Porat	
	Publisher	J. Wiley and Sons	
	Edition	1996	
6.	**Title**	Computer-Based Exercises for Signal Processing Using MATLAB 5	
	Author	J. McClellan (Ed.)	
	Publisher	Prentice Hall	
	Edition	1997	
Reference Books			
1.	**Title**	Theory and Application of Digital Signal Processing	
	Author	L.R. Rabiner and B. Gold	
	Publisher	Phi Learning	
	Edition	1st Edition, 2008	
Course Contents	**UNIT 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**
	UNIT 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**
	UNIT 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**
	UNIT 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**
Tentative List of experiments for Digital Signal Processing Laboratory:	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. 4. Radix-2 & Radix-4 algorithm FFT Calculation using DSP Processors. 5. FIR & IIR Filter Implementation using the DSP Processors. 6. Basics of MATLAB-Realisation of Unit Impulse, Unit Step & Unit Ramp signals. 7. Linear & Circular Convolution of two Sequences, Correlation of two sequences. 8. DFT & IDFT Computation. 9. Radix-2 algorithms FFT Calculation. 10. Generation of Gaussian Distributed Numbers.		
Course Assessment	Theory: Continuous Evaluation 10% Theory: Mid Semester 20% Theory: End Semester 30% Lab: Continuous Evaluation 20% Lab: End Semester Lab Exam 20%		

Course Code: ECBB 401	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	NO
Type of Course			**Core Engineering Course**	
Course Title	**RF AND MICROWAVE ENGINEERING**			
Course Coordinator				
Course objectives:	The goal of this course is to introduce students the concepts and principles of the microwave engineering. To understand the operation of different types of Microwave sources. Scattering parameters are defined and used to characterize devices and system behaviour.			

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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **12** 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. **UNIT II:** **12** 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. **UNIT III:** **12** 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. **UNIT IV:** **12** 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.

	List of Experiments for RF and Microwave Laboratory: • Characteristic of the Reflex klystron tube • Characteristics of Gunn diode • Characteristics of Multihole Directional coupler • Determination of Standing Wave Ratio and Reflection • Impedance and Frequency Measurement • Attenuation Measurement • Time Division Multiplexing • Differential Phase Shift Keying • Ask Modulation & Demodulation. **List of Experiments using CST Studio Suite, comprises the following modules** • 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. • 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. • CST PARTICLE STUDIO® (CST PS) has been developed for the fully consistent • Simulation of free moving charged particles. Applications include electron guns, cathode ray tubes, magnetrons, and wake fields. • CST CABLE STUDIO® (CST CS) for the simulation of signal integrity and EMC/EMI • Analysis of cable harnesses. • CST PCB STUDIO® (CST PCBS) for the simulation of signal integrity and EMC/EMI • EMI on printed circuit boards. • 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 Code	**:**	**HMLB 401**
Course Title	**:**	**MANAGEMENT PRINCIPLES AND PRACTICES**
Type of Course	**:**	Theory
Course Coordinator		
Course Objective		Principles of Management are guidelines and frameworks that help managers to run their organisation efficiently and effectively. It helps them in the day-to-day functioning and while framing the organisation's goals and objectives.

Course Outcomes		**Cognitive Levels**
CO1	Recall the concepts of management process and the functions of management.	**Remembering (Level - I)**
CO2	Recall and describe the different terms used in production management and the fundamentals concept related to marketing.	**Understanding (Level - II)**
CO3	Explain conceptual framework of leadership dynamics.	**Applying (Level - III)**
CO4	Identify and illustrate communication abilities to face professional challenges.	**Analyzing (Level - IV)**

		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours		3	0	0	3	**36**
Pre-requisite	**:**	Nil				

Detailed Syllabus:

Unit I: **09**

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.

Unit II: **09**

Planning and Decision

Planning definition and nature, Importance of Planning, Planning Process, Need for Planning, Principles of 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.

Unit III: **09**

Organizing

Organizing definition. Organisation as a Process, Organisation Structure, Principles of Organisation, Importance of Organisation, Types of Organisations. Departmentation- Meaning, Need and Significance of Departments, Process involved in Departmentation, Methods or Basis of Departmentation; Span of

Management; Centralization and Decentralisation; Delegation.

Unit IV **09**

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.

Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%
Recommended Books	Drucker, F. Peter, "Management-Tasks, Responsibilities & Practices" Dubey, C.H, "Organizational Behaviour" Prentice Hall in India (PHI) Edition 2015. Gupta C. B., "Human Resource Management" Sultan Chand & Sons New Delhi, Edition 2006. Koontz, Hand Weilhrich H, "Essentials of Management", 10th Edition, Tata McGraw Hill Prasad, L M, "Principles and Practices of Management", 6th Edition, Sultan Chand Robbins, Stephen P, Coutler, Mary, "Management" 8th Edition, Pearson Stoner, J A F, Freeman R E, Gilbert, D R, "Management" 6th Edition, Pearson

List of Electives: Bouquets with Specializations

Specialization: Photonics and Optical Communication

Course Code: ECLB 321	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**SEMICONDUCTOR LASER THEORY**			
Course Coordinator				
Course objectives:	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.			

Course Outcomes		**Cognitive Levels**
CO1	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)
CO2	To Define some of the terms related to the basics of laser physics	Understanding (Level - II)
CO3	To Define some of the terms related to the basics of laser physics	Analyzing (Level-IV)
CO4	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)

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **08** 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, **UNIT II:** **08** 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, **UNIT III:** **08** Laser Excitation: Three and Four Level Lasers, Rare Earth Lasers, Tunable Lasers, Semiconductor Lasers Semiconductor Theory, Review Diode Lasers, Quantum Effects. **UNIT IV:** **05** Semiconductor Photon Sources: Electroluminescence. **UNIT V:** **07** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 322	OPTICAL FIBRE COMMUNICATION	3	0	0	3	36

Pre-Requisite Courses:	Solid State Devices and Applications, Analog Electronics
Course Objective	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Course Outcomes		Cognitive Levels
CO1	To recognize and classify the structures of Optical fiber and types.	Remembering (Level - I)
CO2	To discuss the channel impairments like losses and dispersion.	Understanding (Level - II)
CO3	To analyze various coupling losses.	Analyzing (Level-IV)
CO4	To classify the Optical sources and detectors and to discuss their principle	Applying (Level - III)

Course Content

Unit I: **09**

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.

Unit II: **09**

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, impulse response.

Unit III: **09**

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.

	Unit IV: **09** 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.
Book	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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 334	**OPTICAL, ELECTRONIC & PHOTONIC PROPERTIES OF NANOSTRUCTURES**	3	0	0	3	**36**
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To bring out the distinct properties like electronic, optical, and photonic properties of nanostructures					
Course Outcomes						**Cognitive Levels**
CO1	To familiarize about the various properties of nanostructures.					Remembering (Level - I)
CO2	To bring out the differences between nano and macro structures.					Understanding (Level - II)
CO3	To discuss applications and specific properties of nanomaterials.					Analyzing (Level-IV)
CO4	To apply and simulate various properties like electronic, optical, and photonic properties of nanostructures					Applying (Level - III)
Course Content	**Unit-I:** **09** 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. **Unit-II:** **09** 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. **Unit-III:** **09** 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. **Unit-IV:** **06** 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. **Unit V:** **03** Nanophononics: Photonic crystals, Photonic Bandgap, 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.					
Book	1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens. Wiley India Pvt. Ltd. 2. Solid State physics by Pillai, Wiley Eastern Ltd. 3. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd. 4. Nano Technology and Nano Electronics – Materials, devices and measurement 5. Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books					
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%					

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 335	LASERS AND OPTO-ELECTRONICS	2	0	2	3	28
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To bring out the basics of opto-electronic properties and basic theory of LASERS as an application of these studied opto-electronic properties					

Course Outcomes		Cognitive Levels
CO1	To familiarize about the various opto-electronic properties.	Remembering (Level - I)
CO2	To bring out the basic principle of operation of semiconductor lasers.	Understanding (Level - II)
CO3	To implement the afore-mentioned opto-electronic properties in designing the structure of semiconductor lasers.	Analyzing (Level-IV)
CO4	To discuss applications and specific properties of semiconductor lasers.	Applying (Level - III)

Course Content

Unit I: **07**

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.

Unit II: **07**

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.

Unit III: **07**

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.

Unit IV: **07**

Detection of Optical radiations – Basic Principle, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs, Image Intensifiers, Arrays, Solar Cells, noise considerations.

Book

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

Course Assessment

Theory:
Continuous Evaluation 25%
Mid Semester 25%
End Semester Examination 50%
Laboratory:
Continuous Evaluation 50% and End Semester Examination 50%

Course Code: ECLB 371	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**SEMICONDUCTOR DEVICE MODELING**			
Course Coordinator				
Course objectives:	Introduce students to the physics of semiconductors and the inner working of semiconductor devices. Provide students the insight useful for understanding new semiconductor devices and technologies.			

Course Outcomes		**Cognitive Levels**
CO1	To describe the properties of materials and Application of semiconductor electronics.	**Understanding (Level - II)**
CO2	To apply the knowledge of semiconductors to illustrate the functioning of basic electronic devices	**Applying (Level - III)**
CO3	To demonstrate the switching and amplification	**Analyzing (Level-IV)**
CO4	To introduce applications of the semiconductor devices	**Applying (Level - III)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Introduction to Semiconductor Device Modeling
	Author	C. Snowden
	Publisher	World Scientific
	Edition	1986
2.	Title	Fundamentals of Carrier Transport"
	Author	M. Lundstrom
	Publisher	Cambridge University Press
	Edition	2000

Content

UNIT I: **05**

Review of semiconductor physics: Quantum foundation, Carrier scattering, high field effects;

UNIT II: **05**

P- N junction diode modeling: Static model, Large signal model and SPICE models;

	UNIT III: **05** BJT modeling: Ebers Moll, Static, large-signal, small- signal models. Gummel - Poon model. Temperature and area effects. Power BJT model, SPICE models, Limitations of GP model; **UNIT IV:** **03** Advanced Bipolar models: VBIC, HICUM and MEXTARM; **UNIT V:** **10** MOS Transistors: LEVEL 1, LEVEL 2, LEVEL 3, BSIM, HISIMVEKV Models, Threshold voltage modeling. Punch through. Carrier velocity modeling. Short channel effects. Channel length modulation. Barrier lowering, Hot carrier effects. Mobility modeling, Model parameters; **UNIT VI** **08** Analytical and Numerical modeling of BJT and MOS transistors: Introduction to various simulation techniques, Noise modeling; Modeling 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 372	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**FIBRE OPTIC SENSORS AND DEVICES**			
Course Coordinator				
Course objectives:	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.			

Course Outcomes		**Cognitive Levels**
CO1	To expose the students to the basic concepts of optical fibers and their properties	**Understanding (Level I)**
CO2	To provide adequate knowledge about the Industrial applications of optical fibers	**Analyzing (Level-IV)**
CO3	To expose the students to the Laser fundamentals	**Analyzing (Level-IV)**
CO4	To provide adequate knowledge about Industrial application of lasers, holography and medical applications of Lasers.	**Applying (Level - III)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Fundamentals of Fibre Optics in Telecommunication and Sensor Systems
	Author	Bishnu P PAL
	Publisher	Wiley Eastern Ltd. (1994).
	Edition	
2.	Title	Fiber Optic Sensors: Fundamentals and Applications
	Author	David A. Krohn; Trevor W. MacDougall; Alexis Mendez
	Publisher	SPIE, 2015
	Edition	Fourth

Content	**UNIT I:** **03** Optical Sources and Detectors**:** Light-emitting diode: Principles, Structures, LED characteristics, Modulation of LED.

	UNIT II: **05** 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. **UNIT III:** **02** Optical Fiber Sensors and Devices: Overview of fibre optic sensors – advantages over conventional sensors, broadband classification . **UNIT IV:** **08** 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. **UNIT V:** **08** Interferometric Optical Fibre Sensors: Introduction, basic principles of interferometric optical fibre sensors, components and applications of interferometric sensors. Fused Single Mode Optical Fibre Couplers: Introduction, physical principles (coupling coefficient) polarization effect, experimental properties, theoretical modeling, and comparison with experiment. **UNIT VI:** **05** 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. **UNIT VI:** **02** Fibre Optic Sensor Multiplexing: Introduction, general topological configuration, and incoherent and coherent detection. **UNIT VII:** **03** Signal Processing in Monomode Fibre Optic Sensor Systems: Introduction, Transduction mechanisms, Optical Signal Processing, Electronic Processing.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 385	NANO-ELECTRONICS & NANO-PHOTONICS	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	This course is intended to cover basics of electronics, transistor, band structure models, nanocapacitors, coulomb blockade, single electron transistor and nanophotonics					

Course Outcomes		Cognitive Levels
CO1	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.	Remembering (Level - I)
CO2	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.	Understanding (Level - II)
CO3	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	Analyzing (Level-IV)
CO4	To apply and simulate various nano-electronic and nano-photonic structures and to study their behaviors.	Applying (Level - III)

Course Content

Unit I: **09**

Free Electron Theory & The New Ohm's Law: Why Electrons flow, Classical free electron theory, Sommerfeld's theory, The quantum of conductance, Coulomb blockade, Towards Ohm's law. The Elastic Resistor: Conductance of an Elastic Resistor, Elastic Resistor- Heat dissipation.

Unit II: **09**

Materials for nanoelectronics: Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and paedomorphic heterostructures, Inorganic nanowires, Organic semiconductors, Carbon nanomaterials: nanotubes and fullerenes.

Unit III: **09**

Ballistic and Diffusive Transport: Ballistic and Diffusive Transfer Times, Channels for Conduction Conductivity, **Conductivity:** E(p) or E(k) Relations, Counting States, Drude Formula, Quantized Conductance, Electron Density -Conductivity

Unit IV: **06**

Electron transport in semiconductors and nanostructures: Time and length scales of the electrons in solids, Statistics of the electrons in solids and nanostructures, Fermi statistics for electrons, the density of states of electrons in nanostructures, Electron transport in nanostructures.

Unit V: **03**

Electrons in traditional low-dimensional structures: Electrons in quantum wells: Single modulation-doped heterojunctions, Numerical analysis of a single heterojunction, Control of charge transfer, Electrons in quantum wires, Electron transport in quantum wires, Electrons in quantum dots.

Book

1. Introduction to Nano Science and Technology by S.M. Lindsay.
2. Supriyo Dutta -Lessons from Nanoscience: A Lecture Note Series, World Scientific (2012).

	3. Supriyo Dutta --Quantum Transport- Atom to Transistor, Cambridge University Press (2005). 4. Introduction to Nanoelectronics: Science, Nanotechnology, Engineering & Applications by Vladimir.V.Mitin.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 386	INTRODUCTION TO PLAMONICS AND META-MATERIALS	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To expose the students to the basics of plasmonic and related concept of meta-materials.					

Course Outcomes		Cognitive Levels
CO1	The course provides a detailed introduction to the three cornerstones of the future photonic technologies, viz., nanophotonic, plasmonic, and metamaterials, covering their fundamentals and latest advancements	Remembering (Level - I)
CO2	The basics and applied aspects of nanophotonic i.e. controlling, guiding, and manipulating electromagnetic radiation at the nanoscale will be discussed. The course will first cover the principles of photonic crystals, metal optics, surface plasmon resonance and their applications	Understanding (Level - II)
CO3	Later on, the course will focus on metamaterials and meta surfaces, covering their fundamentals and various applications such as tunable devices, absorbers, hyper lens, super lens, beam steering, and in cloaking and transformation optics.	Analyzing (Level-IV)
CO4	The course will also introduce new alternative materials for nanophotonic and summarize different techniques for fabrication of these nanophotonic devices.	Applying (Level - III)

Course Content

Unit I: **09**

Motivation, brief introduction to nanophotonics, plasmonics and metamaterials; Overview of current status of research in academia and industry in the fields of nanophotonics, plasmonics, and metamaterials.

Unit II: **09**

Electromagnetic theory of light; Electromagnetic properties of material; Constitutive relationships and material parameters; Electromagnetic waves in dielectric media. Polarization of light; Reflection and refraction; Fresnel equations; Absorption, dispersion, and scattering of electromagnetic waves.

Unit III: **09**

Matrix theory of dielectric layered media; Fabry–Perot Etalon; Bragg Grating; 1D Photonic crystals — Bloch modes, Dispersion relation and photonic band structure. Real and reciprocal lattices; 2D and 3D Photonic crystals; Bandgap engineering; Devices based on photonic crystals; Emerging Applications of Photonic Crystals.

Unit IV: **06**

Metamaterials concept; Effective medium theories: Maxwell–Garnett theory, Bruggeman theory, Anisotropic mixtures: multilayers and wire media; Negative-permittivity and negative-permeability metamaterials; Double-Negative Materials. Perfect absorbers; Super lens, Hyperbolic metamaterials and application in high-resolution imaging: Hyper lens; Tunable photonic metamaterial-based devices.

Unit V: **03**

Nanofabrication: Thin films —Physical methods: Evaporation, Sputtering, Pulsed laser deposition; Chemical methods: chemical vapor deposition (CVD), Atomic layer

	deposition; Epitaxy: Metal organic CVD, Molecular beam epitaxy; Lithography — photolithography, non-optical lithography; Pattern transfer; Nanophotonic characterization: brief overview of near-field microscopy and other related methods.
Book	1. Plasmonics: Fundamentals and Applications, S. Maier, Springer (2007) 2. Fundamentals of Photonics, 3rd Edition. by Bahaa E. A. Saleh, Malvin Carl Teich. (2019) 3. Fundamentals and Applications of Nanophotonics. by Joseph W. Haus (2016) 4. Optical Metamaterials: Fundamentals and Applications, W. Cai and V. Shalaev Springer (2010)
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code:	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
ECLB 421	Y	N	N	Y
Type of Course	Theory Course			
Course Title	**INTEGRATED OPTICS**			
Course Coordinator				
Course Objectives	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.			

Course Outcomes		**Cognitive Levels**
CO1	To be able to design and analyze an integrated optic waveguide.	**Remembering (Level-I)**
CO2	To understand the working of various photonic components.	**Understanding (Level - II)**
CO3	To be able to choose and analyze the technology suitable for the intended device.	**Applying (Level - III)**
CO4	To understand the recent developments and to apply in the practical optical networks.	**Analyzing (Level-IV)**

Semester	**4th**	**Autumn /Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names	PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices), ECLB 203 (Electromagnetic Theory), ECBB 305 (Optical Fibre Communication)				
Equivalent course codes as per proposed course and old course					

Text Books

1.	Title	Integrated Optics-Theory and Technology
	Author	R G Hunsperger
	Publisher	Springer, 2009
	Edition	6th Edition
2	Title	Optical Waveguide Theory
	Author	A W Snyder and J D Love
	Publisher	Chapman & Hall, London, 1983
	Edition	2nd Edition

Course Contents		
	UNIT I: Planar isotropic waveguide theory: guided and radiation modes, strip waveguides, anisotropic waveguides, end fibre, beam.	**09**
	UNIT 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**
	UNIT 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**

	UNIT 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.	**09**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 422	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	Y

Type of Course	Theory Course
Course Title	**OPTICAL NETWORKS**
Course Coordinator	
Course Objectives	To introduce the students to various optical fiber modes, configurations and various signal degradation factors associated with optical fiber.

Course Outcomes		**Cognitive Levels**
CO1	To get a basic understanding of optical components and optical node design.	**Remembering (Level-I)**
CO2	To get a profound understanding of protocols applied in optical networks: MPLS-TP, GMPLS, SDN, OTN, and Ethernet PBB-TE.	**Understanding (Level - II)**
CO3	To get a profound understanding and analyzing of optical switching methods and networking techniques, circuit, packet, hybrid, burst and flow	**Applying (Level - III)**
CO4	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)**

Semester	**4th**	**Autumn /Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices), ECLB 203 (Electromagnetic Theory), ECBB 305 (Optical Fibre Communication)
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Optical Networks
	Author	R. Ramaswami and K. Sivarajan
	Publisher	Â Morgan Kaufmann Publishers, 2002
	Edition	2nd Edition
	Title	Optical Switching Networks
	Author	Mayer & Martin
	Publisher	Cambridge University Press, 2008
	Edition	2nd Edition

Course Contents		
	UNIT 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**
	UNIT 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 convertors.	**07**

	UNIT 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**
	UNIT 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, protectoration and network lifetime.	**08**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 423	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	Y

Type of Course	Theory Course
Course Title	**NON-LINEAR FIBRE OPTICS**
Course Coordinator	
Course Objectives	The major objective of this course is to present the underlying physical concepts and mechanisms of miscellaneous nonlinear optical phenomena.

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	To understand and apply the concepts and theories of a range of advanced topics in physics.	**Understanding (Level - II)**
CO3	To analyze specialized analytical skills and techniques necessary to carry out advanced calculations in a range of advanced topics in physics.	**Applying (Level - III)**
CO4	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)**

Semester	**4th**		**Autumn /Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices), ECLB 203 (Electromagnetic Theory), ECBB 305 (Optical Fibre Communication)
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Nonlinear Fiber Optics
	Author	Govind P. Agrawal
	Publisher	Academic Press, New York, 1995
	Edition	2nd Edition

Course Contents		
	UNIT 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**
	UNIT 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**
	UNIT 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). Non-linear Fiber Loop Mirrors - Soliton Lasers - Fiber Raman Lasers - Fiber Raman Amplifiers - Fiber Raman Solitons - Erbium doped fiber amplifiers.	**12**

	UNIT IV: DMS for single channel transmission – WDM transmission - Fiber Gratings- Fiber Couplers – Fiber Interferometers – Pulse Compression – Soliton Switching – Soliton light wave systems.	**06**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 424	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	Y

Type of Course	Theory Course
Course Title	**ADVANCED OPTICAL COMMUNICATION SYSTEMS**
Course Coordinator	
Course Objectives	This course aims to present the state of the art in optical communication systems, either digital or analog.

Course Outcomes		**Cognitive Levels**
CO1	To understand the basic concepts and advantages of fibre optics communication. To understand the concept and conditions for light guidance.	**Remembering (Level-I)**
CO2	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)**
CO3	To know the origin of fibre optics losses, including intrinsic and extrinsic loss and know how to calculate link losses.	**Applying (Level - III)**
CO4	To design a basic optical fibre link and then to apply in designing various optical amplifiers, WDM systems and Soliton systems.	**Analyzing (Level-IV)**

Semester	**4th**		**Autumn /Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	PHBB 101 (Engineering Physics), ECBB 201 (Solid State Devices), ECLB 203 (Electromagnetic Theory), ECBB 305 (Optical Fibre Communication)
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Optical Networks – A Practical Perspective
	Author	R. Ramaswami, K. N. Sivarajan and G. H. Sasaki
	Publisher	Elsevier, 2010
	Edition	3rd Edition
2.	Title	Optical Fibre Communications
	Author	G. Keiser
	Publisher	Tata McGraw Hill, 2000
	Edition	3rd Edition

Reference Books		
1.	Title	Fibre-Optic Communication Systems
	Author	G. P. Agarwal
	Publisher	John Wiley and Sons. Inc
	Edition	3rd Edition

Course Contents	**UNIT 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**

	UNIT 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 fibres.	**10**
	UNIT III: Optical Components, Couplers, isolators, multiplexers and filters, optical amplifiers, wavelength converters, optical Transmitters and Detectors, LEDs, lasers, Tunable lasers, photo detectors, switch.	**06**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 447	PHOTONIC MATERIALS AND DEVICES COMMUNICATION	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Analog Electronics					
Course Objective	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.					
Course Outcomes					Cognitive Levels	
CO1	To Develop an understanding of photonic components and optical fiber technology.				Remembering and Understanding (Level – I & II)	
CO2	To Classify the material system/technologies along with their fabrication processes to design efficient photonic devices for communication.				Analyzing (Level-IV)	
CO3	To Design and analyze different types of Photonic/Nano-photonic devices and components.				Applying (Level - III)	
CO4	Analytically evaluate the various photonic devices.				Evaluating (Level V)	
Course Content	**Unit I:** **09** 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. **Unit II:** **09** 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 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. **Unit III:** **09** 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. **Unit IV:** **09** 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.					
Book	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. 4. C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003. 5. D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005.					
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%					

List of Electives: Bouquets with Specializations
Specialization: Circuit Design and Networks

Course Code: ECLB 323	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**ANALYTICAL AND COMPUTATIONAL TECHNIQUES IN ELECTROMAGNETICS**			
Course Coordinator				
Course objectives:	The aim of the course is to give the students' knowledge of numerical approaches to solve electromagnetics problems.			

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)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Analytical and Computational Methods in Electromagnetics
	Author	Ramesh Garg
	Publisher	Boston, MA: Artech House
	Edition	2008
2.	Title	Analytical Techniques in Electromagnetics
	Author	Matthew N. O. Sadiku, Sudarshan R. Nelatury
	Publisher	CRC Press
	Edition	2015

Content	**UNIT I:** **12** 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. **UNIT II:** **10** Special Functions: Bessel functions, Fresnel integrals, etc. **UNIT III:** **14** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 324	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**DETECTION AND ESTIMATION THEORY**			
Course Coordinator				
Course objectives:	To cover the two major domains of statistical signal processing, namely, detection and estimation			

Course Outcomes		**Cognitive Levels**
CO1	Acquire basics of statistical decision theory used for signal detection and estimation.	**Understanding (Level - II)**
CO2	Examine the detection of deterministic and random signals using statistical models.	**Applying (Level – III)**
CO3	Apply the techniques of detection and estimation for real life applications.	**Analyzing (Level - IV)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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	Fundamentals of Statistical signal processing, volume-1: Estimation theory
	Author	Steven M. kay
	Publisher	Prentice Hall
	Edition	1993
3.	Title	Fundamentals of Statistical signal processing, volume-2: Detection theory
	Author	Steven M. kay
	Publisher	Prentice Hall
	Edition	1993

<table>
<tr><td rowspan="4">4.</td><td>Title</td><td>Probability, Random Variables and stochastic processes</td></tr>
<tr><td>Author</td><td>A. Papolis and S. Unnikrishna Pillai</td></tr>
<tr><td>Publisher</td><td>The McGraw-Hill</td></tr>
<tr><td>Edition</td><td>4th Edition, 2002</td></tr>
<tr><td>Content</td><td colspan="2">UNIT I: 03
Introduction: Representations and models for random processes, Probability Spaces, Random variables, distribution and density functions, expectation, conditional probability, Bayes theorem, General Gaussian models.
UNIT II: 03
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.
UNIT III: 05
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.
UNIT IV: 05
Detection of multiple hypotheses: Bayes Criterion, MAP Criterion, M-ary Detection Using Other Criteria, Signal-Space Representations, Performance of M-ary Detection Systems, Sequential Detection of Multiple Hypotheses, Linear models, Rayleigh fading sinusoid.
UNIT V: 04
Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems.
UNIT VI: 04
Properties of estimators: Unbiasedness, efficiency, Criteria for good estimators, Minimum variance unbiased estimation, Cramer-Rao lower bound, asymptotic properties.
UNIT VI: 06
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.
UNIT VII: 06
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.</td></tr>
<tr><td>Course Assessment</td><td colspan="2">Continuous Evaluation 25%
Mid Semester 25%
End Semester 50%</td></tr>
</table>

Course Code: ECLB 373	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		Elective Engineering Course	
Course Title	INFORMATION THEORY AND CODING			
Course Coordinator				
Course objectives:	Understand various error control encoding and decoding techniques			

Course Outcomes		Cognitive Levels
CO1	Perform information theoretic analysis of communication system.	Understanding (Level - II)
CO2	Design a data compression scheme using suitable source coding technique.	Applying (Level – III)
CO3	Design a channel coding scheme for a communication system.	Analyzing (Level - IV)
CO4	Apply error control techniques in communication networks.	Evaluating (Level –V)

Semester	Autumn: Yes		Spring: No		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours 36 Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Information Theory, Coding and Cryptography
	Author	R Bose
	Publisher	TMH
	Edition	2007
2.	Title	Multidedia Communications: Applications, Networks, Prot ocols and Standards
	Author	Fred Halsall
	Publisher	Perason Education Asia
	Edition	2002
3.	Title	Introduction to Data Compression
	Author	K Sayood
	Publisher	Elsevier
	Edition	3/e, 2006

4.	Title	Introduction to Error Control Codes
	Author	S Gravano
	Publisher	Oxford University Press
	Edition	2007
Content	**UNIT I:** **08** 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. **UNIT II:** **06** 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. **UNIT III:** **04** Linear Predictive Coding SOURCE CODING: Image and Video Formats: GIF, TIFF, SIF, CIF, QCIF. **UNIT VI:** **04** Image compression: READ, JPEG, Video Compression: Principles I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard. **UNIT V:** **08** ERROR CONTROL CODING: BLOCK CODES: Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding, Single parity codes, Hamming codes, Repetition codes, Linear block codes, Cyclic codes, Syndrome calculation. **UNIT VI:** **06** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 374	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**COMMUNICATION NETWORKS**			
Course Coordinator				
Course objectives:	To understand the working principle of various communication protocols.			

Course Outcomes		**Cognitive Levels**
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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT II:** **08** 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

	UNIT II: **06** 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). **UNIT II:** **12** 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 networks, WDM systems, and cross connects optical LAN, Optical paths and Networks. **UNIT II:** **10** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 425	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	Y	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**RF COMPONENTS AND CIRCUIT DESIGN**			
Course Coordinator				
Course objectives:	The aim of the course is to provide different operational functioning of RF Circuit.			

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)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **10** 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. **UNIT II: 08** 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 representation, Impedance transformation for general load, Standing wave ratio, Special transformation conditions. Admittance Transformations: Parametric admittance equation, Additional graphical displays. **UNIT III: 05** 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. **UNIT IV: 10** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 426	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	Y	N	N	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	ANALOG AND MIXED SIGNAL IC DESIGN			
Course Coordinator				
Course objectives:	This course is aimed to introduction to Analog IC design and design Flow of Analog ICs. It also aims to understand design of differential Amplifiers, operation Amplifiers and CMOS op amp design.			

Course Outcomes		Cognitive Levels
CO1	To study the basic building blocks of the Analog device.	Remembering (Level-I)
CO2	Differentiate Analog, Digital and Mixed Signal CMOS Integrated Circuits.	Understanding (Level - II)
CO3	To design and analyse the single stage MOS Amplifiers.	Applying (Level - III)
CO4	Study and Design the Operational Amplifiers.	Analyzing (Level-IV)

Semester	Autumn: Yes		Spring: No		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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
Content	**UNIT I:** **12** 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. **UNIT II:** **12** 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. **UNIT III:** **12** 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. **UNIT 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	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 427	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	Y	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**ARCHITECTURAL DESIGN OF ICs**			
Course Coordinator				
Course objectives:	This course covers algorithm, architecture and circuit design trade-offs to optimize for power, performance and area.			

Course Outcomes		**Cognitive Levels**
CO1	To study the basic algorithmic design flow.	**Understanding (Level - II)**
CO2	To analyse the trade-off between algorithm and architecture.	**Applying (Level - III)**
CO3	To synthesise different architectures.	**Analyzing (Level-IV)**
CO4	To apply in the practical design of ASIC & ASISP.	**Evaluating (Level-V)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

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

Content

UNIT I: **08**

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;

	UNIT II: **12** 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. **UNIT III:** **08** 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. **UNIT IV:** **08** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

SPECIALIZATION: MICROPROCESSOR AND VLSI

Course Code: ECLB 325	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**DE Course: (Y/N)**
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**ANALOG VLSI CIRCUITS**			
Course Coordinator				
Course Objectives	To develop the insight of Analog MOS device and amplifiers, their frequency response and stability analysis.			

Course Outcomes		**Cognitive Levels**
CO1	Understanding the MOS Operation and small signal models.	**Understanding (Level-II)**
CO2	To analyze single stage amplifiers with different loads.	**Analyzing (Level-IV)**
CO3	To design single and differential CMOS amplifiers	**Creating (Level-VI)**
CO4	Understanding the role of feedback in amplifier.	**Understanding (Level-II)**

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	Design of Analog CMOS Integrated Circuits
	Author	Behzad Razavi
	Publisher	McGraw Hill Education
	Edition	2000
2.	Title	CMOS Analog Circuit Design
	Author	Phillip Allen and Douglas R. Holberg
	Publisher	OUP USA
	Edition	3rd Edition, 2011

Reference Books		
1.	Title	Operation and Modelling of the MOS Transistor
	Author	Yannis Tsividis
	Publisher	Oxford University Press
	Edition	2nd edition, 2003

Course Contents	**UNIT I:** Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, MOSFET basics, Device Structure and	**9**

	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.	
	UNIT 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**
	UNIT 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 frequency compensation. Frequency Response of Amplifiers: Amplifier transfer function, General Considerations, Miller Effect, Common Source Stage, Source Followers, Common Gate Stage.	**9**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 326	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	Y	Y

Type of Course	Theory Course/ Lab Course
Course Title	**DIGITAL VLSI CIRCUITS**
Course Coordinator	
Course Objectives	To provide the understanding of the VLSI design process and MOS based digital integrated circuits.

Course Outcomes		**Cognitive Levels**
CO1	Interpret the design of digital integrated circuits, MOS fundamentals and analysis of MOSFET based digital circuits.	**Understanding (Level-II)**
CO2	Design and study the MOS inverters and combinational circuits,	**Applying (Level-III)**
CO3	Design the CMOS based sequential circuit, dynamic logic circuits and MOS memories.	**Creating (Level-VI)**
CO4	To understand the VLSI design flow and design styles.	**Understanding (Level-II)**

Semester	**5th**	**Autumn**

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

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	CMOS Digital Integrated Circuits
	Author	Sung-Mo Kang, Yusuf Leblebici
	Publisher	Tata McGraw Hill
	Edition	2014
2.	Title	Digital Integrated Circuits: A Design Perspective
	Author	J.M Rabaey, A. Chandrakasan, B.Nikolic
	Publisher	Pearson
	Edition	2012
Reference Books		
1.	Title	Introduction to VLSI Circuits and Systems
	Author	J. P. Uyemura
	Publisher	Wiley
	Edition	2006

Course Contents	**UNIT 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**
	UNIT 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, Transistor sizing in static CMOS, logical effort, Pass-transistor logic, sizing issues.	**9**
	UNIT 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**
	UNIT IV: VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concepts of Regularity, Modularity and Locality, VLSI Design Styles. CMOS Sub system design: Adders, Multipliers, MOS memories: Introduction, DRAM and SRAM.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative list of Experiments	• Adder circuit • SRAM Cell design • CMOS Circuit design • SPICE simulation	

Course Code: ECLB 375	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**DSP PROCESSORS AND ARCHITECHTURES**			
Course Coordinator				
Course objectives:	To impart the knowledge of basic DSP filters and number systems to be used different types of A/D, D /A conversion errors.			

Course Outcomes		**Cognitive Levels**
CO1	Acquire the knowledge & concepts of digital signal processing techniques.	**Understanding (Level - II)**
CO2	Acquire knowledge of DSP architecture or processor	**Understanding (Level - II)**
CO3	Develop basic DSP algorithms using DSP processors	**Applying (Level – III)**
CO4	Compare various DSP processors and their architecture.	**Evaluating (Level –V)**

Semester	**Autumn:**		**Spring: yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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, 2000
Reference Books:		
3.	Title	Digital Signal Processors, Architecture, Programming and Applications
	Author	B. VenkataRamani and M. Bhaskar
	Publisher	TMH, 2000
	Edition	

Content

UNIT I: **05**

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.

UNIT II: **06**

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. **UNIT III:** **05** 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. **UNIT IV:** **06** Execution Control and Pipelining: Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, Pipeline Programming models. **UNIT V:** **05** 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. **UNIT VI:** **05** 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. **UNIT VII:** **05** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 376	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	N	N	Yes
Type of course	Theory			Elective Engineering Course
Course Title	**REAL TIME EMBEDDED SYSTEMS**			
Course Coordinator				
Course objectives:	To study the architecture and programming of ARM processors and to introduce the basic concepts of hard real time multiprocessing.			

Course Outcomes		**Cognitive Levels**
CO1	Ability to design and develop ARM processor-based systems.	**Understanding (Level - II)**
CO2	Ability to comprehend and appreciate the significance and role of microcontrollers in embedded systems.	**Applying (Level – III)**
CO3	Ability to analyze and demonstrate program design and optimization and proper process scheduling.	**Analyzing (Level - IV)**
CO4	Ability to apply the concept of process, multi-processes and operating systems in embedded system design.	**Evaluating (Level –V)**

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **09** **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. **UNIT II:** **09** **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. **UNIT III:** **09** **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. **UNIT IV:** **09** **PROCESS AND OPERATING SYSTEMS** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 428	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**ADVANCED MICROCONTROLLERS**			
Course Coordinator				
Course objectives:	To introduce the basic concepts of advanced microcontroller, and assembly language programming and to provide extensive knowledge of microcontroller-based systems and interfacing techniques.			

Course Outcomes		**Cognitive Levels**
CO1	Ability to discriminate RISC and CISC processors, and work with PIC microcontrollers	**Understanding (Level - II)**
CO2	Ability to work with the 16-bit microcontroller RL78 and design microcontroller-based systems for a Real-world application.	**Applying (Level - III)**
CO3	Gaining design knowledge and concepts on the MSP430 family of microcontrollers.	**Understanding (Level - II)**
CO4	Ability to design real-time systems by deploying the Interfacing peripherals.	**Analyzing (Level-IV)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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, 2008.
Reference Books:		
1.	Title	MSP 430 Micro controller basics
	Author	John H. Davies
	Publisher	Elsevier, 2008.

Content	**UNIT 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. **UNIT II:** **MSP430 16-BIT MICROCONTROLLER 10** 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 **UNIT 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. **UNIT IV:** **COMMUNICATION INTERFACE USING MSP 430 MICROCONTROLLER 08** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 429	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Elective Engineering Course
Course Title	**ANALOG AND MIXED SIGNAL IC DESIGN**			
Course Coordinator				
Course objectives:	This course is aimed to introduction to Analog IC design and design Flow of Analog ICs. It also aims to understand design of differential Amplifiers, operation Amplifiers and CMOS op amp design.			

Course Outcomes		**Cognitive Levels**
CO1	To study the basic building blocks of the Analog device	**Understanding (Level - II)**
CO2	To analyse the characteristics of distinct devices.	**Applying (Level - III)**
CO3	To design and analyse the behaviour of analog amplifiers.	**Analyzing (Level-IV)**
CO4	To understand the working A/D & D/A Converter and to apply in the practical Mixed signal IC.	**Understanding (Level - II)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **9** 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. **UNIT II:** **9** 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. **UNIT III:** **9** 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. **UNIT-IV:** **9** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 430	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	YES
Type of course				Elective Engineering Course
Course Title	VLSI INTERCONNECTS			
Course Coordinator				
Course objectives:	Introduce students to the basic interconnect parameters and its model. Students will learn Scaling and crosstalk issues of interconnects. They will also learn the repeater design methods and various advanced interconnects technique.			

Course Outcomes		Cognitive Levels
CO1	To understand the basic interconnect parameters and its model.	Understanding (Level - II)
CO2	TO study different scaling issues in interconnects.	Applying (Level - III)
CO3	To analyse theoretical and device level modelling of crosstalk.	Analyzing (Level-IV)
CO4	To learn the repeater design methods and various advanced interconnects technique.	Understanding (Level - II)

Semester	Autumn: NO		Spring: YES		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours 36 Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	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
2.	Title	Interconnection Noise in VLSI Circuits
	Author	F. Moll, M. Roca
	Publisher	Kluwer Academic Publishers
	Edition	

Reference Book:		
1.	Title	Introduction to VLSI Circuits and Systems
	Author	John P. Uymera,
	Publisher	Wiley Student Edition
2.	Title	CMOS Digital Integrated Circuits-Analysis and Design
	Author	S.M. Kang and L. Yusuf
	Publisher	Tata Mc-Graw Hill (TMH)
	Edition	3rd Edition

Content	**UNIT I:** **9** 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. **UNIT II:** **9** 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. **UNIT III:** **9** Repeater Design: Driving Interconnects for Optimum speed and power; Short channel model of CMOS Repeater - Transient Analysis of an RC loaded CMOS repeater, Delay 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. **UNIT IV:** **9** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

SPECIALIZATION: RF AND MICROWAVE ENGINEERING

Course Code: ECLB 327	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**	
	No	No	No	Yes	
Type of Course	Theory			Elective Engineering Course	
Course Title	**TELECOMMUNICATION SWITCHING AND NETWORKS**				
Course Coordinator					
Course objectives:	Students learn about various switching systems, time division switching, traffic management, and signaling in telecommunication systems.				
Course Outcomes					**Cognitive Levels**
CO1	Will be familiar with the basics of switching techniques and signalling.				**Understanding (Level II)**
CO2	Analyze basic telecommunication traffic theory.				**Analyzing (Level IV)**
CO3	Will be able to evaluate of probability of blocking for various switching networks.				**Evaluating (Level V)**
CO4	Apply different protocols to build a perfect communication network				**Analyzing (Level IV)**
Semester	**Autumn:**		**Spring: yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Telecommunication Switching Systems and Networks
	Author	Thiagarajan Viswanathan,
	Publisher	PHI
	Edition	2011
2.	Title	Telecommunication system
	Author	Roger L. Freeman
	Publisher	Prentice Hall
Reference Books:		
3.	Title	Wireless Mobile Communication
	Author	Theodore S. Rappaport
	Publisher	Pearson
	Edition	3rd
4.	Title	RF Circuit Design
	Author	R. Ludwig and P. Bretchko
	Publisher	Pearson
	Edition	2000

Content	**UNIT I:** **05** Basic Switching System, Simple Tele-Phone Communication, Telephone Transmitter, Telephone receiver, Telephone's bell &dialer pulsing mechanism, subscribers telephone sets, dialing types, signaling tones. **UNIT II:** **07** Introduction to Electromagnetic Exchanges, Basic line circuits in telephony and telegraphy; long-haul communication circuits; statistical bandwidth sharing, principles of traffic switching. **UNIT III:** **08** 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. **UNIT IV:** **08** Basic terminologies: BHCA, BHCR, CCR, CCS, CM, Erlang, Grade 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. **UNIT V:** **08** Time Division space switching, Time Division Time Switching, Time multiplexed space switching, Time multiplexed Time Switching, Combination Switching
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 328	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	N	N	Y
Type of Course	Theory			Elective Engineering Course
Course Title	ANTENNA FOR WIRELESS COMMUNICATION SYSTEMS			
Course Coordinator				
Course objectives:	The purpose of the course is to provide a comprehensive coverage of coding techniques for multiple-input, multiple-output (MIMO) communication systems.			

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)

Semester	Autumn: No		Spring: Yes		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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:		
1.	Title	Space-time processing for MIMO communications
	Author	A.B. Gershman and N.D. Sidiropoulus
	Publisher	Wiley, Hoboken
	Edition	2005
Content	**UNIT I:** **05** Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications **UNIT II:** **07** 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. **UNIT III:** **08** Patch antenna, microstrip array. Gain directivity, impedance, polarization and radiation pattern measurements. **UNIT IV:** **08** 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. **UNIT V:** **08** Non-coherent & coherent CDMA spatial processors, spatial processing rake receiver, Multi-user spatial processing, dynamic resectoring, downlink beam forming for CDMA.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 377	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	YES
Type of Course	Theory			Elective Engineering Course
Course Title	**RADIO AND MICROWAVE WIRELESS SYSTEM**			
Course Coordinator				
Course objectives:	To understand the how propagation through Radio waves and microwaves takes place, the system design considerations and the use of radio waves and microwaves in satellite communication.			

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 features of terrestrial communication systems	**Evaluating (Level-V)**

Semester	**Autumn: No**		**Spring: Yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **05** 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 **UNIT II:** **07** 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. **UNIT III:** **08** Propagation phenomena include: diffraction and wave propagation over obstacles; multipath propagation; atmospheric and ionospheric effects. **UNIT IV:** **08** Receiver design aspects include: radio receiver architectures, receiver figures of merit, noise in cascaded systems, noise figure, and noise temperature. **UNIT V:** **08** System examples are: terrestrial communication systems; satellite communications; radar; radiometric receivers; software-defined systems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 431	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**RF INTEGRATED CIRCUITS**			
Course Coordinator				
Course objectives:	This course is aimed to cover basics of RF power amplifiers, oscillator and synthesizer.			

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)**

Semester	**Autumn: yes**		**Spring: No**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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
Content	**UNIT I:** **9** 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	

	UNIT II: **9** 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 **UNIT VI:** **9** RF power amplifiers: Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, design and linearity considerations. **UNIT IV:** **9** Oscillators & synthesizers: Basic topologies, VCO, describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 432	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Elective Engineering Course
Course Title	**MICROWAVE DEVICES AND CIRCUITS**			
Course Coordinator				
Course objectives:	This course is aimed to cover basics of microwaves and circuits. This course also aimed to learn microwave link. It also aims to understand microwave generators tubes and oscillator.			

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)**

Semester	**Autumn: Yes**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **09** 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. **UNIT II:** **09** 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. **UNIT III:** **09** Gunn diode and its modes of operation, Avalanche IMPATT diode, TRAPATT diode, operations and V-I characteristics of Tunnel diode, Schottky diode, Backward diode and Varactor diodes, PIN diode and its applications. **UNIT IV:** **09** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 433	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course				Departmental Elective course
Course Title	**RF AND MICROWAVE NETWORKS**			
Course Coordinator				
Course objectives:	The goal of this course is to introduce students to the advance concepts and principles of the microwave engineering, To Understand Microwave devices, components, their characteristics, their working, and their applications			

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)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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
Reference Books:		

Content	**UNIT I:** **09** 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 **UNIT II:** **09** 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. **UNIT III:** **09** 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. **UNIT IV:** **09** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

SPECIALIZATION: EMBEDDED SYSTEM DESIGN

Course Code: ECLB 329	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**DC Course: (Y/N)**	**DE Course: (Y/N)**
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**LOW POWER DEVICES AND SYSTEMS**			
Course Coordinator				
Course Objectives	To provide the fundamental knowledge of VLSI systems using CMOS technology for low power and high-performance applications			

Course Outcomes		**Cognitive Levels**
CO1	To understand the importance of low power design.	**Understanding (Level-II)**
CO2	To study the various source of power consumption in CMOS circuits.	**Understanding (Level-II)**
CO3	To apply the techniques to reduce the power dissipation in CMOS circuits.	**Applying (Level-III)**
CO4	To analyse the circuit with probabilistic power technique.	**Analyzing (Level-IV)**

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

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

Course Contents	**UNIT 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**

	UNIT 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**
	UNIT III: Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Logic level: Gate 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.	**9**
	UNIT 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**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 378	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
		N	N	Yes
Type of course	Theory			Elective Engineering Course
Course Title	**FPGA BASED PHYSICAL DESIGN**			
Course Coordinator				
Course objectives:	To learn field programmable gate array (FPGA) technologies and utilize associated computer aided design (CAD) tools.			

Course Outcomes	**Cognitive Levels**
CO1	
CO2	
CO3	
CO4	

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Field Programmable Gate Array Technology
	Author	Stephen M. Trimberger
	Publisher	Springer International Edition
2.	Title	Digital Systems Design
	Author	Charles H. Roth Jr, Lizy Kurian John
	Publisher	Cengage Learning
	Edition	2008

Content

UNIT I: **06**

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.

UNIT II: **10**

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.

UNIT III: **10**

SRAM Programmable FPGAs: Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 andXC4000 Architectures.

	UNIT IV: **10** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 434	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	No	Yes
Type of course	Theory			Elective Engineering Course
Course Title	MICRO FABRICATION TECHNOLOGY			
Course Coordinator				
Course objectives:	Students will learn basic fabrication techniques of crystal growth and various IC fabrication steps and procedures. Students will also learn fabrication of various ICs, testing and their packaging.			

Course Outcomes		Cognitive Levels
CO1	Explain different basic fabrication techniques of crystal growth.	Understanding (Level - II)
CO2	Explain the processes of different types of device fabrication.	Understanding (Level - II)
CO3	Design various ICs, testing and their packaging.	Applying (Level - III)
CO4	Evaluate and Apply appropriate IC fabrication process for a given problem.	Analyzing (Level-IV)

Semester	Autumn: YES		Spring: NO		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours 36 Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	VLSI Fabrication Principles
	Author	S.K. Ghandhi
	Publisher	John wiley
2.	Title	VLSI Technology
	Author	S.M. Sze
	Publisher	Tata. MH
3.	Title	Solid State Electronics Devices
	Author	Ben G. Streetman & Sanjay Banerjee
	Publisher	PHI
	Edition	6th Edition
Reference Book:		
1.	Title	Silicon VLSI Technology
	Author	James D. Plummer, Michael D. Deal, Peter B. Griffin

	Publisher	Prentice Hall
Content	**UNIT I:** **08** 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. **UNIT II:** **10** 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. **UNIT III:** **10** 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. **UNIT IV:** **08** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 435	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of Course	Theory			Elective Engineering Course	
Course Title	**EMBEDDED SYSTEM DESIGN**				
Course Coordinator					
Course objectives:	The course will enable the students to understand the basics of an embedded system and program an embedded system. The student will also learn the method of designing an Embedded System for any type of applications and understand operating systems concepts, types and RTOS.				
Course Outcomes				**Cognitive Levels**	
CO1	To model embedded systems with appropriate hardware and software components			**Understanding (Level - II)**	
CO2	To analyse, program and use a typical ARM processor and its peripherals			**Applying (Level - III)**	
CO3	To categorize and classify operating system tasks with special emphasis on real time systems			**Analyzing (Level - IV)**	
CO4	To apply the study of embedded technology to product design			**Analyzing (Level - IV)**	
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	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
Content	**UNIT I:** **09** 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. **UNIT II:** **09** 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. **UNIT III:** **09** Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages. **UNIT IV:** **09** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 436	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
				Yes
Type of course	Theory			Elective Engineering Course
Course Title	**CPLD AND FPGA ARCHITECTURES AND APPLICATIONS**			
Course Coordinator				
Course objectives:	Acquire Knowledge about various architectures and device technologies of PLD's.			

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	To model the digital designs including FSMs to Processor architectures using the knowledge of HDL Language.	**Analyzing (Level - IV)**
CO3	To apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs.	**Evaluating (Level - V)**
CO4	To implement practical and state of the art of Digital VLSI design, suitable for real life and Industry applications.	**Creating (Level – VI)**

Semester	Autumn:		Spring		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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 Book:		
1.	Title	Field Programmable Gate Arrays
	Author	J. Old Field, R. Dorf
	Publisher	John Wiley & Sons
	Edition	New York, 1995
Content	**UNIT I:** **09** 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. **UNIT II:** **09** 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. **UNIT III:** **09** Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures, Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures. **UNIT IV:** **09** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Specialization: Communication and Signal Processing

Course Code: ECLB 330	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**	
	No	No	No	Yes	
Type of course	**Theory**			Elective Engineering Course	
Course Title	**DIGITAL IMAGE PROCESSING**				
Course Coordinator					
Course objectives:	Overview of digital image processing field; understand the fundamental DIP algorithms and implementation; gain experience in applying image processing algorithms to real problems.				
Course Outcomes					**Cognitive Levels**
CO1	To understand the fundamentals Image Processing techniques.				**Understanding (Level-II)**
CO2	To Choose appropriate technique for image enhancement both in spatial and frequency domains.				**Understanding (Level-II)**
CO3	To be familiar with image compression and segmentation.				**Applying (Level - III)**
CO4	To Explore of image processing algorithms for object detection.				**Analyzing (Level - IV)**
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	Digital Image Processing using MATLAB			
	Author	Gonzalez, Woods, Eddins			
	Publisher	Gatesmark Publishing			
	Edition	2nd Edition			
Reference Book:					
1.	Title	Fundamentals of Digital Image Processing			
	Author	Anil K Jain			
	Publisher	PHI Publication			
	Edition	First Edition			

2.	Title	Digital Image Processing
	Author	William K Pratt
	Publisher	Wiley
Content	**UNIT I:** **09** 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. **UNIT II:** **09** 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 degradation function, inverse filtering, Wiener filtering, constrained least squares filtering, geometric transformations. **UNIT III:** **09** 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. **UNIT IV:** **09** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 331	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Elective Engineering Course
Course Title	**NEXT GENERATION NETWORKS**			
Course Coordinator				
Course objectives:	The objective of this course is to familiarize the students to area of next generation networks (NGN) and introduce them to the basic concepts related to NGN such as their architecture, applications, challenges and opportunities.			

Course Outcomes		**Cognitive Levels**
CO1	Demonstrate a comprehensive understanding of emerging network technologies, their applications, advantages, disadvantages, and future potential.	**Analyzing (Level –IV)**
CO2	Evaluate and select appropriate NGN technologies for specific applications, considering associated risks.	**Evaluating (Level –V)**
CO3	Articulate the architecture and technology options for Multi-Service Networks (MSNs).	**Applying (Level – III)**
CO4	Analyze the benefits and limitations of key NGN technologies.	**Analyzing (Level –IV)**

Semester	**Autumn: Yes Sem: VII**		**Spring: NO**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Next generation Telecommunication Networks, Services and Management
	Author	Edited by Thomas Plevyak, VeliSahin
	Publisher	Wiley & IEEE Press Publications
	Edition	2012
2.	Title	Next Generation Network Services.
	Author	Robet Wood.
	Publisher	Pearson Pvt. Ltd
	Edition	3rd Edition
3.	Title	Next Generation Network Services
	Author	Neill Wilkinson
	Publisher	John Wiley Publications
	Edition	2002

<table>
<tr><td colspan="3">Reference Books:</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td>Next Generation Networks</td></tr>
<tr><td>Author</td><td>Monique J. Morrow</td></tr>
<tr><td>Publisher</td><td>CISCO Press</td></tr>
<tr><td>Edition</td><td>2007</td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td>Next Generation Networks: Perspectives and Potentials</td></tr>
<tr><td>Author</td><td>Jingming Li Salina, Pascal Salina</td></tr>
<tr><td>Publisher</td><td>John Wiley Publications</td></tr>
<tr><td>Edition</td><td>2008</td></tr>
<tr><td>Content</td><td colspan="2">UNIT I: 06
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.

UNIT II: 13
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, 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.

UNIT III: 10
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.

UNIT IV: 07
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.</td></tr>
<tr><td>Course Assessment</td><td colspan="2">Continuous Evaluation 25%
Mid Semester 25%
End Semester 50%</td></tr>
</table>

Course Code: ECLB 379	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Elective Engineering Course
Course Title	**STATISTICAL SIGNAL PROCESSING**			
Course Coordinator				
Course objectives:	This course aims to familiarize several algorithms for processing and estimation of random signals. This course teaches filtering methods for stochastic processes and covers the spectral analysis.			

Course Outcomes		**Cognitive Levels**
CO1	Able to remember, understand and apply the theory, the basic methodologies and algorithms of statistical signal processing.	**Applying (Level –III)**
CO2	Masters the most important estimation principles such as minimum variance, maximum likelihood, least squares and minimum mean square error estimators.	**Evaluating (Level –V)**
CO3	Understands the basics of detection and classification theory: hypothesis testing, receiver operating characteristics (ROC), the Neyman-Pearson and Bayesian detectors.	**Understanding (Level – II)**
CO4	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)**

Semester	**Autumn: Yes**		**Spring: NO**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Discrete Random Signals and Statistical Signal Processing,
	Author	Charles W. Therrien
	Publisher	Prentice Hall Signal Processing Series
	Edition	2004
2.	Title	Statistical Digital Signal Processing and Modeling
	Author	M. H. Hayes

	Publisher	John Wiley & Sons, Inc
	Edition	2004
3.	Title	Statistical and Adaptive Signal Processing
	Author	D.G. Manolakis, V.K. Ingle and S.M. Kogon
	Publisher	McGraw Hill,
	Edition	2000
Reference Books:		
1.	Title	Statistical Digital Signal Processing and Modeling
	Author	Monson Hayes
	Publisher	John Wiley & Sons, Inc.,
	Edition	2002
Content	**UNIT I:** **05** 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. **UNIT II:** **07** Parameter Estimation Theory Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased 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. **UNIT III:** **08** 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. **UNIT IV:** **09** 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. **UNIT V:** **07** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 380	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	**Theory**			Elective Engineering Course
Course Title	**MULTIMEDIA COMMUNICATIONS AND SYSTEM**			
Course Coordinator				
Course objectives:	The objective of the paper is to facilitate the student with the idea of how multimedia content is processed the issues in transportation and the use of compression techniques needed wireless free space communications The prerequisites are to have basic understanding of voice, video and data, basic processing techniques.			

Course Outcomes		**Cognitive Levels**
CO1	Understand basics of different multimedia networks and applications.	**Understanding (Level –II)**
CO2	Understand different compression techniques to compress audio and video.	**Understanding (Level –II)**
CO3	Describe multimedia Communication across Networks.	**Applying (Level – III)**
CO4	Analyse different media types to represent them in digital form.	**Analyzing (Level –IV)**
CO5	Compress different types of text and images using different compression techniques.	**Analyzing (Level –IV)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Multimedia Communication Systems
	Author	Rao, Bojkovic, Milovanovic,
	Publisher	PHI Learning Pvt. Ltd.
	Edition	First Edition
2.	Title	Multimedia System Design
	Author	Andleigh, Thakrar
	Publisher	PHI Learning Pvt. Ltd.
	Edition	First Edition

Reference Book:

1.	Title	Multimedia Information Networking
	Author	Sharda
	Publisher	Prentice Hall Inc.

	Edition	First Edition
2.	Title	Multimedia making it work
	Author	Vaughan
	Publisher	Tata Mc Graw Hill
	Edition	First Edition
Content	**UNIT I:** **06** Multimedia Communication: Introduction, Network requirements, multimedia terminals, multimedia Requirement for ATM networks, Multimedia terminals. Audio visual Integration. Audio to visual mapping. **UNIT II:** **10** 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. **UNIT III:** **10** Distributed multimedia systems, Resource management of DMS, IP networking, Multimedia operating systems, distributed multimedia servers, Distributed multimedia applications, Multimedia File Formats. **UNIT IV:** **10** Multimedia communication standards, MPEG-1, MPEG-2, MPEG-4Audio/Video, MPEG-4 Visual Texture coding (VTC), Multimedia communication across networks. Compression Techniques: JPEG, MPEG.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 437	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**SATELLITE COMMUNICATION**			
Course Coordinator				
Course objectives:	To provide the knowledge about satellite communication systems, operation and planning.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the history of satellite communication systems.	**Understanding (Level-II)**
CO2	To analyse the orbital and functional principles of satellite communication systems	**Analysing (Level-IV)**
CO3	To adapt and evaluate a satellite link and suggest enhancements to improve the link performance	**Evaluation (Level-V)**
CO4	To select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.	**Applying (Level-III)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
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

Content	**UNIT I:** **12** 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. **UNIT II:** **06** Earth space propagation effects, Frequency window, Free space loss, Atmospheric absorption, Rainfall Attenuation, Ionospheric scintillation, Telemetry, Tracking and command of satellites. **UNIT III:** **10** Satellite Multiple Access System FDMA techniques, SCPC & CSSB systems, TDMA frame structure, burst structure, frame efficiency, 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. **UNIT IV:** **08** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 438	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**WIRELESS AND ADHOC NETWORKS**			
Course Coordinator				
Course objectives:	To familiarize the fundamentals of end to end and security aspects of Network and MAC layer in modern wireless Adhoc network. To design the protocols of different layers for given QoS.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the challenges and constraints of wireless sensor network and its subsystems	**Understanding (Level-II)**
CO2	To examine the physical layer specification, modulation and transceiver design considerations	**Analyzing (Level-IV)**
CO3	To adapt and analyse the protocols used at the MAC layer and scheduling mechanisms	**Application/Analysis (Level-III/Level-IV)**
CO4	To evaluate and synthesize the application areas and practical implementation issues.	**Evaluation/Synthesis (Level-V/Level-VI)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **06** Introduction to adhoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models. **UNIT II:** **09** 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. **UNIT III:** **09** 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. **UNIT IV:** **09** 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. **UNIT V:** **09** Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary prespective. Integration of adhoc with Mobile IP networks.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 439	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	**Theory**			Elective Engineering Course
Course Title	**OPTICAL SIGNAL PROCESSING**			
Course Coordinator				
Course objectives:	To introduce the basic principles required for the understanding of optical signal processing techniques.			

Course Outcomes		**Cognitive Levels**
CO1	Understand basic concepts of light propagation, spatial frequency and Spectral analysis.	**Remembering (Level-I)**
CO2	To study and design different domain filtering techniques.	**Understanding (Level - II)**
CO3	Apply the transform domain approach for study of light behaviours.	**Applying (Level –III)**
CO4	Ability to develop optical filters, modulators and detectors for various applications of light processing	**Analyzing (Level –IV)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **05** 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. **UNIT II:** **07** 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. **UNIT III:** **08** 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. **UNIT IV:** **16** Binary spatial filters: Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometry 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 440	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**ERROR CONTROL CODING**			
Course Coordinator				
Course objectives:	In order to transfer data without error from source to destination, focus must be made on coding. This syllabus is highly intended to emphasize bulk and burst error-correcting codes.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the fundamental limits on the error free representation of information signals and the transmission of such signals over a noisy communication channel.	**Understanding (Level - II)**
CO2	To design and analyse lossless data compression techniques with varying efficiencies as per problem requirements.	**Applying (Level - III)/Analyzing (Level - IV)**
CO3	To investigate the mathematical tools for source coding and error correction coding and design error correction codes.	**Evaluating (Level – V)**
CO4	To design various decoding strategies for block and convolutional codes.	**Creating (Level –VI)**

Semester	**Autumn: Yes**		**Spring: Yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Error Control Coding
	Author	Shu Lin & D.J. Costello
	Publisher	PHI, 2004.
	Edition	2rd edition
Reference Books:		
1.	Title	Application of Error Control
	Author	Shu Lin
	Publisher	PHI
	Edition	1974 edition
2.	Title	Digital Communication
	Author	Simon Haykin
	Publisher	John Wiley and Sons
	Edition	1988
Content	**UNIT I:** **06** Basics of vector algebra Galois Filed arithmetic in detail, Implementation of Galois Field Arithmetic.	

	UNIT II: **08** BCH Codes, Decoding of BCH Codes, implementation of error correction, Non binary BCH and Recd-Solomon Codes, error detection of binary BCH codes. **UNIT III:** **08** Burst error correcting codes, decoding of single burst error correcting cyclic codes, Fire code interleaved codes, phased burst error correcting codes, Concatenated codes. **UNIT IV:** **14** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 441	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**DIGITAL COMMUNICATION TECHNIQUES**			
Course Coordinator				
Course objectives:	To learn the advanced digital communication standards and techniques.			

Course Outcomes		**Cognitive Levels**
CO1	To comprehend the development of communication systems	**Remembering/Understanding (Level-I/Level-II)**
CO2	To apply the matched filter concept and find signal-to-noise ratio.	**Application (Level-III)**
CO3	To study and analyse different digital modulation techniques, should analyse and propose solutions for different real time communication problems.	**Analysis (Level-IV)**
CO4	To analyse and investigate different source coding and channel coding techniques should analyse real time digital communication problems.	**Evaluation (Level-V)**

Semester	**Autumn: NO**		**Spring: YES**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Digital communication techniques
	Author	M.K. Simon, S.M. Hinedi and W.C. Lindsey
	Publisher	Prentice Hall India, New Delhi, 1995
2.	Title	Digital communications
	Author	Simon Haykin
	Publisher	John Wiley and sons, 1998
Reference Books:		
3.	Title	Modern Digital Communication Technique – Fundamental & Applications
	Author	Bernard Skler
	Publisher	Prentice Hall, 2001 edition, ISBN – 0130847881
4.	Title	Digital Communications
	Author	Ian Glover & Peter Grant
	Publisher	Prentice Hall 2003 edition
Content	**UNIT I:** **08** Power spectrum and communication over memoryless channel: PSD of a synchronous data pulse stream; M-ary Markov source; Convolutionaly coded modulation; Continuous phase modulation – Scalar and vector communication	

	over memoryless channel – Detection criteria. **UNIT II:** **08** Coherenet 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. **UNIT III:** **12** Band-limitted Channels and Digital Modulation: Eye pattern; demodulation in the presence of ISI and AWGN; Equalization 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. **UNIT IV:** **08** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECLB 453	**Bio-Medical Electronics**	3	0	0	3	**36**
Pre-Requisite Courses:	Electronic Measurement and Instrumentation					
Course Objective	To provide students with a comprehensive understanding of human physiology, bioelectric signals, biomedical instruments, and the techniques for measuring biological parameters, while also equipping them with knowledge about patient monitoring systems for effective healthcare applications.					
Course Outcomes					**Cognitive Levels**	
CO1	Explain the principles of human physiology, bioelectric signals, and the basic components of biomedical instruments.				Understanding (Level II)	
CO2	Analyze the bioelectric potentials and their measurement using electrodes in the cardiovascular system.				Analyzing (Level IV)	
CO3	Apply techniques for measuring biological parameters, including blood pressure, heart sounds, temperature, and bioelectric signals like ECG, EEG, and EMG.				Applying (Level III)	
CO4	Evaluate the design and functionality of patient monitoring systems, including intensive care and remote monitoring systems.				Evaluating (Level V)	
Course Content	**Unit I:** **09** **Human Physiology and Basics:** Introduction to human physiology, Basic components of Biomedical instruments, bioelectric signals. **Unit II:** **09** **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 **Unit III:** **09** **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. **Unit IV:** **09** **Patient Monitoring System:** The Elements of Intensive Care Monitoring system, Remote monitoring through telephone, internet, satellite link,					
Books	**Name of Text Books:** 1. Biomedical Instrumentation & Measurement by L. Cromwell, F.J. Weibell and E.A. Pfeiffer, 2nd Ed., PHI. 2. 2. Principles of Medical Electronics & Biomedical Instrumentation, C Raja Rao & S.K Guha, University Press. **Name of 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					
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%					

Specialization: Antenna Theory

Course Code: ECLB 332	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	Yes
Type of Course	Theory			Elective Engineering Course
Course Title	**RF INTEGRATED CIRCUITS**			
Course Coordinator				
Course objectives:	To provide in-depth understanding of the analog integrated circuit and building blocks and a basic idea on mixed signal IC design.			

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)**

Semester	**Autumn: yes**		**Spring: No**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	**UNIT I:** **05** 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. **UNIT II:** **10** 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. **UNIT III:** **05** Mixers: Nonlinear systems as linear mixers, multiplier-based mixers, subsampling mixers, diode-ring mixers. **UNIT VI:** **08** RF power amplifiers: Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, design and linearity considerations. **UNIT IV:** **08** Oscillators & synthesizers: Basic topologies, VCO, describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 381	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	No	Yes	
Type of course	Theory			Elective Engineering Course	
Course Title	**RADAR SIGNAL PROCESSING**				
Course Coordinator					
Course objectives:	To do the Performance evaluation of radar system and perform Simulation of radar target signal, clutter for analysing a system and study effectiveness of a radar system in terms of its detection and estimation accuracy. .				
Course Outcomes					**Cognitive Levels**
CO1	Able to Learn advanced signal processing technics for Radar applications.				**Understanding (Level - II)**
CO2	Able to learn different signal models in radar.				**Understanding (Level – II)**
CO3	Able to Analyze the pulse compression concept and doppler processing.				**Analyzing (Level - IV)**
CO4	Able to evaluate the data received from radar and learn beam forming and space time processing.				**Evaluating (Level – V)**
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	Rader Adaptive signal processing			
	Author	I. Haykin, Simon S			
	Publisher	John Wiley & Sons			
2.	Title	Fundamentals of Radar signal processing			
	Author	Mark A Richards			
	Publisher	M C Graw Hill			
Reference Book:					
1.	Title	Radar Principles			
	Author	Peyton Z. Peebles			
	Publisher	Wiley			
2.	Title	Radar Principles			
	Author	Nadav Levanon			
	Publisher	Wiley			

Content	**UNIT I:** **05** 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. **UNIT II:** **07** The Radar System, the radar range equation, scattering and RCS, RCS models, propagation, antennas, receivers, noise figure. **UNIT III:** **08** Radar Signal Processing Fundamentals, detection and likelihood ratio, binary detection, matched filtering, radar ambiguity functions, pulse compression and radar waveforms, radar resolution. **UNIT IV:** **08** 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. **UNIT V:** **08** Applications of Radar Signal Processing: Pulse-Doppler radar, CFAR detection, synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), moving target indication (MTI), displaced-phase-center-antenna technique (DPCA), adaptive radar, super resolution (MUSIC), space-time adaptive processing (STAP).
Curse Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 382	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory			Elective Engineering Course
Course Title	**MILLIMETER WAVE TECHNOLOGY**			
Course Coordinator				
Course objectives:	To train the students the different millimetre wave transceivers architectures and illustrate their operation principle and to provide the design consideration of millimetre waves systems.			

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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Microwave, Millimeter wave and sub-millimeter wave vacuum electron devices
	Author	RajeshwariChatterji
	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

Content	**UNIT I:** **06** 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. **UNIT II:** **06** Klystron – velocity modulation and bunching, Travelling wave tube – slow wave structure and Brillouin diagram. Maser – population inversion, pumping and stimulated emission. **UNIT III:** **06** 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. **UNIT IV:** **06** Reflex klystron, magnetron, Gunn diode, IMPATT and TRAPPAT diodes, parametric oscillators – Principle and analysis of oscillator configurations, efficiency, tunability.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 442	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**ANTENNA THEORY AND DESIGN**			
Course Coordinator				
Course objectives:	To study the various types of antennas and their applications.			

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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

4.	Title	Antennas and Microwave propagation
	Author	R. E. Collin
	Publisher	Tata Mc-Graw Hill
	Edition	2004
5.	Title	Antenna Engineering hand book
	Author	R. C. Johnson and H. Jasik
	Publisher	Mc-Graw Hill
	Edition	1984
Content	**UNIT I:** **09** 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. **UNIT II:** **09** 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. **UNIT III:** **09** 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 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. **UNIT IV:** **09** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 443	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
		No	No	Yes
Type of course				Elective Engineering Course
Course Title	**MODERN RADAR AND AVIONICS SYSTEM**			
Course Coordinator				
Course objectives:	This course covers the basics of Navigation, Guidance, and Control used in aerospace systems. To understand basic avionic systems and aerospace systems and how navigation is done by the global positioning system.			

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)**

Semester	**Autumn:**		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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:		
1.	Title	The Avionics Handbook
	Author	Cary R. Spitzer
	Publisher	CRC Press
	Edition	2000
2.	Title	Introduction to Avionics
	Author	Collinson R. P. G
	Publisher	Chapman and Hall
	Edition	1996
Content	**UNIT I:** **06** 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. **UNIT II:** **06** Guided missiles; Classifications; Description of tactical missiles. Guidance phases during flight; Categories of Homing and command guidance. The kinematic equations. **UNIT III:** **12** 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 requirements, Avionics system architectures. **UNIT IV:** **12** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 444	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory		**Elective Engineering Course**	
Course Title	**RADAR ENGINEERING**			
Course Coordinator				
Course objectives:	To provide an understanding of the basic concepts, operation, and applications of modern radar systems.			

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)**

Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 36 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

4.	Title	Introduction to radar systems
	Author	Skolnik
	Publisher	McGraw hill
	Edition	2nd Edition 2003
Content	**UNIT I:** **07** 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. **UNIT II:** **10** 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. **UNIT III:** **09** 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. **UNIT IV:** **10** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Specialization: Machine Learning and Internet-on-Things

Course Code: ECLB 333	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**	
	No	No	No	Yes	
Type of course	**Theory**			Elective Engineering Course	
Course Title	**WAVELET TRANSFORMS**				
Course Coordinator					
Course objectives:	The objective of this course is to establish the theory necessary to understand and use wavelets and related constructions				
Course Outcomes					**Cognitive Levels**
CO1	Acquire the basic concepts, theory, and algorithms behind wavelet transform.				**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)**
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
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 Book:		
1.	Title	Introduction to Wavelets and Wavelet Transform,
	Author	C. S. Burrus, Ramose and A. Gopinath,
	Publisher	Prentice Hall Inc.
	Edition	First Edition
Content	**UNIT I:** **05** 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. **UNIT II:** **07** 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. **UNIT III:** **08** 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. **UNIT IV:** **08** 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. **UNIT V:** **08** Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, **Condition-1:** Unit area under scaling function, **Condition-2:** Orthonormality of translates of scaling functions, **Condition-3:** Orthonormality of scaling and wavelet functions, **Condition-4:** Approximation conditions (Smoothness conditions), Designing Daubechies orthogonal wavelet system coefficients, Constraints for Daubechies' 6 tap scaling function.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 383	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
				Yes
Type of course	**Theory**			**Elective Engineering Course**
Course Title	**PATTERN RECOGNITION AND MACHINE LEARNING**			
Course Coordinator				
Course objectives:	The main objective of this course is to enabling the student with basic knowledge on the techniques to build an intellectual machine for making decisions behalf of humans.			

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)**

Semester	**Autumn: Yes**		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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 Book:		
1.	**Title**	Machine Learning for Big Data
	Author	Jason Bell
	Publisher	John Wiley and Sons
	Edition	2015
Contents	**UNIT I:** **06** 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. **UNIT II:** **10** Discriminant Learning: Non-parametric learning, perceptrons, neural networks, support vector machines. Feature Extraction: feature normalization, KL expansion, principal component analysis, discriminant analysis. **UNIT III:** **10** 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. **UNIT IV:** **10** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 384	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	YES
Type of Course	Theory			Elective Engineering Course
Course Title	**SIGNATURE ANALYSIS AND RADAR IMAGING**			
Course Coordinator				
Course objectives:	To objective of this course is to study the working of radar and processing of the data collected by the radar.			

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)**

Semester	**Autumn: yes**		**Spring: Yes**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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:		
3.	Title	Radar Signal Principles
	Author	Nathanson
	Publisher	Mcgraw hill publications
	Edition	1964

Content	**UNIT I:** **05** 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.

	UNIT II: **07** 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. **UNIT III:** **08** 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. **UNIT IV:** **08** 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. **UNIT V:** **08** 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 alarm probability, cell averaging cfar, the effect of varying pfa, analysis of cell averaging cfar, ca cfar limitations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 445	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
		Yes	Yes	YES
Type of course	Theory			Elective Engineering Course
Course Title	**EMBEDDED REAL TIME OPERATING SYSTEMS**			
Course Coordinator				
Course objectives:	Introduction to Embedded System, design and applications.			

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)**

Semester	**Autumn:**		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Contents	**UNIT I:** **06** Real life examples of Embedded system, Basics of Developing for Embedded system, Embedded system Initialization.

	UNIT II: **09** 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. **UNIT III:** **09** 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. **UNIT IV:** **12** Memory management, Dynamic Memory Allocation in Embedded 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 446	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Elective Engineering Course
Course Title	**NEURAL NETWORKS**			
Course Coordinator				
Course objectives:	To understand the fundamentals of neural network and learning.			

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)**

Semester	**Autumn: NO**		**Spring: Yes SEM VIII**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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
Content	**UNIT I:** **06** 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. **UNIT II:** **08** 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. **UNIT III:** **10** Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection, BACK PROPAGATION - back propagation and differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, Accelerated convergence, supervised learning. **UNIT IV:** **12** 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.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

List of Open Electives to be offered to Other Departments

Course Code	**ECLB 387**	**Semester: Even (Specify Odd/Even)**	**Semester: Session: Month from:**
Course Name	**INTRODUCTION TO NANO SCIENCE AND NANO TECHNOLOGY**		
Credits	**3**	**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		
Course Objectives	To focus on the nanoscale properties and to give an overview of the exciting advancement in this area.		

Course Outcomes		**Cognitive Levels**
CO1	Understanding of the basic science behind the properties of materials at the nanometre scale	**Understanding (Level - II)**
CO2	To Analyze several important nanoscale materials for chemical engineering applications.	**Analyzing (Level - IV)**
CO3	Understanding of the differences between the properties of micro and nano levels.	**Understanding (Level - II)**
CO4	To Analyze the characterization techniques of nanoscale materials.	**Analyzing (Level - IV)**

Module No.	**Title of the Module**	**List of Topics**
Unit 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.
Unit 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.
Unit III	Application of Nanomaterial	Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application.
Unit IV	Recent special nanomaterials	Carbon based nanomaterials – CNT- graphene- core-shell structures- Micro and Mesopores Materials- Organic-Inorganic Hybrids- ZnO- Silicon -- DNA- RNA-Nanoproducts
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25%	

	End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to the laboratory for overall grading
Recommended Reading material:	
1.	Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2.	Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3.	Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4.	Processing & properties of structural naonmaterials - Leon L. Shaw, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

Course Code: ECLB 388	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	**N**	**N**	**Yes**
Type of Course	Theory			Open Elective Engineering Course
Course Title	**GROWTH, FABRICATION AND MANUFACTURING OF ELECTRONIC DEVICES**			
Course Coordinator				
Course objectives:	To have fundamental knowledge about structure of devices, VI characteristics of devices like PN Junction diode, Zener diode, MOSFET, BJT and Opto electronic.			

Course Outcomes		**Cognitive Levels**
CO1	To Understand crystal structures of elements used for fabrication of semiconductor Devices and study energy band structure.	**Understanding (Level - II)**
CO2	To Analyze fermi levels, movement of charge carriers, Diffusion current and Drift current.	**Analyzing (Level – IV)**
CO3	To Evaluate the behaviour of semiconductor junction under different biasing Conditions. Fabrication of different semiconductor devices, Varactor diode, Zener diode, Schottky diode, BJT, MOSFET, etc.	**Evaluate (Level - V)**
CO4	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.	**Understanding (Level - II)**

Semester	**Autumn: NO**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Load**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Solid State Electronic Devices
	Author	Ben. G. Streetman &Sanjan Banerjee
	Publisher	PHI Private Ltd
	Edition	5th Edition, 2003
2.	Title	Operation & Mode line of The MOS Transistor
	Author	YannisTsividis
	Publisher	Oxford University Press
	Edition	2nd Edition, 1999

3.	Title	Semiconductor Devices Modeling a Technology	
	Author	Nandita Das Gupta &Aamitava Das Gupta	
	Publisher	PHI Private Ltd	
	Edition	2004	
Content	**UNIT 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**
	UNIT 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**
	UNIT III: Assembly Techniques & Packaging of VLSI Devices: Introduction to packaging, Package design considerations, VLSI Assembly techniques, Packaging fabrication technology. Surface Mount Technology (SMT): Through hole technology, Surface Mount Technology, applications & SM Components.		**9**
	UNIT IV: Special Techniques for Modern Processes: Self-aligned silicides, hallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.		**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECLB 389	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	N	N	Yes
Type of Course	Theory			Open Elective Engineering Course
Course Title	NEURAL NETWORKS AND FUZZY LOGIC			
Course Coordinator				
Course objectives:	The main objective of this course is to provide the student with the basic understanding of neural networks and fuzzy logic fundamentals, Program the related algorithms and design the required and related systems			

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)

Semester	Autumn: NO		Spring: Yes		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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

Content	UNIT I:	05
	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. **UNIT II:** **05** 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. **UNIT III:** **09** Single Layer Feed Forward Neural Networks Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications. **UNIT IV:** **08** 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. **UNIT V**: **09** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 390		Semester: Even (Specify Odd/Even)	Semester: Session Month from:
Course Name	**ELECTRONIC MATERIALS AND THEIR APPLICATIONS**		
Credits	**3**	**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)		
Course Objectives	Understanding the various materials and its properties of contribution towards electrical and electronic field.		

Course Outcomes		**Cognitive Levels**
CO1	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)**
CO2	To Understand the difference between electronic structures and physical properties of semiconductors, metals, and dielectrics.	**Understanding (Level - II)**
CO3	To analyze the electronic and optical transport characteristics of semiconductors and to understand the Understand the physics behind solid state electronics and optoelectronic devices.	**Analyzing (Level-IV)**
CO4	To apply the basic design of major microelectronic and optoelectronic devices, their features, and limitations.	**Applying (Level - III)**

Module No.	**Title of the Module**	**List of Topics**
Unit 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.
Unit 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.
Unit III	Semiconducting and magnetic materials	Semiconductors: Introduction, types of semiconductors, temperature dependence of semiconductors, compound semiconductors, basic ideas of amorphous and organic semiconductors. Magnetic Materials: classification of magnetic materials, ferromagnetism-B-H curve (Qualitative), hard and soft magnetic materials, magneto materials applications.
Unit IV	Dielectric and insulating materials	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.

Unit V	Optoelectronic and nano electronic materials	Optoelectronic materials. Introduction, properties, factor affecting optical properties, role of optoelectronic materials in LEDs, LASERs, photodetectors, solar cells. Nano electronic Materials: Introduction, advantage of nanoelectronic devices, materials, fabrication, challenges in Nano electronic materials.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Recommended Reading material:		
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.	
3.	B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th edition, PHI Learning, 2009.	
4.	Eugene A. Irene, Electronic Materials Science, Wiley, 2005	

Course Code: ECLB 391	Open course (YES/NO)	HM Course (Y/N)	DC(Y/N)	DE(Y/N)
	NO	NO	NO	NO
Type of Course	Elective			
Course Title Code	**OPTIMIZATION TECHNIQUES**			
Course Coordinator				
Course objectives:	To cover the concepts of optimization methods and algorithms developed for solving various types of optimizations**.**			

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)**

Semester	**Autumn:**	**Spring:**

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3			3	**32**
Prerequisite course code as per proposed course numbers	NIL				
Pre requisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per	NIL				

Proposed course numbers					

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
Content	**Unit I:** **05** Preliminaries: Vector Spaces and Matrices, Linear Transformations, Eigenvalues and Eigenvectors, Orthogonal Projections, Quadratic Forms, Matrix Norms, Concepts from Geometry, Elements of Calculus. **Unit II:** **07** 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 **Unit III:** **08** Linear Programming: Introduction to Linear Programming, Simplex Method, Duality **Unit IV:** **08** Nonlinear Constrained Optimization: Problems with Equality Constraints, Problems with Inequality Constraints, Karush Kuhn Tucker Condition, Convex problems Optimization **Unit V:** **08** Algorithms for Constrained Optimization: Projections, Project gradient methods, Penalty methods.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECLB 448	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	N	N	Yes
Type of Course	Theory			Open Elective Engineering Course
Course Title	GREEN TECHNOLOGIES			
Course Coordinator				
Course objectives:	To understand the Green technologies and their applications.			

Course Outcomes		Cognitive Levels
CO1	Understand basic concepts of green technology.	Remembering (Level-I)
CO2	Explain the different types of wastes and minimization techniques.	Understanding (Level - II)
CO3	Specific understanding of Green reagents and solvents.	Applying (Level –III)
CO4	Correlate the greener approach to industrial application and effect of green house.	Analyzing (Level –IV)

Semester	Autumn: NO		Spring: Yes		
	Lecture	Tutorial	Practical	Credits	Total Teaching Load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Green Chemistry: Environmentally Benign
	Author	V. K. Ahluwalia
	Publisher	Ane Books India, New Delhi
	Edition	2006
2.	Title	Green chemistry: Environment Friendly Alternatives
	Author	ReactionsRashmiSanghi and M M Srivastava
	Publisher	Narosa Publishing House
	Edition	

Content	
	UNIT I: **07** 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.

	UNIT II: **08** 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. **UNIT III:** **08** Green reagents and solvents: Green oxidation reaction, photochemical reaction, microwave, ultrasound assisted reactions, green reagents and solvents. **UNIT IV:** **13** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 449	Open course (YES/NO)	HM Course (Y/N)	DC(Y/N)	DE(Y/N)
Type of Course	Theory and Laboratory			
Course Title	**MACHINE LEARNING AND PATTERN RECOGNITION**			
Course Coordinator				
Course objectives:	The aim of this course is to learn distinct machine learning and pattern recognition algorithms.			

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)**

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per	NIL				
Proposed course numbers					

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	Machine Learning: An Algorithmic Perspective
	Author	Stephen Marsland
	Publisher	CRC Press
	Edition	2009
2.	Title	Pattern Classification, 2nd edt.
	Author	R. O. Duda, P. E. Hart and D. G. Stork
	Publisher	Wiley India
	Edition	2007

Content

Unit I: **06**

Basic definition: Machine Learning, Pattern, and Pattern Recognition. Feature vector and Feature space, Features of pattern recognition, Classifier and Decision Boundry, Phases of pattern recognition, its advantage and disadvantage, Design Principles of Pattern Recognition: Statistical and Structural approach. Feature Extraction: different shape and region based methods, Overfitting and Under- fitting.

Unit II: **12**

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.

Unit III: **12**

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 Neighbour Learning. Clustering approach: K-means, GMM. REINFORCEMENT LEARNING– Introduction to Reinforcement Learning , Learning Task, Example of Reinforcement Learning in Practice, Learning Models for Reinforcement – (Markov Decision

	process, Q Learning - Q Learning function, Q Learning Algorithm), Application of Reinforcement Learning, Introduction to Deep Q Learning. Bootstrapping, Boosting, Bagging and Combining Classifiers. **Unit IV**: **06** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECLB 450	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	**Elective Course**			
Course Title	**WIREIRELESS COMMUNICATION AND SENSOR NETWORKS**			
Course Coordinator				
Course objectives:	To make students understand the concept of Wireless sensor Networks			

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/Understandin g ng (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/Synthesis (Level-V/Level-VI)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 48 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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	Waltenegus Dargie, Christian Poellabauer
	Publisher	John Wiley & Sons Publications
	Edition	5th Edition, 2011
3.	Title	Wireless Sensor Networks-Technology, Protocols, and Applications
	Author	Kazem Sohraby, Daniel Minoli, &TaiebZnati,
	Publisher	John Wiley
	Edition	5th Edition, 2007
Content	**UNIT – I:** **08** Single Node Architecture Hardware Components Network Characteristics unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks Types of wireless sensor networks. **UNIT – II:** **08** 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. **UNIT – III:** **08** 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. **UNIT – IV:** **12** 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.	
Course Assessment	Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%	

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

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

Course Code: ECLB 451	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	No	No	Yes	No
Type of course	**Elective Course**			
Course Name	**DATA COMMUNICATION AND NETWORKING**			
Credits	3	**Contact Hours**	36	
Faculty (Names)	**Coordinator(s)**			
	Teacher(s) (Alphabetically)			

Course Code: ECLB 451	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	**Core Engineering Course**			
Course Coordinator				
Course objectives:	To build a strong understanding of the fundamental concepts of computer networking.			

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)**

Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 48 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisi					

te					
credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

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.

Content	**UNIT I: 08** Introduction to data communication and networking: Why study data communication? Data Communication, Networks, Protocols 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) **UNIT II: 08** 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. **UNIT III: 08** 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. **UNIT IV: 12** **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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

ECLB 452	Open Course (Yes/No)	HM Course (Yes/No)	DC (Y/N)	DE (Y/N)	
Type of Course	Theory				
Course Title	**MICROELECTRONICS AND VLSI TECHNOLOGY**				
Course Coordinator					
Course Objectives:	To understand the process techniques for IC fabrication.				

Course Outcomes		**Cognitive Levels**
CO1	To understand the clean room technology and basic fabrication process flow of semiconductor devices.	**Understanding (Level-II)**
CO2	To implement digital circuits such as CMOS inverter, Pseudo NMOS, DCVS, Domino etc.	**Application (Level-III)**
CO3	To design the layout and stick diagram of various logic gates.	**Application/Analysis (Level-III/Level-IV)**
CO4	To evaluate the static and dynamic switching characteristics of CMOS inverter.	**Evaluation (Level-V)**

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	VLSI Technology
	Author	S M Sze
	Publisher	McGrawHill
	Edition	2nd Edition
2.	Title	Modern VLSI Design Systems on Silicon
	Author	Wayne Wolf
	Publisher	Pearson Education Asia
	Edition	2nd Edition
3.	Title	CMOS Digital Integrated circuits- Analysis and design
	Author	Sung- Mo Kang and Yusuf Leblenici
	Publisher	McGrawHill
	Edition	2nd Edition
4.	Title	Digital Integreted Circuits-(A design perspective)
	Author	Jan M. Rabaey
	Publisher	P.M.I
	Edition	2nd Edition
Contents	**Unit I** **10** 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 temperature, Epitaxy of silicon, selective epitaxial growth of Si, Characterization of epitaxial films.
	Unit II **9** 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.
	Unit III: **8** 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.
	Unit IV **9** 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.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%